Joint Collaborative Team on Video Coding (JCT-VC)
of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11
6th Meeting: Torino, IT, 14–22 July 2011

Document: JCTVC-F800

Title:	**Meeting report of the sixth meeting of the Joint Collaborative Team on Video Coding (JCT-VC), Torino, IT, 14–22 July 2011**
Status:	Report Document from Chairs of JCT-VC
Purpose:	Report

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Source: Chairs

Summary

The Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T WP3/16 and ISO/IEC JTC 1/SC 29/WG 11 held its sixth meeting during 14–22 July 2011 at the Polytecnico di Torino, Torino (Turin), IT. 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 2.11 of this document.

The JCT-VC meeting sessions began at approximately 0900 hours on Thursday 14 July 2011. Meeting sessions were held on all days (including weekend days) until the meeting was closed at approximately 1315 hours on Friday 22 July. Approximately 254 people attended the JCT-VC meeting, and approximately 700 input documents were discussed. The meeting took place in a collocated fashion with a meeting of WG 11 – one of the two parent bodies of the JCT-VC. The subject matter of the JCT-VC meeting activities consisted of work on the new next-generation video coding standardization project 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 fifth JCT-VC meeting in implementing the 3rd HEVC Test Model (HM3) and editing the 3rd HEVC specification Working Draft (WD3), 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 4 (HM4), the HEVC specification Working Draft 4 (WD4), and a document specifying common conditions and software reference configurations for HEVC coding experiments. Moreover, 13 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 21–30 November 2011 under ITU-T auspices in Geneva, CH, 1–10 February 2012 under WG 11 auspices in San José, USA, 2–9 May 2012 under ITU-T auspices in Geneva, CH, and 11–20 July 2012 under WG 11 auspices in Stockholm,SE.

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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 sixth meeting during 14–22 July 2011 at the Polytecnico di Torino, Torino (Turin), IT. The JCT-VC meeting was held under the chairmanship of Dr. Gary Sullivan (Microsoft/USA) and Dr. Jens-Rainer Ohm (RWTH Aachen/Germany).

2 Meeting logistics

The JCT-VC meeting sessions began at approximately 0900 hours on Wednesday 14 July 2011. Meeting sessions were held on all days (including weekend days) until the meeting was closed at approximately 1315 hours on Friday 22 July. Approximately 254 people attended the JCT-VC meeting, and approximately 700 input documents were discussed. The meeting took place in a collocated fashion with a meeting of WG 11 – one of the two parent bodies of the JCT-VC. The subject matter of the JCT-VC meeting activities consisted of work on the new next-generation video coding standardization project 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

Information regarding logistics arrangements for the meeting had been provided at http://www.mpeg97.org/uk/default.asp.

2.1 Primary goals

The primary goals of the meeting were to review the work that was performed in the interim period since the fifth JCT-VC meeting in producing the 3rd HEVC Test Model (HM) software and editing the 3rd HEVC specification Working Draft (WD3), review the results from interim Core Experiments (CEs), review technical input documents, and establish fourth versions of the Working Draft (WD4) and HEVC Test Model (HM4).

2.2 Documents and document handling considerations

2.2.1 General

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

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

Document registration and upload times and dates listed in Annex A and in headings for documents in this report are in Paris/Geneva time. Dates mentioned for purposes of describing events at the meeting (rather than as contribution registration and upload times) follow the local time at the meeting facility.

Decisions made by the group that affect the normative content of the draft standard are identified in this report by prefixing the description of the decision with the string "Decision:".

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.

2.2.2 Late and incomplete document considerations

The formal deadline for registering and uploading non-administrative contributions had been announced as Friday, 1 July 2011.

Non-administrative documents uploaded after 2359 hours in Paris/Geneva time Sunday July 3 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.

The following documents that did not arrive until the last two days of the meeting were not presented or discussed due to time constraints: JCTVC-F544, JCTVC-F766, JCTVC-F768, JCTVC-F770, JCTVC-F772, JCTVC-F773.

All contribution documents with registration numbers JCTVC-F626 to JCTVC-F774 were registered after the "officially late" deadline (and therefore were also uploaded late). Some documents in this range include break-out activity reports that were generated during the meeting and are therefore considered report documents rather than late contributions.

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

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

- JCTVC-F092 (a technical proposal) [uploaded 07-05]
- JCTVC-F292 (a technical proposal) [uploaded 07-07]
- JCTVC-F377 (a technical proposal) [uploaded 07-07]
- JCTVC-F406 (a technical proposal) [uploaded 07-12]
- JCTVC-F418 (a technical proposal) [uploaded 07-08]
- JCTVC-F487 (a technical proposal) [uploaded 07-11]
- JCTVC-F544 (a technical proposal) [uploaded 07-20]

The following other document not proposing normative technical content was registered in time but uploaded late:

- JCTVC-F228 (a study on screen content test sequences)

The following cross-verification reports were uploaded late: JCTVC-F074, JCTVC-F079. JCTVC-F117, JCTVC-F127, JCTVC-F137, JCTVC-F154, JCTVC-F163, JCTVC-F170, JCTVC-F180, JCTVC-F181, JCTVC-F206, JCTVC-F207, JCTVC-F209, JCTVC-F210, JCTVC-F211, JCTVC-F212, JCTVC-F244, JCTVC-F245, JCTVC-F246, JCTVC-F249, JCTVC-F250, JCTVC-F266, JCTVC-F279, JCTVC-F351, JCTVC-F360, JCTVC-F361, JCTVC-F374, JCTVC-F389, JCTVC-F394, JCTVC-F404, JCTVC-F409, JCTVC-F430, JCTVC-F432, JCTVC-F435, JCTVC-F439, JCTVC-F443, JCTVC-F476, JCTVC-F478, JCTVC-F481, JCTVC-F482, JCTVC-F486, JCTVC-F504, JCTVC-F519, JCTVC-F520, JCTVC-F525, JCTVC-F527, JCTVC-F531, JCTVC-F534, JCTVC-F535, JCTVC-F539, JCTVC-F540, JCTVC-F547, JCTVC-F548, JCTVC-F551, JCTVC-F555, JCTVC-F561, JCTVC-F579, JCTVC-F589, JCTVC-F590, JCTVC-F602, JCTVC-F615, JCTVC-F616, JCTVC-F619, JCTVC-F620, JCTVC-F624, JCTVC-F625.

The following document registrations were later cancelled or otherwise never discussed or provided: JCTVC-F164, JCTVC-F165, JCTVC-F334, JCTVC-F357, JCTVC-F398, JCTVC-F526, JCTVC-F545, JCTVC-F613, JCTVC-F664, JCTVC-F703, JCTVC-F718, JCTVC-F742.

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 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-F313 (a cross-verification report, corrected 2011-07-06)
- JCTVC-F364 (a cross-verification report, corrected 2011-07-06)
- JCTVC-F365 (a cross-verification report, corrected 2011-07-06)
- JCTVC-F485 (a cross-verification report, corrected 2011-07-06)
- JCTVC-F598 (a technical proposal, corrected 2011-07-16)

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).

2.2.3 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.

2.2.4 Outputs of the preceding meeting

The report documents of the previous meeting, particularly the meeting report JCTVC-E600, the HEVC Test Model (HM) JCTVC-E602, and the Working Draft (WD) JCTVC-E603, 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.

2.3 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.

2.4 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

2.5 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.

2.6 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.

2.7 Communication practices

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

JCT-VC email lists are managed through the site http://mailman.rwth-aachen.de/mailman/options/jct-vc, and to send email to the reflector, the email address is jct-vc@lists.rwth-aachen.de. Only members of the reflector can send email to the list. However, membership of the reflector is not limited to qualified JCT-VC participants.

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

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.

2.8 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.
- **AMVR**: Adaptive motion vector resolution.
- **APS**: Adaptation parameter set.
- **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.

- **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 – 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).

2.9 Liaison activity

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

2.10 Opening remarks

No particular non-routine opening remarks were recorded.

2.11 Contribution topic overview

The approximate subject categories and quantity of contributions per category for the meeting were summarized and categorized into "tracks" (A, B, or P) for "parallel session A", "parallel session B", or "Plenary" review, as follows. Discussions on topics categorized as "Track A" were primarily chaired by Gary Sullivan, and discussions on topic categorized as "Track B" were primarily chaired by Jens-Rainer Ohm.

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

- AHG reports (20) Track P (section 3)
- Project development, status, and guidance (0) Track P (section 4)
- CE summary reports (12) – Reviewed with individual CE-related contributions
- CE1: Motion vector storage reduction (21) Track A (section 5.1)
- CE2: Motion partitioning and OBMC (17) Track A (section 5.2)
- CE3: Motion compensation interpolation (22) Track A (section 5.3)
- CE4: Quantization (38) Track B (section 5.4)
- CE5: CAVLC entropy coding improvement (8) Track B (section 5.5)
- CE6: Intra prediction improvement (46) Track B (section 5.6)
- CE7: Additional transforms (18) Track B (section 5.7)
- CE8: Non-deblocking loop filtering (29) Track A (section 5.8)

- CE9: MV coding and skip/merge operation (37) Track A (section 5.9)
- CE10: Core transform design (11) Track B (section 5.10)
- CE11: Coefficient scanning and coding (13) Track B (section 5.11)
- CE12: Deblocking filtering (22) Track A (section 5.12)
- Clarifications and bug fix issues (3) Track P (section 6.1)
- HM settings and common test conditions (5) Track P (section 6.2)
- Source video test material (4) Track P (section 6.3)
- Functionalities (8) Track P (section 6.4)
- Loop filtering (52) Track A (section 6.5,)
- Block structures and partitioning (12) Track B (section 6.6)
- Motion compensation operation and interpolation filters (28) Track A (section 6.7)
- Motion vector coding (33) Track A (section 6.8)
- Inter mode coding (11) Track A (section 6.9)
- High-level syntax and slice structure (40) Track A (section 6.10)
- Quantization (20) Track B (section 6.11)
- Alternative coding modes (3) Track B (section 6.12)
- Entropy coding (35) Track B (section 6.13)
- Transform coefficient coding (34) Track B (section 6.14)
- Intra prediction and mode coding (83) Track B (section 6.15)
- Transforms (23) Track B (section 6.16)
- IBDI and memory compression (8) Track A → Track B (section 6.17)
- Parsing throughput, robustness and error resilience (11) Track A (section 6.18)
- Complexity assessment (2) Track P (section 6.19)
- Encoder optimization (4) Track A (section 6.20)
- Category not clear (to be resolved) (section **Error! Reference source not found.**)

Overall Track A: 333; Track B: 341

3 AHG reports

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

JCTVC-F001 JCT-VC AHG report: Project management (AHG 1) [G. J. Sullivan, J.-R. Ohm (co-chairs)] [upload 07-21]

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 had been made available at the ITU-based JCT-VC site (http://ftp3.itu.int/av-arch/jctvc-site/2011_03_E_Geneva) or the new "Phenix" site (http://phenix.it-sudparis.eu/jct/), particularly including the following:

- The meeting report (JCTC-E600)
- The HM 3 encoder description (JCTVC-E602)
- The HEVC Working Draft (JCTVC-E603)
- Finalized core experiment descriptions (JCTVC-E701 through JCTVC-E712)

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

- HEVC software guidelines (JCTVC-C404)
- HEVC Reference Software Manual (JCTVC-E447)
- Common HM test conditions and software reference configurations (JCTVC-E700)

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

Since the approval of software copyright header language at the preceding parent-body meetings, this topic seemed to have been resolved.

No major news was reported regarding future meeting plans, etc.

JCTVC-F002 JCT-VC AHG report: HEVC Draft and Test Model editing (AHG 2) [K. McCann, T. Wiegand (co-chairs), B. Bross, W.-J. Han, J.-R. Ohm, S. Sekiguchi, G. J. Sullivan (vice-chairs)]

This document reports on the work of the JCT-VC ad hoc group on HEVC Draft and Test Model editing (AHG2) between the 5th JCT-VC meeting in Geneva (16-23 March, 2011) and the 6th JCT-VC meeting in Torino (14-22 July, 2011).

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

- JCTVC-E602 HM3: HEVC Test Model 3 and Encoder Description
- JCTVC-E603 WD3: HEVC text specification Working Draft 3

Editing JCTVC-E603 was assigned a higher priority than editing JCTVC-E602.

Two drafts of JCTVC-E602 and eight drafts of JCTVC-E603 were published by the Editing AHG between the 5th JCT-VC meeting in Geneva (16-23 March, 2011) and the 6th JCT-VC meeting in Torino (14-22 July, 2011).

JCTVC-E602 had now progressed beyond the “skeleton” stage of the previous JCTVC-D502, but it still needed significant further improvement.

The main changes in JCTVC-E603, relative to the previous JCTVC-D503, were listed in the report.

Some open issues that remained for JCTVC-E603 were also listed.

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

- Approve the edited JCTVC-E602 and JCTVC-E603 documents as JCT-VC outputs
- Continue to edit the HEVC WD and Test Model documents to ensure that all agreed elements of HEVC are fully described
- Compare the HEVC documents with the HEVC software and resolve any discrepancies that may exist, in collaboration with the Software AHG
- Continue to improve the editorial consistency of HEVC WD and Test Model documents
- Ensure that, when considering the addition of new tools to HEVC, properly drafted text for addition to the HM Test Model and/or the HEVC Working Draft is made available in a timely manner

Remarks recorded during the discussion included the following:

- Terminology may need some improvement.
- Much better quality than last time, no major holes in the description, provision of clean text for adoptions is extremely helpful in editing.
- Generally, interactions between adoptions was one area where difficulties arose.

JCTVC-F003 JCT-VC AHG report: Software development and HM software technical evaluation (AHG 3) [F. Bossen, D. Flynn, K. Sühring] [presented verbally, upload 08-11]

This report summarizes the activities of the AhG on Software development and HM software technical evaluation that have taken place between the 5th and 6th JCT-VC meeting. Activities focused on integration of tools adopted at the 5th meeting into a common code base.

A brief summary of activities related to each mandate is given below.

- 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.
- A draft documentation of software usage was produced and distributed on the reflector. A refined version thereof was submitted as input contribution JCTVC-F634.
- Version 3.0 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-3.0-anchors/).
- Versions 3.1, 3.2 and 3.3 of the software were delivered ahead of the 6th JCT-VC meeting.
- A number of mismatches between text and software were identified, mainly relating to high-level syntax.
- Additionally a revised version of the software guidelines was submitted as input contribution JCTVC-F688.

Multiple versions of the HM software were produced and announced on the jct-vc email reflector. 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 in the report (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).

Version 3.0 was released on April 18, 2011. All integrations listed in JCTVC-E700 for this version were integrated as planned. This release was announced on the email reflector, along with performance data w.r.t. version 2.0 as included in the report.

It was noted that substantial coding efficiency improvements were achieved for all configurations.

Version 3.1 was released on May 25, 2011. Most integrations listed in JCTVC-E700 for this version were integrated as planned, except for JCTVC-E045 and JCTVC-E483.

After discussion on the general JCT-VC email reflector, this version also included a modification to the rate computation. As the generated bitstreams include MD5 checksums for each frame, it is undesirable to simply consider the size of a bitstream file to derive the bitrate. Additionally version 3.0 of the software contained a minor bug wherein SPS and PPS bits were not counted. The modified rate computation included in version 3.1 considers all bits except for SEI messages and Annex B (start codes). The omission of Annex B bytes leads to a slight improvement of BD-rate numbers (in the order of 0.2-0.3% for configurations other than AI).

Version 3.2 was released on June 13, 2011. All planned integrations were included in this version.

Additionally parts of the code were rewritten – leading to a reduction of encoding and decoding run times.

Version 3.3 was released on July 4, 2011. It fixed several minor issues. More consequently, older and inactive code was removed, leading to a substantial reduction of the number of lines of code.

In addition to the regular HM development process, two branches were created to promote tools to a wider audience:

- HM-3.0-dev-sdip which contained an implementation of the SDIP technique
- HM-3.1-dev-acds which contained an implementation of ALF using alternate filter shapes

The high-level syntax described in the WD text had not yet been fully implemented in the software. Discussions took place on the reflector to identify discrepancies – which were reported in document JCTVC-F714.

In particular, substantial work was reported to be needed to support proper reference frame buffer management.

The AHG recommended the following:

- To continue to develop reference software based on HM version 3.3 and improve its quality.
- To continue to identify bugs and discrepancies with respect to the text, and to address them.
- To review the proposed update to software guidelines as submitted in JCTVC-F688.

It was noted that the proponents of some adopted technology partially did not deliver in time, which had led to a delay in the delivery of HM v3.1 and v3.2.

It was noted that the bit count of HM v3.1 and later may not be exactly comparable – as start codes are counted in some versions and not counted in others.

The mismatch between the software and text is mainly w.r.t. high-level syntax.

The software guidelines were updated and should be strictly observed.

The question was asked as to what is the difference in terms of coding efficiency and runtime between the LC and HE cases with the current versions? Analysis of this issue was encouraged.

High-level syntax is one area where work is needed.

Code clean-up was particularly suggested to be needed for ALF.

The retesting of tools after integration is desirable – and the ability to switch off features is a necessary element of that.

To speed up the integration process, providing earlier access to the software before its performance is fully verified can be very useful. Features should often take only a few hours to integrate, so there should be no need to impose a week-long delay before letting the coordinator review process begin to proceed.

JCTVC-F004 JCT-VC AHG report: Slice support development and characterization R. Sjöberg (Ericsson), Y. Chen (Qualcomm), M. Horowitz (eBrisk), K. Kazui (Fujitsu), A. Segall (Sharp)

This report summarized the slice support development and characterization ad hoc group activities between the 5th and the 6th JCT-VC meetings, and the input documents related to this ad hoc group.

Various related issues were reviewed in the report, including HM encoder settings, the order of slice header syntax elements, picture parameters, the use of the frame_num and idr_pic_id syntax elements, POC, RPLM, reference picture marking, entropy coding initialization, quantization parameter setting, ALF and SAO parameter setting, deblocking filter control syntax, DRBFlag, ERBIndex, and ColDirFlag.

The coding efficiency and complexity effects of slice-based coding were analyzed in the report, and the related input documents for the Torino meeting were reviewed.

The AHG recommended for the JCT-VC to review the list of slice issues reported in the report and the slice-related input document contributions.

High-level syntax coordination was noted as a general issue needing attention.

The overhead associated with 1500 byte packets was measured and reported.

It was noted that the HM software no longer counts start code prefixes, whereas this count was previously included.

In the discussion of the AHG report, it was asked whether start codes should be counted. The arguments on this aspect were as follows: they are sometimes replaced by network specific mechanisms, some of which may be more or less compact; furthermore, we are only measuring relative improvements, and it does not really matter much whether we count them or not.

JCTVC-F005 JCT-VC AHG report: Spatial transforms (AHG 5) [P. Topiwala, M. Budagavi, R. Cohen, R. Joshi (AHG chairs)]

This AHG was quite active in the interim period since the preceding meeting. 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-F030. For CE7, its activities are reported in JCTVC-F027, and the associated proposals were listed in the report. In addition to submissions directly related to CEs, there were also other contributions in the general AHG topic area, related to topics such as dynamic range analysis, hardware implementation analysis, and analysis of SIMD implementation for one proposal. This AHG interacts with several other AHGs, notably on Complexity Assessment and Quantization.

During discussion of the report, there was discussion about a software implementation issue for which Frank Bossen suggested a solution that was not resolved so far.

JCTVC-F006 JCT-VC AHG report: In-loop and post-processing filtering (AHG 6) T. Yamakage, K. Chono, Y. J. Chiu, I. S. Chong, M. Narroschke

The following summarizes the In-loop and post-processing filtering AHG activities between the 5th JCT-VC meeting in Geneva, CH (16 to 23 March, 2011) and the current 6th JCT-VC meeting in Torino, IT (14 to 22 July, 2011).

Related technical contributions were reviewed in the report, including those for the relevant CEs (CE8 and CE12).

The report included a suggestion to re-institute a CE on SAO (there were several input documents on this). Of course, this would only be reasonable to decide if sufficient evidence about benefits is given.

The report also suggested for the JCT-VC to create a BoG to study reduction of line buffers, with thorough consideration of deblocking filter, SAO and ALF impacts.

JCTVC-F007 JCT-VC AHG report: Coding block structures (AHG 7) [K. Panusopone, W. J. Han, T. K. Tan, T. Wiegand (chairs)]

This report summarized the Coding block structures AHG activities between the 5th JCT-VC meeting in Geneva, Switzerland (16 to 23 March, 2011) and the 6th JCT-VC meeting in Torino, Italy (14 to 22 July, 2011).

Several changes had been made to coding block structure at the Geneva meeting, including modified definition of TU partition when max RQT depth is equal to 1 and modified CAVLC coded block flag coding under the residual quadtree. Common test conditions were also changed to apply the same maximum RQT depth across all test conditions. The coding performance of HM-3.2 with maximum RQT depths set to 1 and 2 was reported in the report against common test conditions.

There were some coordinated activities relating to Coding block structure AHG that occurred between the Geneva meeting and the Torino meeting. CE2 studied non-square quadtree transform units for symmetric motion partitions. CE6 investigated RQT and SDIP harmonization. A list of related input documents was provided in the report.

The recommendations of the Coding block structures AhG were to:

- Study the interaction of non-square transforms and the RQT.
- Study complexity reduction methods for coding block structures processing including early termination technique and transform skip mode.
- Encourage more experts to volunteer to contribute on improving coding efficiency and simplification of Coding block structures.

No specific comments were made in the discussion of this report.

JCTVC-F008 JCT-VC AHG report: Reference pictures memory compression (AHG 8) [K. Chono, T. Chujoh, C. S. Lim, A. Tabatabai, M. Zhou]

This document summarized the AHG activities between the 5th Meeting: Geneva, CH, 16-23 March 2011, and the current 6th Meeting: Torino, 14-22 July, 2011.

Decoder-side motion compensation memory access bandwidth of HM 3.0 Anchor streams was measured by using a module in HM2.0 branch software (https://hevc.hhi.fraunhofer.de/svn/svn_HEVCSoftware/branches/HM-2.0-ahg-memory).

It was reported that decoder-side motion compensation memory access bandwidths of HM2.0 and HM 3.0 are similar since HM3.0 does not adopt new tools that drastically increase or decrease motion compensation memory access bandwidth. The average memory bandwidth increase was reported as −0.22% for HE Random access, −0.02% for LC Random access, −2.12% for HE Low delay, and −0.05% for LC Low delay. The detailed results were reported in an attached XLS sheet. There was reportedly no contribution document on this aspect.

Regarding reference picture memory compression schemes proposed for the HM design, the relevant contribution documents were listed in the report, and the performance of the technical proposals was summarized.

Regarding the study of data format alignment between reference picture memory compression and display processing and the study the visual quality impact of reference picture memory compression, the report indicated that there was no discussion on reflector and no submitted contribution documents.

In the discussion of the report, it was asked whether there appeared to be any tendency of convergence towards selecting a technology for reference picture memory compression. There did not yet seem to be such a convergence.

JCTVC-F009 JCT-VC AHG report: Entropy coding (AHG 9) [M. Budagavi, G. Martin-Cocher, A. Segall, W. Wan]

There was a kick-off message related to this AHG on the JCTVC reflector. There were no other email exchanges. Several AHG members interested in this area were actively participating in proposal/cross-verification of entropy coding within CE5 and CE11.

It was noted that there were several contributions to the Torino meeting that are related to the mandates of the Ad Hoc Group. They were broadly categorized as follows:

- CE5 (CAVLC entropy coding improvements) related contributions
- CE11 (coefficient scanning and coding) related contributions
- CAVLC related contributions
- CABAC context reduction contributions
- Other CABAC contributions
- PIPE/V2V related contribution
- Contributions related to parsing dependencies between entropy coding and other processes

A summary of the contributions was provided in the report.

The AHG provided a table comparing different proposals for CAVLC improvements.

The report also analysed the parsing dependencies between entropy decoding and other processes.

The report included a summary of proposals with associated measured BD impacts.

JCTVC-F010 JCT-VC AHG report: Quantization (AHG 10) [M. Budagavi, M. Karczewicz, K. Sato, G. Martin-Cocher]

There were seven emails related to this AhG on the JCTVC reflector. The emails were related to Quantization matrix support in HEVC. Sony circulated three sets of quantization matrices: default, symmetric, and asymmetric to the AhG.

There were reported to be several contributions to the Geneva meeting that are related to the mandates of the Ad Hoc Group. They were broadly categorized as follows:

- CE4 (Quantization)
- QP coding
- Quantization matrices
- RDOQ

The relevant contributions were reviewed in the report.

No specific comments were made in the discussion.

JCTVC-F011 JCT-VC AHG report: Video test material selection (AHG11) [T. Suzuki (Chair)] [upload 07-14]

There were reportedly some offers to the AHG chair to generate new test sequences for the development of HEVC. Although such offers are not official commitments, however, the features of potential new test sequences were discussed, and the following features were suggested in the report:

- Fade to black, fade up to black. (Different frame rates.)
- Insertion of a 'flash frame' (white, red, green, blue)

- Flashing lights
- Smoke
- Steady cam moving camera
- Replay effects (page turn, slab turn, starburst)
- Slow motion sequence (p24 only).
- Confetti
- Water and grass

It was reportedly planned to capture uncompressed, 4:2:2 files at 1280x720p59.94 (720p59.94). It could also be captured as 1080x1920p23.98 if that would be helpful. If possible, 4:4:4 content is valuable.

There was a concern on adding a flash frame. A smart encoder would handle a flash frame by modifying the GOP structure to minimize its impact. Given that the common test conditions specify a fixed GOP structure, the positioning of the flash frame is very important. If the flash frame is located at a non-reference frame, its impact on the sequence PSNR and rate would be negligible. If the flash frame is located on an I frame, it would reportedly have a more negative impact.

There were reportedly no contributions on general video test material, but two contributions on screen content had been submitted: JCTVC-F562 and JCTVC-F726.

The AHG recommended the following to the JCT-VC:

- to continue to investigate test sequences to cover a greater variety of scenes
- to continue to collect new test materials
- to clarify the condition to use test materials in JCT-VC
- to update the common test conditions reflecting the discussion in Torino meeting if necessary

No specific comments were made in the discussion of this report.

JCTVC-F012 JCT-VC AHG report: Complexity assessment (AHG 12) [D. Alfonso (chair), J. Ridge, X. Wen (vice-chairs)]

This report summarized the activities of the Ad Hoc Group on Complexity Assessment between the 5th JCT-VC meeting held in Geneva in March 2011 and the current meeting in Torino.

There was moderate activity on the e-mail reflector related to Complexity Assessment since the last meeting. The main topics discussed were the anchor results for the new HM 3.x and the complexity-related mandates for Ad-hoc Groups and Core Experiments.

It has been remarked that the efficiency of current HM in memory allocation can be improved, particularly for what concerns implementations of deblocking filter, PCM and fine granularity slices.

It has been also remarked that it may be useful to ask proponents to report memory usage for both HM encoder and decoder, in order to avoid undesirable increases in memory allocation, without putting too much emphasis on this request to avoid compromising the software readability.

The following contributions related to complexity assessment were submitted to the current JCT-VC meeting:

- JCTVC-F043, “Complexity assessment methodology”
- JCTVC-F342, “ALF complexity analysis”
- JCTVC-F447, “SIMD optimization of proposed HEVC core transforms”

The AHG report suggested to particularly consider the JCTVC-F043 proposed complexity analysis methodology. A draft of this contribution had been circulated on the reflector between the meetings, although no comments were received about it, either in favor or against it. The JCTVC-F043 document was still under study and there was not necessarily a strong consensus in the AHG to adopt it as the official JCT-VC complexity assessment method.

JCTVC-F013 JCT-VC AHG report: Screen content coding (AHG13) [O.C. Au (Chair), J. Xu, H. Yu (Vice Chairs)]

This contribution summarized the Screen Content Coding (SCC) Ad Hoc Group activities between the 5th JCT-VC meeting in Geneva, Switzerland (16 to 23 March, 2011) and the current 6th JCT-VC meeting in Torino, Italy (14-22 July, 2011).

Some new screen content coding test sequences have been proposed (JCTVC-F562, JCTVC-F726), and associated test conditions have been proposed (JCTVC-F696). Coding analysis and technical proposals for coding tools had also been submitted. For investigations of HEVC performance, the common test configurations were used.

One issue raised in the discussion has been chroma sampling structures (e.g., 4:2:0 vs. 4:4:4) and the conversions between them.

JCTVC-F014 AHG14 (Loss Robustness) Report [S. Wenger]

AHG14 on loss robustness worked by correspondence in the period between the E and F meetings of JCT-VC. The focus of the work was in discussions related to error resilience testing and common conditions. No technical proposals towards the standards were evaluated or discussed by correspondence, though this report contains a list of documents that, in the chair's opinion, may be related to the mandate of AHG14.

The AHG report suggested particular methods for testing loss robustness. This included an expressed need for a decoder that reacts reasonably to packet losses. It was remarked that encoder optimization for loss robustness is also important. A desire was also expressed for having a greater ability to test robustness behaviour for operation on much longer test sequences (e.g., looped test sequences) than what is currently used in our common conditions.

A main aspect is about possible test conditions for error resilience. Longer test sequences would be needed (which could be the usual sequences in loop or shuttle mode). The current software crashes in most cases when a packet is lost. Some input documents related to error resilience were reviewed in the report.

JCTVC-F015 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 summarizes the activities of the high-level syntax ad hoc group between the 5th JCT-VC meeting held in Geneva in March 2011 and the current meeting in Torino.

Many issues were noted where the high-level syntax deviates between text and software, but were reported to be straightforward to fix, and some volunteers to accomplish this had been identified. Work to resolve these issues was encouraged to take place during the meeting week in side activity.

JCTVC-F016 JCT-VC AHG report: Decoder-side motion vector derivation (DMVD) (AHG 16) [Yi-Jen Chiu (chair), Elena Alshina, Haoping Yu (vice-chairs)]

One primary contribution, JCTVC-F500, was identified as being related to the work of this AHG. Two cross-check reports of this proposal (JCTVC-F724 by Huawei and JCTVC-F735 by MERL) were reported to have been submitted. The AHG report included tabulated results of coding efficiency and runtime testing of JCTVC-F500.

No specific comments were made in the discussion.

JCTVC-F017 JCT-VC AHG report: Scalable coding investigation (AHG 17) [J. Boyce (chair), J. Kang, K. Minoo, W. Wan, Y.-K. Wang (vice chairs)]

This report summarized the activities of the Scalable coding investigation Ad Hoc Group between the 5th JCT-VC meeting held in Geneva in March 2011 and the current meeting in Torino.

There was no activity on the e-mail reflector related to scalable coding investigation, although there was considerable discussion about requirements on the mpeg-hevc-ext reflector of the HEVC Extensions AHG of MPEG.

The report listed the relevant contributions.

The issues will be further discussed in context of high-level syntax, and a joint meeting will be planned with MPEG Requirements to consider requirements aspects.

JCTVC-F018 JCT-VC AHG report: Weighted prediction (AHG 18) [Philippe Bordes, TK Tan (co-chairs)]

This report summarizes the activities of the Ad Hoc Group 18 on Weighted Prediction between the 5th JCT-VC meeting held in Geneva in March 2011 and the current meeting in Torino.

There was moderate activity on the e-mail reflector related to Weighted Prediction.

There were some email discussions about the architecture of the software analysis module in HM. It was suggested to integrate the analysis module for estimating the WP explicit parameters inside the encoder application.

A request for algorithms for estimating WP parameters was made on the reflector. Technicolor provided and distributed one implementation.

An alternative method for estimating explicit WP parameters had been developed by Toshiba (JCTVC-F326) and NTT (JCTVC-F397).

Another important topic was the sequences to be used to test and the validation of the WP implementation. The “Fading tool” presented at the previous JVTVC meeting (JCTVC-E041) was delivered through a FTP server.

The “Fading tool” may be used to create fade-to-black, fade-to-white sequences and cross-fading sequences, and corresponding WP explicit parameters. An implementation of both WP functionalities and of a WP parameter estimation algorithm (described in JCTVC-F265) in HM3.0 had been provided to AHG18 participants.

Fading sequences created with the fading tool and the regular HEVC sequences were made available. To cope with copyright issues, frame copyright and copyright statements had been added to the fade sequences. However, it was encouraged to use the fading tool rather than downloading the fade sequences.

All the WP related proposals have reported a gain between 20% to 30% on average for fading sequences, and a gain between 2.5% and 7.8% for cross-fade sequences.

Support for WP implementation in HM3.0 has been provided by Technicolor and Toshiba. Cross-checks had been conducted by INRIA, Toshiba and Technicolor.

No specific comments were made in the discussion.

JCTVC-F019 JCT-VC AHG report: Alternative LCU scan processing (AHG 19) [M. Horowitz (chair), F. Henry, A. Segall (vice-chairs)]

This report summarized the alternative LCU scan processing AHG activities between the 5th and 6th JCT-VC meetings, and the input documents to this meeting related to this AHG.

At least two software implementations related to the Alternative LCU Scan Processing AHG were publically announced. Both implementations, listed below, used a variant of the HM 3.0 software as a base on which additional functionality was added.

- Tiles (Cisco, eBrisk Video, Sharp, and TI) https://s3.amazonaws.com/ebrisk_ftp/tiles+related+files/Jul+2011+meeting+tiles+software/released+version/HM3.0-Tiles_v0.zip
- Wavefront parallel processing software (Orange Labs) distributed to 7 companies/institutions on email requests to felix.henry@orange-ftgroup.com

Ultra-low-delay coding was also noted to be relevant to the work of this AHG.

It was suggested to study the possibility of re-designing the software related to slices.

The AHG report listed the relevant contributions.

JCTVC-F020 JCT-VC AHG report: Chroma format support (AHG 20) [David Flynn, Dzung Hoang] [upload 07-14]

This report summarized the activities of Ad Hoc Group 20 on Chroma Formats between the 5th and 6th JCT-VC meetings. There was little activity on the reflector during this period. An initial set of software modifications for non-4:2:0 chroma format support was reported to have been identified by the chairs.

It was suggested to start implementing non-4:2:0 chroma format support in the software (although this should perhaps at first be done in separate branch).

4 Project development, status, and guidance

See the section discussing functionalities for relevant contributions.

5 Core experiments

5.1 CE1: Motion vector storage reduction

5.1.1 Summary

JCTVC-F021 CE1: Summary report of Core Experiment 1 on Motion Data Storage Reduction [J. Jung, P. Onno, Y.-W. Huang] [upload 07-05]

(Track A, day 1.)

This document summarizes the activities of the Core Experiment CE1 on motion data storage reduction. At the 5th JCT-VC meeting some input documents were proposed to modify the motion data storage in combination with the temporal MV predictor. The experiments are clustered in 3 categories: category A of this CE explores the different possible combinations between the MDSR position and the temporal motion vector predictor position. Category B evaluates different methods to reduce the motion data storage. Category C evaluates the impact of the spatial sampling factor of MDSR.

5.1.2 Contributions

JCTVC-F064 CE1: Results of Experiments A.6, A.8, and A.10 [Y.-W. Chen, J.-L. Lin, X. Guo, Y.-W. Huang (MediaTek)]

JCTVC-F081 CE1: Evaluation results on A.09, A.13-16 and an alternative solution [M. Zhou (TI)]

Also contains a new proposal (also found in JCTVC-F465) – this aspect was not part of CE1 and was delegated for review in the BoG coordinated by B. Bross.

JCTVC-F112 CE1: Results of Experiments A.3, A.7, A.9, A.11 [S. Park, J. Park, B. Jeon (LGE)]

JCTVC-F114 CE1: crosscheck for A.1 [Hendry, S. Park, J. Park, B. Jeon (LGE)]

JCTVC-F202 CE1: Cross-check of experiment A.8 [B. Li (USTC), J. Xu (Microsoft)]

JCTVC-F266 CE1: Cross-check of experiment A11 (LG / JCTVC-F112) and A14 (TI / JCTVC-F081) [J. Jung, J.-M. Thiesse (Orange Labs)] [late upload 07-12]

JCTVC-F278 Results about CE1 experiments related to A.1, A.5 and B.x tests [G. Laroche, P. Onno, T. Poirier (Canon)]

JCTVC-F280 CE1: cross-check by Canon of experiment B.1 and B.7 from ETRI (JCTVC-F353) [G. Laroche, P. Onno, T. Poirier (Canon)]

JCTVC-F327 CE1: Cross check report of subtest A.3 from Toshiba [A. Tanizawa, T. Shiodera (Toshiba)]

JCTVC-F337 CE1: Results of partition size based selection for motion vector compression (A.12) [S. Fukushima, M. Nishitani, M. Ueda, K. Arakage, H. Takehara (JVC Kenwood)]

JCTVC-F353 CE1: Results of experiments B.1 and B.7 [S.-C. Lim, H. Y. Kim, J. Lee, J. S. Choi (ETRI)

JCTVC-F354 CE1: Cross-check result of experiments B.2, B.3, B.4, B.5, B.6, B.8, B.9, B.10, B.11, and B.12 (JCTVC-F278) by ETRI [S.-C. Lim, H. Y. Kim, J. Lee (ETRI)]

JCTVC-F382 CE1: Cross-check report for A05 (JCTVC-F278) [I.-K. Kim (Samsung)]

JCTVC-F383 CE1: Cross-check report for A13, A15 and A16 (JCTVC-F081) [I.-K. Kim (Samsung)]

JCTVC-F425 CE1: Result of Test A2 [K. Sato (Sony)]

JCTVC-F434 CE1 Test A7: Cross-check report from Institute for Infocomm Research for JCTVC-F112 [Y. H. Tan, C. Yeo (I2R)]

JCTVC-F473 CE1: Cross-check report of experiment A.2 and A.10 by Panasonic [T. Sugio, T. Nishi (Panasonic)]

JCTVC-F513 CE1: Results of experiment A.4 [Y. Chiu, L. Xu, W. Zhang, Y. Han (Intel)]

JCTVC-F662 CE1: Crosscheck for test A.4 [Marta Mrak] [late reg. 07-06, upload 07-07]

JCTVC-F715 Cross-check report for A.12 (JCTVC-F337), C.1 and C.2 (JCTVC-F021) [J. Zhao, S. H. Kim, A. Segall (Sharp)] [late reg. 07-12, upload 07-12]

5.1.3 Discussion and Conclusions

For all three categories in the CE, it was indicated that the software was fully checked to ensure that it was doing what was intended.

For all of the subtests in Category A, the current HM design performed as well or better than any of the others, and the alternatives were not substantially simpler.

Category B considers a clipping range for minimizing motion vector storage precision for the temporal MV, either with variable MV precision or fixed MV precision, and also a (JCTVC-E221) proposed two modes of reducing the storage of MVs for different reference indices.

The benefit of the adaptive precision for temporal MV prediction does not seem adequate to justify the need to manipulate the data.

For the clipping ranges proposed for temporal MV prediction, the complexity benefit for imposing a more limited range did not seem to be sufficiently large to motivate changing the current design to limit the range.

The reference scaling mode from JCTVC-E221 / JCTVC-F278 did not seem to provide a sufficient degree of simplification to warrant changing the current design (with some loss of coding efficiency). This could be discussed again if some other motivation arises (e.g. from CE9 consideration).

For Category C, the test results seem to indicate that the factor-of-16 reduction in motion vector storage is sufficiently precise; only 0.1% bit rate savings can be obtained by disabling the motion data storage reduction completely.

5.2 CE2: Motion partitioning and OBMC

5.2.1 Summary

JCTVC-F022 CE2: Summary report of Core Experiment on motion partitioning and OBMC [X. Zheng, P. Bordes, P. Chen, I.-K. Kim (CE Coordinators)]

This document summarizes the activities of CE2 related to Motion Partitioning and OBMC. The description of the experiment can be found in JCTVC-D702. In this CE, five tools have been studied and evaluated: Asymmetric Motion Partitioning (AMP), Non-rectangular Motion Partitioning (NRMP), Overlapped Block Motion Compensation (OBMC), Non-Square Quadtree Transform (NSQT) and OBMC with Motion Merging. 14 companies have been involved as proponent or cross-checker.

Some subtests involve feature combinations, where it may be desirable to identify which aspect is the source of the reported gain.

The schemes that add more segmentation shapes come with increased encoder requirements to evaluate those additional shapes. It was asserted that an encoder that does not test all of these would not be degraded in quality relative to not having them in the design.

Regarding OBMC, JCTVC-F299-v2 has draft text – actually pseudocode, and not connected to the rest of the draft.

It was remarked that the OBMC requires generation of larger motion partitions. The complexity increase related to this seems substantially dependent on implementation architecture.

5.2.2 Contributions

JCTVC-F049 CE2: Report of OBMC with Motion Merging [C.-C. Chen, Y.-Y. Chen, C.-L. Lee, W.-H. Peng, H.-M. Hang (NCTU/ITRI)]

JCTVC-F299 CE2:Overlapped Block Motion Compensation for 2NxN and Nx2N Motion Partitions [L. Guo, P. Chen, I. S. Chong, R. Joshi, X. Wang, M. Karczewicz (Qualcomm)]

JCTVC-F379 CE2: Test result of asymmetric motion partition (AMP) [I.-K Kim, W.-J Han, J. H. Park (Samsung), X. Zheng (HiSilicon)

JCTVC-F385 CE2: Cross-check report for Qualcomm's OBMC for 2NxN and Nx2N motion partitions (JCTVC-F299) [I.-K. Kim (Samsung)]

JCTVC-F410 **CE2: Non-Square Quadtree Transform for symmetric motion partitions [Y. Yuan (Tsinghua), X. Zheng (Huawei), X. Peng (USTC), J. Xu (Microsoft), L. Liu (HiSilicon), Y. Wang, X. Cao (Tsinghua Univ.), C. Lai, J. Zheng (HiSilicon), Y. He (Tsinghua Univ.), H. Yu (Huawei)]**

JCTVC-F579 **Cross-check report for Huawei's proposal on inter non-square TU technique (JCTVC-F410) by Motorola Mobility [K. Panusopone, X. Fang, V. Kung, L. Wang (Motorola Mobility)] [late upload 07-12]**

JCTVC-F748 **Cross-check report on a variant of JCTVC-F410 [late reg. 07-16, upload 07-17]**

JCTVC-F412 **CE2: Non-Square Quadtree Transform for symmetric and asymmetric motion partitions [Y. Yuan (Tsinghua), X. Zheng (Huawei), X. Peng (USTC), J. Xu (Microsoft), I.-K Kim (Samsung), L. Liu (HiSilicon), Y. Wang, X. Cao (Tsinghua Univ.), C. Lai, J. Zheng (HiSilicon), Y. He (Tsinghua Univ.), H. Yu (Huawei)]**

JCTVC-F415 **CE2: Non-rectangular motion partitioning [X. Zheng (HiSilicon), H. Yu (Huawei), S. Li, Y. He (Tsinghua Univ.), P. Bordes (Technicolor)]**

JCTVC-F435 **CE2: Cross-check of Huawei's study on Non-Square Quadtree Transform JCTVC-F410 & JCTVC-F412 [S. Oudin] [late upload 07-06]**

JCTVC-F515 **CE2: Cross verification results of NCTU's OBMC with motion merging (JCTVC-F049) by Intel [Yi-jen Chiu, Lidong Xu, Wenhao Zhang, Yu Han]**

JCTVC-F520 **CE2: Cross-check of non-rectangular motion partitioning (JCTVC-F415) [J. Xu (Microsoft)] [late upload 07-14]**

JCTVC-F582 **CE2: Asymmetric Motion Partition, Non-Square Quadtree Transform and Overlapped Block Motion Compensation [L. Guo, M. Karczewicz, Xianglin Wang (Qualcomm), Y. Yuan, Y. He (Tsinghua), X. Zheng, H. Yu (Huawei)]**

JCTVC-F642 CE2: Cross-check report for AMP, NSQT and OBMC (JCTVC-F582) [I.-K Kim (Samsung)] [late reg. 07-05, upload 07-06]

JCTVC-F687 CE2: Report on the Combination of OBMC with Motion Merging and Non-Square Quadtree Transform [C.-C. Chen, Y.-Y. Chen, C.-L. Lee, W.-H. Peng, H.-M. Hang (NCTU/ITRI)] [late reg. 07-08, upload 07-09]

JCTVC-F704 CE2: Cross verification of JCTVC-F687 [Yi-jen Chiu, Lidong Xu, Wenhao Zhang, Yu Han] [late reg. 07-11, upload 07-11]

5.2.3 Discussion and Conclusions

BoG (coordinated by J. Boyce) reported in JCTVC-F751 Sun. 0815.

Text was provided for the relevant contributions, which reportedly looked roughly OK at first glance.

0. No additional stuff
1. JCTVC-F410 NSQT w/o 2x8 (0.6%)
2. JCTVC-F410 & JCTVC-F379 NSQT w/o 2x8 w/AMP disabled in CC (0.6% → 1.3%)
3. JCTVC-F410 & JCTVC-F379 NSQT + 2x8 w/o AMP disabled in CC (0.8% → 1.5%)
4. JCTVC-F410 & JCTVC-F379 NSQT + 2x8 + AMP (1.5%) [+encode search]
5. JCTVC-F410 & JCTVC-F379 & JCTVC-F299 NSQT + 2x8 + AMP + OBMC for 2NxN (2.2%) [+decode worst case]

Other possibilities that may be worth some thought:

6. **NSQT w/o 2x8 + JCTVC-F379 AMP (1.3%) – Decision: This combination was Adopted**

   Later discussion in Tue plenary: Does AMP deblock at non-8x8 boundaries? A: No, so it's OK.

   Additional later remark: Might AMP be introducing some visual artifacts because of this? (e.g. 4x8, 4x16 artifacts). A proponent indicated that in their informal experience, they had not noticed an issue, although no formal subjective analysis had been conducted.

   As a larger issue, not just in regard to AMP, it seems worth consideration of whether we are losing any significant quality by not deblocking at non-8x8 edges in general. Note that AVC has such deblocking.

   Initially, the adoption was pending HM 3.3 integration and review and study of inferred merge RD incl. runtime impact during the meeting. The status was then reviewed Thu 8:45pm with no reported surprise, although the software needs some (but not an excessive degree of) work in regard to coding guidelines: needs work on compile errors, variable names, brackets, indentation, and memory allocation).
7. AMP only (enabled or disabled in CC)
8. The last option above using OBMC with just one-line overlap (being tested, roughly 2.1%)
9. NSQT (w/o 2x8) with AMP w OBMC (rough guess 2.0%)

AMP and NSQT provide more gain in LD (esp. Class E), roughly making up for less effective prediction by more effective residual coding.

5.3 CE3: Motion compensation interpolation

5.3.1 Summary

JCTVC-F023 CE3: Summary report of Core Experiment on interpolation for MC [E. Alshina, T. Chujoh (CE coordinators)]

This contribution is a summary of CE3: interpolation for MC. In total 15 companies joined this CE as proponent, cross-checkers or observers. In total 21 tests were carried out and verified during this Core Experiment.

Various results were tabulated and analyzed in the summary report. Additional remarks from the discussion of the topic are recorded below.

It was acknowledged that phase shift of Motorola proposal (in JCTVC-F574) is 3/16 rather than 4/16; asserted that the effect on chroma can be fixed by modifying the chroma interpolation to align the position (proposed in JCTVC-F599, not part of CE). It was conjectured that the 3/16 shift method might work best with more reference pictures (offering phase diversity of referenceable positions).

As studied in JCTVC-F443, the 3/16 phase shift results in a greater frequency of selecting these positions relative to the use of 1/4 phase shift for these positions.

A BoG (coordinated by T. Suzuki) was asked to discuss and summarize the CE3 contributions and identify which things need further review.

It was agreed that for measuring average performance, we should weight the average according to the frequency of usage that is actually experienced when using the filter. The worst case will also be studied.

5.3.2 Contributions

JCTVC-F048 CE3: Modifications of region-based adaptive interpolation filter [S. Matsuo, Y. Bandoh, T. Ito, S. Takamura, H. Jozawa (NTT)]

JCTVC-F100 CE3: Results on MC boundary filter (tool 4) [K. Kondo, T. Suzuki (Sony)]

JCTVC-F101 CE3: Results on Bi/Uni MC filter (tool 5) [K. Kondo, T. Suzuki (Sony)]

JCTVC-F222 CE3: Cross-check report for Sony's test JCTVC-F100 by eBrisk Video [F. Kossentini, N. Mahdi (eBrisk)]

JCTVC-F246 CE3: Cross-check report by Nokia for 2.2, 4.3, 4.6 [K. Ugur (Nokia)] [late upload 07-06]

JCTVC-F247 CE3: DCT derived interpolation filter test by Samsung. [E. Alshina, A. Alshin (Samsung)]

JCTVC-F248 CE3: Interpolation filter with shorter tap-length for small PU's [K. Ugur, J. Lainema (Nokia)]

In this contribution, a shorter filter was used for bi-predictive small PUs (PUs smaller than 8x8).

JCTVC-F259 CE3: Cross-check report for test1 JCTVC-F315 [K. Kondo, T. Suzuki (Sony)]

JCTVC-F260 CE3: Cross-check report for test2.1 JCTVC-F247 [K. Kondo, T. Suzuki (Sony)]

JCTVC-F261 CE3: Cross-check report for test3 JCTVC-F248 [K. Kondo, T. Suzuki (Sony)]

JCTVC-F314 CE3 Subset 2.4: Cross-Verification of Samsung's interpolation filter (JCTVC-F247) by Qualcomm [I. S. Chong, M. Karczewicz (Qualcomm)]

JCTVC-F315 CE3: Non-uniform tap length filtering for bidirectional prediction [T. Chujoh, T. Yamakage (Toshiba]

JCTVC-F316 CE3: Cross-check report for Samsung's tool 2.3 (JCTVC-F247) [T. Chujoh, T. Yamakage (Toshiba)]

JCTVC-F317 CE3: Cross-check report for Sony's tool 5 (JCTVC-F101) [T. Chujoh, T. Yamakage (Toshiba)]

JCTVC-F322 CE3 : Cross-check for NTT's proposal on Region-Based Adaptive Interpolation Filter (JCTVC-F048) [T. Yoshino, K. Kawamura, S. Naito (KDDI)]

JCTVC-F344 Cross-check report on CE3 Subtest 4.1 and 4.4 (JCTVC-F100) [K. Chono, H. Aoki (NEC)]

JCTVC-F443 CE3: Cross-check by Samsung for Motorola Mobility tests on interpolation filters [E. Alshina (Samsung)] [late upload 07-07]

This cross-check report contained substantially more detail than is typical of such contributions.

JCTVC-F568 CE3: Cross-check report for Samsung's test JCTVC-F247 by Motorola Mobility [J. Lou, K. Minoo, L. Wang (Motorola Mobility)]

JCTVC-F570 CE3: Cross-check report for eBrisk's test JCTVC-F216 by Motorola Mobility [J. Lou, L. Wang (Motorola Mobility)]

JCTVC-F574 CE3: Fixed interpolation filter tests by Motorola Mobility [J. Lou, K. Minoo, D. Baylon, K. Panusopone, L. Wang, A. Luthra (Motorola Mobility)]

JCTVC-F576 CE3: Slice-type based adaptive interpolation filter tests by Motorola Mobility [J. Lou, K. Minoo, D. Baylon, K. Panusopone, L. Wang, A. Luthra (Motorola Mobility)]

5.3.3 Discussion and Conclusions

5.4 CE4: Quantization

5.4.1 Summary

JCTVC-F024 CE4: Summary report of Core Experiment on quantization [K. Sato, M. Budagavi, M. Coban, H. H. Aoki, X. X. Li (CE coordinators)] [upload 07-12]

Subtest 1: Signalling MaxCUDepthDQP at LCU level: No gain – further study.

Subtest 2: QP prediction from neighboring CU QP values (9 contributions).

Subtest 3: Adaptive de-quantization offset.

For subtest 1 and 2, a TM5-like rate control is used, mainly using variance of CUs as a criterion to determine the QP (intended to be subjectively adapted). This may not be fully realistic in real-world applications. One expert commented that sometimes this simple approach even produces worse quality.

For subtest 2, a combination proposed inJCTVC-F661 (comb. of 2.3.g&f&e) gives roughly 0.35% bitrate reduction on average and is suggested for adoption. One expert mentions that 2.3.e is not in the original CE description and is in principle a new technique. Another suggested combination (JCTVC-F705) is made from 2.3g&(b||c).

Compared to constant-QP settings, the variable-QP scenario tested here is 6% worse.

Subtest 3: 2 methods (ARL making adaptation based on data, AQO based on Laplacian model). AQO only uses one offset value, but different for each components, ARL uses multiple (variable) offset values.

It seemed not to be clear whether the gain is by re-allocation of bits. With RDOQ on, gain by ARL is 1.1% BR reduction maximum, 0.8% for AQO with lambda refinement. Lambda is adapted on a sequence-by-sequence basis. With RDOQ off, gain is 1.8% and 1.9%.JCTVC-F610 is another similar contribution with only one offset for all three components, and is reported to give even better gain.

Need to identify methods to clarify where the gain comes from. Further study on subtest 3 (CE cont.)

Following these suggestions, JCTVC-F661 and JCTVC-F705 were presented in more detail.

5.4.2 Contributions

JCTVC-F221 CE4 Subtest1: the signalling of minCUDQPsize at LCU level [C. Pang, O. C. Au, X. Wen, J. Dai, F. Zou, X. Zhang (HKUST)]

JCTVC-F525 CE4 Subtest 1: Crosscheck of JCTVC-F221 HKUST signalling of minCUDQPsize at LCU level [D. Hoang (Zenverge)] [late upload 07-08]

JCTVC-F102 CE4 Subtest 2: Cross-check report of HKUST's proposal JCTVC-F156 (test 2.1.a) [H. Aoki, K. Chono, Y. Senda (NEC)]

JCTVC-F103 CE4 Subtest 2: QP prediction based on intra/inter prediction (test 2.4.b) [H. Aoki, K. Chono, Y. Senda (NEC)]

JCTVC-F156 CE4 Subtest2: QP prediction with previous CU (subtest 2.1.a) [C. Pang, O. C. Au, X. Wen, F. Zou, J. Dai, X. Zhang (HKUST)]

JCTVC-F159 CE4 Subtest 2: QP prediction based on intra prediction (test 2.3.g) [H. Aoki, K. Chono (NEC), M. Kobayashi, M. Shima (Canon)]

JCTVC-F300 CE4 Subtest 2: Delta QP prediction results of test 2.2.b and 2.3.f [M. Kobayashi, M. Shima (Canon)]

JCTVC-F332 CE4 Subtest 2: QP prediction from spatially neighboring CUs (test 2.3.b, 2.3.c) [M. Coban, M. Karczewicz (Qualcomm)]

JCTVC-F346 CE4 Subtest 2.3: Cross-check of Qualcomm's proposal (JCTVC-F332) on delta QP prediction [J. Jia, J. Park (LGE)]

JCTVC-F619 Crosscheck of JCTVC-F332 CE4 Subtest 2.3.c : QP prediction from spatially neighboring CUs [D. Hoang (Zenverge)] [late upload 07-09]

JCTVC-F421 CE4: X-check of 2.2.b and 2.3.f [K. Sato (Sony)]

JCTVC-F420 CE4: Result of 2.3.d and 2.3.e [K. Sato (Sony)]

JCTVC-F355 CE4 Subtest2: Cross-check report of Sony's proposal JCTVC-F420 (tests 2.3.d and 2.3.e) by ETRI [S.-C. Lim, H. Y. Kim, J. Lee (ETRI)]

JCTVC-F400 CE4 Subtest 2: Delta QP prediction results [M. Kobayashi, M. Shima (Canon)]

JCTVC-F640 CE4 Subtest 2: Cross-check report for JCTVC-F400 (test 2.3.g and 2.3.f combined) [H. Aoki, K. Chono, Y. Senda (NEC)] [late reg. 07-05, upload 07-06]

JCTVC-F644 CE4 Subtest 2: Cross-check report for JCTVC-F648 (test 2.3.g and 2.3.e.r1 combined) [H. Aoki, K. Chono, Y. Senda (NEC)] [late reg. 07-05, upload 07-07]

JCTVC-F661 CE4 Subtest 2: combination of test 2.3.g, 2.3.f and 2.3.e [H. Aoki, K. Chono (NEC), M. Kobayashi, M. Shima (Canon), K. Sato (Sony)] [late reg. 07-06, upload 07-08]

For intra CU, the intra prediction direction is used to determine from which CU to predict the QP.

For inter CUs, a prediction mode based method (using QP from the left or top CU with same prediction mode) or a mode using average.

Gain is 0.4% for intra, 0.2-0.3% for inter.

Question: Is it a problem to introduce dependencies between prediction mode and de-quantization? Apparently not, it is stored anyway.

JCTVC-F707 CE4 Subtest 2: Cross check report of JCTVC-F661 for MinCUDQPSize = 32x32 [M. Coban] [late reg. 07-11, upload 07-12]

JCTVC-F689 Cross-check of CE4 Subtest 2, Combination of 2.3.g, 2.3.f and 2.3.e (JCTVC-F661) [Rickard Sjöberg (Ericsson)] [late reg. 07-08, upload 07-13]

JCTVC-F394 Cross-check of MV coding JCTVC-F661 [T. Yamamoto (Sharp)] [late upload 07-12]

JCTVC-F705 CE4 Subtest 2: Spatial QP prediction: combination of test 2.3.g with 2.3.b/2.3.c [M. Coban, M. Karczewicz] [late reg. 07-11, upload 07-11]

Both combinations give approx. 0.4% for intra, 0.2/0.1% for inter.

JCTVC-F732 CE4 Subtest2: Verification result of Qualcomm's Spatial QP prediction (JCTVC-F705) [M. Shima (Canon)] [late reg. 07-13, upload 07-16]

JCTVC-F119 CE4 Subtest3: Adaptive De-Quantization Offset [X. Li, X. Guo, S. Lei (MediaTek)]

JCTVC-F368 CE4 Subtest 3.3.1.a: Cross-check MediaTek proposal JCTVC-E091 [X. Shen, X. Zhu, B. Yu (Zhejiang Univ.)]

JCTVC-F203 CE4.3.a Cross-check of Adaptive De-Quantization Offset [B. Li (USTC), G. J. Sullivan, J. Xu (Microsoft)]

JCTVC-F255 CE4 Subtest3: Cross-check report of RIM's proposal JCTVC-E276 (Subtest 3.3.2.a) [X. Li, X. Guo (MediaTek)]

JCTVC-F276 CE4-subtest3.3.2: Quantization with Adaptive Reconstruction Levels [Xiang Yu, Jing Wang, Dake He (RIM)]

JCTVC-F702 CE4-subtest3.3.2: Cross-check of Adaptive Reconstruction Levels (JCTVC-F276) [J. Xu (Microsoft)] [late reg. 07-11, upload 07-14]

JCTVC-F310 CE4 Subset 3: Cross checking of MediaTek proposal JCTVC-E091 on adaptive quantization offset with SAO off. [C. Auyeung (Sony)]

JCTVC-F237 CE4: Crosscheck of RIM ARL proposal (Subtest 3.3.2.b, RDOQ off) (JCTVC-F276) [M. Budagavi (TI)]

JCTVC-F238 CE4: Crosscheck of Sony proposal on dQP prediction (2.3e mod) (JCTVC-F420) [M. Budagavi (TI)]

JCTVC-F273 CE4: Cross-check MediaTek's proposal (Subtest 3.3.1.b) [X. Yu, J. Wang, D. He (RIM)]

JCTVC-F440 CE4: Cross check of MediaTek proposal by Samsung [E. Alshina (Samsung)]

JCTVC-F441 CE4: Cross check from RIM proposal by Samsung [E. Alshina (Samsung)]

JCTVC-F507 CE4: Cross-check of NEC and Canon's proposal JCTVC-F159 by Huawei [H. Yang, H. Yu (Huawei)]

JCTVC-F508 CE4: Cross-check of NEC proposal JCTVC-F103 by Huawei [H. Yang, H. Yu (Huawei)]

JCTVC-F648 CE4: Result of Combination 2.3.g + 2.3.e [K. Sato (Sony)] [late reg. 07-05, upload 07-11]

JCTVC-F757 Request to revisit CE4 Subtest2 results M. Shima (Canon), K. Sugimoto (Mitsubishi Electric), K. Panusopone (Motorola Mobility), H. Aoki, K. Chono (NEC), M. Coban (Qualcomm), K. Sato, K. Kondo (Sony) [late reg. 07-18, upload 07-18]

This joint contribution asserts that TM5-based subjective quality adaptive quantization is a reasonable method for evaluating QP prediction and delta-QP entropy coding technologies. Commercial video encoders reportedly use similar subjective quality adaptive quantization schemes. The TM5-based subjective quality adaptive quantization was used not only for CE4 Subtest2 but also for new QP prediction and delta-QP entropy coding technologies such as JCTVC-F046, JCTVC-F174, JCTVC-F422, JCTVC-F499, and JCTVC-F577. In CE4 discussions, it had been agreed to adopt the TM5-based subjective quality adaptive quantization into HM software. It was suggested that this implies that the TM5-based subjective quality adaptive quantization is endorsed for evaluating QP prediction and delta-QP entropy coding technologies and that CE4 Subset2 results obtained by using the software were successfully evaluated. In addition, as described in JCTVC-F756, the QP coding BoG participants reportedly agreed that use of TM5-based subjective quality adaptive quantization is realistic enough and should be sufficient for the text condition of the next CE on QP coding. QP prediction schemes were asserted to be orthogonal to other technologies such as intra prediction, in-loop filtering, etc., and it was reportedly expected that a QP prediction scheme (2.3.g+2.3.f+2.3.e) that is suggested by CE4 summary for HM adoption will perform the best among spatial QP prediction proposals of CE4 Subtest2 also in the next version of HM. It was proposed that the 2.3.g+2.3.f+2.3.e proposal (JCTVC-F661 and JCTVC-F705) be adopted into HM4.0.

A concern was raised looking at the fact that the current dQP implementation in software is not in the best state (see plenary discussion of Tuesday), and introducing new elements with even more dependencies might cause even more problems (with relatively small gain). The CE should target a consistent bundle of dQP prediction and entropy coding, which is cleaner. It was suggested that the "Most recent QP dependency" should be removed.

No action was taken on this.

General note: To assess the benefit of more compressive coding of dQP, other more realistic application cases of dQP adaptation (see e.g. JCTVC-F492) would be helpful.

5.4.3 Discussion and Conclusions

Subtest 1 – discontinue.

Subtest 2 – further study for more realistic situations.

Agreed action: Include the TM5 step3 scheme (default off) in the HM for testing tools where the QP must be adapted at the CU level (with K. Chono volunteering to do the software work). It seems that, if necessary, very simple methods may fulfil this purpose. The adaptation should also be further improved if possible.

Subtest 3 – further study.

In plenary discussion it was suggested that the current method should be improved in terms of implementation.

5.5 CE5: CAVLC entropy coding improvement

5.5.1 Summary

JCTVC-F025 CE5: Summary report of Core Experiment on CAVLC entropy coding improvements [X. Wang, P. Wu (CE coordinators)] [upload 07-13]

5.5.2 Contributions

JCTVC-F345 Cross-check report on CE5: Modifications for inter mode and split flags coding in CAVLC (JCTVC-E258) [K. Chono, H. Aoki (NEC)]

JCTVC-F390 CE5: Simplification of transform coefficient coding in CAVLC [Y. Yasugi, T. Yamamoto (Sharp)]

In JCTVC-F390, a run mode bypass mechanism is proposed. According to the scheme, when the level of the last non-zero coefficient is greater than one and the current block is an intra-coded luma block, run mode is bypassed with level mode started directly. It's asserted that such a run mode bypass scheme can lower encoding and decoding complexity. It's reported that there is no change in coding performance with proposed scheme.

Comments: It would be good to see more detailed analysis on complexity reduction.

A proposal was presented with regard to that. Disagreement was raised w.r.t. that run mode is not necessarily more complex than level mode, and invoking the level mode instead may even increase the complexity.

No action was taken on this.

JCTVC-F404 CE5: Cross-check of Yonsei Univ. and Samsung's proposal (JCTVC-F408) [Y. Yasugi (Sharp)] [late upload 07-06]

JCTVC-F408 CE5: Run and level mode coding improvement in CAVLC [S. Kim, J. Lee, S. Lee (Yonsei Univ.), J. Chen, J. Park (Samsung)]

In JCTVC-F408, several things are proposed.

- For intra block coding, one more parameter table is added specifically for block size 16x16 or larger. The parameter table is used in determining codeword mapping in run-level coding. Currently in HM3.0 one table is shared for block size 8x8 and larger.
- Modifications to VLC table adaptive selection in level coding. In HM3.0 one set of threshold values is defined in VLC table selection. Based on the proposal these threshold values are made dependent on factors such as block type (intra luma, P luma, B luma, or chroma) as well as RQT depth.
- Modifications to VLC tables

With all the changes above, it is reported that the BD-rate savings are 0.7% for Intra, 0.3% for random access and 0.2% for low delay.

Comments:

- Relative to JCTVC-E446, (2) and (3) seems to be new changes also (1) would need to be modified if (2) and (3) are used.
- In the software, (1) and (2) are controlled under one macro. It would be good to know the performance improvement from (1) alone.

Gain for (1) alone is 0.4/0.2/0.1 for AI/RA/LD

(1) needs 2 additional tables (approx. 400 byte in total), adopting this standalone would not be justified. JCTVC-F612 is also similar to (1) but does not add tables.

Further study in CE5 (if continued, there are more non-CE contributions for CAVLC improvements).

Action: present JCTVC-F408 in the non-CE section - done.

See notes in non-CE section.

JCTVC-F409 CE5: Crosscheck for Sharp's proposal (JCTVC-F390) [J. Lee, S. Kim, S. Lee (Yonsei Univ.), J. Chen, J. Park (Samsung)] [late upload 07-12]

JCTVC-F524 CE5: Results on modified inter mode coding and joint coding of split flags for CAVLC [Anand Kotra, Virginie Drugeon, Thomas Wedi (Panasonic)]

Two techniques are proposed in JCTVC-F524.

For inter mode coding, the VLC index mapping table is currently defined CU depth dependent in HM3.0. This proposal proposes that for each CU depth level, multiple (3 or 5) VLC mapping tables are used depending on the partitioning and prediction information of the CUs above and left.

A joint coding scheme of CU split flags for I-frame. More specifically based on the proposal split flags of four neighboring CUs at the same depth level are grouped and coded together. For each CU depth, three

VLC tables are used based on neighboring block flags. In addition, different set of VLC tables are trained based on slice QP value smaller than 30 or not.

Coding gain from two proposed techniques is reported to be about 0.1% for different configurations.

Comments:

Cross-checker suggested code improvement, e.g. avoid duplication of code.

Less gain than in original proposal, not worthwhile to consider. Version 4 shows more gain for the range of high QPs (not the common test conditions).

No action was taken on this.

5.5.3 Discussion and Conclusions

There was not enough feedback from CE participants to take action on an adoption recommendation for the above proposals.

5.6 CE6: Intra prediction improvement

5.6.1 Summary

JCTVC-F026 CE6: Summary report of Core Experiment on intra prediction improvements [A. Tabatabai, M. Budagavi, K. Chono, R. Joshi, A. Segall, H. Yu (CE coordinators)]

Intra prediction improvement core experiments were divided into 5 categories:

- CE6.a: Block based Intra Prediction
- CE6.b: Short Distance Intra Prediction (SDIP) Harmonization
- CE6.c: Differential Coding of Intra Mode (DCIM)
- CE6.d: Parallel Intra Coding
- CE6.e: Intra Smoothing

BUDI: Description of BUDI seems to be reasonably understandable for the first time. The proponents suggested to select version 2a (saying this balances the tradeoffs for luma/chroma). Reduction of encoding time to 97%, decoding time unchanged, bitrate reduction 0.1-0.2% for the different 2x versions.

Question: Harmonization with MDIS? Is used for block sizes 8x8, 16x16 and 32x32.

Gain by BUDI is much lower than reported in the last meeting.

The reduction in encoding time (skipping the checking of planar mode) is not BUDI specific.

Conclusion: No action.

SDIP: Different harmonizations were investigated.

- RQT is roughly unchanged (same for rectangular TU) but a flag is embedded to support SDIP. This comes with same performance as un-harmonized version for HE and small gain (0.2%) for LC. Another method is case 2 which is less harmonized in introducing structures such as 8x32 in RQT -> case 1.
- Harmonization with mode-dependent DCT/DST.
- Harmonized version is using MDCS unchanged from HM 3.0 for the case of square blocks. This comes with same compression performance of non-harmonized version. Further results unveil that MDCS in combination with SDIP is a bit less well-performing (due to use of SDIP modes?).

- Harmonization of LM mode: 2 different versions, both with unchanged performance. Question: How is division handled if the sum of hor/ver block lengths is not a power of 2? A: LM used only for square blocks -> LM mode with 1st position.
- Harmonization with MDIS: No problem with normal MDIS. There is also a combination suggestion with an MDIS modification in CE6e.
- Combination with planar prediction gives small gain (0.1%).
- Combination with de-blocking causes losses (used now for both square and non-square blocks whereas original SDIP did not use de-blocking) Question: Is this useful for small partitions?
- (Note: There is another version provided by Qualcomm which is actually new and should not have been considered in this CE.)
- Combination with DC prediction filtering (no harmonization filtering) does retain gains of both methods.

The harmonization effort was judged to be satisfactory.

Concern was raised w.r.t. the throughput that can be achieved for the very small non-square blocks (2x8, 1x16). There is another doc (JCTVC-F343) that reports almost zero loss when 1x16 is disabled; however it is reported verbally that omitting 2x8 may cause more severe losses.

Question: Is the new mode 32x2 included in harmonized result? A: Yes. Some of the gain of the harmonized result may be due to that (it was not in the SDIP branch).

Gain seems to be lower than reported last meeting? Not completely true, as the higher-gain versions of SDIP included modes such as 1x4 which are not used any more. Lowest gain reported last meeting was 2.0 and 3.2% for most simple HE and LC versions, now the gain is 1.4% and 2.1%.

Encoding time increase seems to be roughly 36% and 55% for the HE and LC cases. This is approx. doubled as compared to the previous reports (with HM2). The implementers explain that this is due to lack of encoder optimization in HM3. Reason: Method of generating intra prediction references

Currently, numbers comparing SDIP branch versus HM3 are given in JCTVC-F026, and numbers comparing harmonized SDIP versus SDIP branch in JCTVC-F532. Exact numbers of gains and encoder/decoder run times for complete harmonized version vs. HM3.0 to be provided: 1.6%/2.6% BR red., 39%/56% enc. runtime increase, 3%/6% decoder runtime increase.

Conclusion: Further study: Performance when 1x16 and 2x8 TU sizes are disabled, potentially include 2x16 which is assumed to be (according to expert's opinion) less problematic than 2x8 in terms of throughput. Furthermore, reduction of encoder runtime should be investigated.

Breakout (coordinated by W. Gao) will informally discuss the throughput issue. (See notes under JCTVC-F755.)

Preliminary decision (Monday): Adopt SDIP harmonized (RQT without 2x32/32x2, LM mode 1st position, conventional de-blocking not new method of JCTVC-F556, other items as above), without 1x16/16x1, provided that software implementation in HM3.3 is provided by Wed. 2359 with sufficient quality according to the guidelines, and appropriate WD text.

The WD text submitted was assessed to be of sufficient quality (confirmed by WJ Han Thu. 07-21 p.m.)

The Friday plenary assessed the results of the integration in HM 3.3, which indicated that the encoder runtime for HE was increased by 38%, for LC by 61%, whereas the compression gain became 0.2% lower than expected in both intra configurations. The preliminary decision was later revised – SDIP will be further studied in a CE (not included in the WD & HM).

An early-skip search method was noted in the encoder software for non-square cases. This was mentioned in v3 of the JCTVC-E278, although not described in detail. It was noted that encoder search algorithms should be documented in proposals. A proper description would be needed for the HM text.

It was also pointed out that possibly a harmonization with non-square inter coding would be desirable.

JCTVC-F532 should be updated with the additional results HM3.0 vs. harmonized version, as reported elsewhere in the report.

Disable flag shall be implemented.

Regarding DCIM, see notes below (no action).

5.6.2 Contributions

JCTVC-F151 CE6 Subtest A: Cross-check report on Bidirectional UDI mode (JCTVC-F509) [H. L. Tan, Y. H. Tan, C. Yeo (I2R)]

JCTVC-F204 CE6.a: Cross-check of cases 7 and 8 for BUDI [X. Peng (USTC), J. Xu (Microsoft)]

JCTVC-F348 Cross-check report on CE6.a BUDI [Keiichi Chono, Hirofumi Aoki (NEC)]

JCTVC-F509 CE6.a: Report of Bidirectional UDI mode for Intra prediction [Y. Lin (HiSilicon), H. Yang (Huawei), C. Lai (HiSilicon), J. Zheng (HiSilicon), L. Liu (HiSilicon)]

JCTVC-F565 CE6.a: Cross Check of Tests 9 and 10 for BUDI Mode (JCTVC-F509) [G. Van der Auwera (Qualcomm)]

JCTVC-F110 CE6.b Test 4: LM mode harmonization on SDIP [J. Lim, B. Jeon (LGE)]

JCTVC-F139 CE6.b: Cross-check of Test 2 Case 1 (Huawei JCTVC-F506) [J. Jung, J. Le Tanou (Orange Labs)]

JCTVC-F155 CE6 Subtest B: Cross-check report on SDIP Test 2b (JCTVC-F506) [C. Yeo, Y. H. Tan (I2R)]

JCTVC-F195 CE6.b Test 4: Cross-verification results of Microsoft's LM mode harmonization on SDIP (JCTVC-F196) by LG [J. Lim, B. Jeon (LGE)]

JCTVC-F196 CE6.b Report of Test 4: Harmonization of LM mode and the chroma prediction in SDIP [X. Peng (USTC), J. Xu (Microsoft)]

JCTVC-F197 CE6.b Report of Test 3: Interaction between SDIP and MDCS [X. Peng (USTC), J. Xu (Microsoft)]

JCTVC-F231 CE6.b: Cross-check report of Test 3 : Interaction between SDIP and MDCS, proposal JCTVC-F197 [R. Boitard, L. Guillo (INRIA)]

JCTVC-F239 CE6.b: Crosscheck of SDIP+Mode dependent DCT/DST (test2, case3) (JCTVC-F506) [M. Budagavi (TI)]

JCTVC-F308 CE6.b Cross-check of Test1: Interaction between SDIP and RQT [J. Xu, A. Tabatabai (Sony)]

JCTVC-F309 CE6.b Cross-check of Test3: Interaction between SDIP and MDCS [J. Xu, A. Tabatabai (Sony)]

JCTVC-F336 CE6.b.5 Report: Harmonization of SDIP and MDIS [G. Li, N. Ling (Santa Clara Univ.), L. Liu, C. Lai, J. Zheng, P. Zhang (Hisilicon)]

JCTVC-F349 Cross-check report on CE6.b SDIP [K. Chono, H. Aoki (NEC)]

JCTVC-F392 CE6.b: Cross-check of Short Distance Intra Prediction (SDIP) [T. Yamamoto (Sharp)]

JCTVC-F437 CE6.b: Crosscheck Report of Qualcomm's Proposal JCTVC-F556 [M. Guo, X. Guo (MediaTek)]

JCTVC-F489 CE6.b test6 : cross-checking of results from Huawei/Hisilicon on SDIP+Planar [Edouard François (Canon)]

JCTVC-F506 CE6.b: Harmonization of SDIP and MDDT [H. Yang, J. Zhou, H. Yu, C. Lai (Huawei)]

JCTVC-F518 CE6.b Test6: Report of harmonization on Planar prediction in SDIP [Y. Lin, C. Lai (HiSilicon), X. Cao (Tsinghua), J. Zheng, L. Liu (HiSilicon)]

JCTVC-F532 CE6.b Test Summary and spec text of SDIP [X. Cao, Y. Wang, Y. He(Tsinghua), X. Peng(USTC), G. Li(Santa Clara University), J. Xu(Microsoft), H. Yang, H. Yu(Huawei), C. Lai, Y. Lin, L. Liu, J. Zheng(HiSilicon)]

JCTVC-F533 CE6.b Report on test1 Harmonization of SDIP and RQT [X. Cao, Y. Wang, Y. He(Tsinghua), X. Peng(USTC), J. Xu(Microsoft), H. Yang, H. Yu(Huawei), C. Lai, Y. Lin, L. Liu, J. Zheng(HiSilicon)]

JCTVC-F536 CE6.b Report on test7 Harmonization of SDIP and deblocking filter [X. Cao, Y. He(Tsinghua), X. Peng(USTC), J. Xu, F. Wu(Microsoft), C. Lai, J. Zheng(HiSilicon), H. Yu(Huawei)]

JCTVC-F539 CE6.b Test8 Crosscheck report for Qualcomm's results [C. Lai, L. Liu, J. Zheng(HiSilicon)] [late upload 07-10]

JCTVC-F556 CE6.b: Report on SDIP Harmonization with Deblocking, MDIS, MDCS, and HE Residual Coding [G. Van der Auwera, J. Sole, Y. Zheng, X. Wang, I. S. Chong, R. Joshi, M. Karczewicz (Qualcomm)]

JCTVC-F638 CE6.b: Cross-verification of Qualcomm's JCTVC-F556 section 4 on SDIP Harmonization for HE Residual Coding [V. Seregin, J. Chen (Samsung)] [late reg. 07-05, upload 07-06]

JCTVC-F674 Cross Check of CE6.b Test 5 (JCTVC-F556) on SDIP Harmonization with MDIS [J. Zhao, A. Segall (Sharp)] [late reg. 07-07, upload 07-07]

JCTVC-F557 CE6.b SDIP Harmonization: Cross Check Results for Test 5 on MDIS and Test 7 on Deblocking (JCTVC-F532) [G. Van der Auwera (Qualcomm)]

JCTVC-F630 CE6.b4:Cross-check results (JCTVC-F026) [A. Gabriellini, M. Mrak (BBC)] [late reg. 07-04, upload 07-04]

JCTVC-F684 CE6.b: Additional simulation results of RQT and SDIP harmonization [Keiichi Chono (NEC), Krit Panusopone (Motorola Mobility)] [late reg. 07-07, upload 07-07]

JCTVC-F697 Crosscheck for additional simulation results of RQT and SDIP harmonization from NEC and Motorola Mobility (JCTVC-F684) [C. Lai, L. Liu, J. Zheng (HiSilicon)] [late reg. 07-10, upload 07-10]

JCTVC-F566 CE6.c: Differential Coding of Intra Modes [Ehsan Maani, Tomoyuki Yamamoto, Akiyuki Tanizawa, Taichiro Shiodera, Virginie Drugeon]

This document presents the description and results of Differential Coding of Intra Modes (DCIM) of JCTVC-B109. On average, using this technique, 0.8% and 0.7% gain is achieved compared to HM 3.0 anchors for High Efficiency (HE) and Low Complexity (LC) settings, respectively.

The presentation deck provides additional results combining SDIP and DCIM, showing that gain of 0.4% is retained (not in Word file).

Decoding time increases by roughly 3% for HE, 5-6% for LC.

Four different versions were presented which are different in terms of encoding time increase 6–13% for HE, 14–24% for LC, 0.4–0.8% for HE, 0.1–0.7% for LC.

Question: What are worst-case numbers for decoding time increase? Could be up to 30%.

Comment: Gain in terms of BR reduction is only half of what was reported last time, whereas the encoding time went up. This seems to be a general tendency of all intra coding methods currently investigated.

Conclusion: In terms of tradeoff gain vs. complexity, this should not be adopted. Further study (there may be similar approaches suggested in the non-CE category).

JCTVC-F240 CE6.c: Crosscheck of DCIM (case 4) (JCTVC-F566) [M. Budagavi (TI)]

JCTVC-F413 CE6.c: Cross-check of Differential Coding of Intra Mode (DCIM) [G. Van Wallendael, S. Van Leuven, J. De Cock, R. Van de Walle (Ghent Univ.)]

JCTVC-F534 CE6.c Crosscheck report for DCIM [C. Lai, L. Liu, J. Zheng(HiSilicon)] [late upload 07-07]

JCTVC-F605 CE6.d Parallel Intra Coding [J. Zhao, A. Segall (Sharp)]

JCTVC-F328 CE6.d: Cross check report of Sharp's proposal (JCTVC-F605) from Toshiba [A. Tanizawa, T. Shiodera (Toshiba)]

This contribution reports results for the parallel intra prediction concept that was proposed in JCTVC-E315. The parallel prediction unit (PPU) defines a group of pixels that are intra-coded in a parallel fashion. Parallelization is achieved by partitioning the intra-coded blocks into two sets. Blocks in the first set are predicted in parallel using available pixels outside the PPU; blocks in the second set are also predicted in parallel using available pixels outside the PPU as well as pixels from the first set of blocks.

Here, the performance of the parallel intra prediction is reported in the context of HM3.0. Three configurations are considered. First, a "checkerboard" partitioning is considered. Second, a "stripe" configuration is reported. Finally, for comparison, the impact of disabling 4x4 prediction completely (but allowing 4x4 transforms) is reported. For the case of parallel intra prediction with stripe partitioning, an average coding efficiency impact of 0.2%, 0.5% and 1.3% for, respectively, low delay, random access, and all intra common test conditions was reported. For the case of checker board partition, there is a coding efficiency impact of 1.5% and 1.8% for all intra and intra LC coding. In comparison, disabling 4x4 prediction (8x8 prediction with 4x4 residuals) results in 3.9% and 5.3% rate increase for intra and intra LC configurations.

Main question to be clarified: Is parallelism at the level of PUs needed? Comparison against parallelism at slice level? Slice-level parallelism may be the better way to go.

No support was expressed to adopt this. No request was made for further information, such that the results of this CE could be referred to in the future when potentially more evidence might be available that this kind of parallelism is needed.

JCTVC-F583 CE6.d: Cross Check Result for Sharp's Parallel Intra Coding (JCTVC-F605) [G. Van der Auwera (Qualcomm)]

JCTVC-F628 CE6.d: Cross Check Result for Sharp's Parallel Intra Coding (JCTVC-F605) by ETRI [Seunghyun Cho, Sukho Lee, Nakwoong Eum (ETRI)] [late reg. 07-04, upload 07-04]

JCTVC-F126 CE6.e: Report on Mode-Dependent Intra Smoothing Modifications [G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm)]

This contribution proposes modifications to mode-dependent intra smoothing (MDIS), which is studied in CE6.e. The decision mapping table is updated and planar mode is included. On average the BD-rate impact is −0.1% for both intra-coding test conditions, while execution times are unchanged. For the BasketballDrill (class C) sequence, the coding impacts are −0.9% (HE) and −1.8% (LC). It was proposed to adopt the MDIS modifications into the HM.

Note: As before, the table is trained from a large set of sequences including our test set. It was, however, commented by several experts (including the cross-verifiers) that the new table is more consistent (symmetry of modes, etc.).

Decision: Adopt the new LUT as suggested in JCTVC-F126.

JCTVC-F171 CE6.e: Cross-verification report on Qualcomm's improved MDIS (JCTVC-F126) [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)]

JCTVC-F673 Cross Check of Qualcomm's Proposal (JCTVC-F126) on Mode-Dependent Intra Smoothing Modifications [J. Zhao, A. Segall (Sharp)] [late reg. 07-07, upload 07-07]

JCTVC-F411 CE6.e: Cross-check of Intra Smoothing [G. Van Wallendael, S. Van Leuven, J. De Cock, R. Van de Walle (Ghent Univ.)]

5.6.3 Discussion and Conclusions

A new MDIS LUT was adopted as suggested in JCTVC-F126, as recorded above.

Investigation on BUDI was discontinued.

For further planning of CE6 – see under section 6.15.

5.7 CE7: Additional transforms

5.7.1 Summary

JCTVC-F027 CE7: Summary report of Core Experiment on additional transforms [R. Cohen, C. Yeo, R. Joshi, F. Fernandes (CE coordinators)] [upload 07-08]

The types of proposed transforms and methods generally fall into one or more of the following categories:

- (1,2,6) Mode-dependent DCT/DST or DCT/KLT, where the horizontal and vertical transform depends upon the Intra prediction mode. 8x8 versions and improvements to the existing 4x4 version are tested.
- (3) Mode-dependent secondary 4x4 KLT applied to lowest frequency coefficients of 8x8 and larger transform blocks, used horizontally and/or vertically depending upon mode (KLT derived based on DST correlation model).
- (4) Secondary rotational 8x8 transform applied to lowest frequency coefficients of 8x8 and larger transform blocks, rate-distortion optimized selection.
- (5) Adaptive selection of 2-D DCT or DST, rate-distortion optimized or coefficient-based selection.

The last two cases have increase in encoding time as it is necessary to test different transforms. Results overview:

	Overall BD-Rate change for the luma (Y) components (%)					
Tool	1 (JCTVC-F138) 8x8 MD DCT/KLT	2 (JCTVC-F282) 8x8 MD DCT/DST	3 (JCTVC-F224) MD secondary 4x4	4 (JCTVC-F294) RD secondary ROT	5 (JCTVC-F229) RD or fast 2-D Intra/Inter DST-II	6 (JCTVC-F283) Reduced-complex. 4x4 DST
Reference / Config	HM3.0	HM 3.0	HM 3.0	HM3.0	HM 3.0	HM 3.0
AI-HE	−0.4	−0.2	−0.4	−0.9	−0.3 | −0.2 | N/A | N/A	0.0
AI-LC	−0.2	0.0	−0.3	−1.0	0.4 | 0.5 | N/A | N/A	0.0
RA-HE	−0.2	−0.2	−0.3	−0.5	−0.5 | −0.5 | −0.4 | −0.2	0.0
RA-LC	−0.1	0.0	−0.2	−0.6	0.1 | 0.1 | −0.2 | −0.1	0.0
LD-HE					−0.7 | −0.7 | −0.7 | −0.4	
LD-LC					−0.2 | −0.2 | −0.4 | −0.2	
LD-HE(P)					−0.6 | −0.6 | −0.7 | −0.3	
LD-LC(P)					−0.2 | −0.2 | −0.4 | −0.2	

	Encoding time as compared to reference (%)					
Tool	1 (JCTVC-F138) 8x8 MD DCT/KLT	2 (JCTVC-F282) 8x8 MD DCT/DST	3 (JCTVC-F224) MD secondary 4x4	4 (JCTVC-F294) RD secondary ROT	5 (JCTVC-F229) RD or fast 2-D Intra/Inter DST-II	6 (JCTVC-F283) Reduced-complex. 4x4 DST
Reference / Config	HM3.0 | SDIP	HM 3.0	HM 3.0	HM3.0	HM 3.0	HM 3.0
AI-HE	101	102	101	125	122 | 111 | N/A | N/A	101
AI-LC	101	100	101	157	139 | 123 | N/A | N/A	101

RA-HE	100	102	100	105	115 | 114 | 117 | 107	102
RA-LC	100	102	100	105	115 | 113 | 115 | 108	99
LD-HE					113 | 112 | 115 | 107	
LD-LC					112 | 111 | 112 | 106	
LD-HE(P)					119 | 116 | 120 | 109	
LD-LC(P)					120 | 117 | 120 | 111	

	Decoding time as compared to reference (%)					
Tool	1 (JCTVC-F138) 8x8 MD DCT/KLT	2 (JCTVC-F282) 8x8 MD DCT/DST	3 (JCTVC-F224) MD secondary 4x4	4 (JCTVC-F294) RD secondary ROT	5 (JCTVC-F229) RD or fast 2-D Intra/Inter DST-II	6 (JCTVC-F283) Reduced-complex. 4x4 DST
Reference / **Config**	HM3.0	HM 3.0	HM 3.0	HM3.0	HM 3.0	HM 3.0
AI-HE	102	103	101	101	101 | 101 | N/A | N/A	100
AI-LC	102	100	101	100	101 | 102 | N/A | N/A	101
RA-HE	102	102	100	101 | 101	99 | 99 | 99 | 100	102
RA-LC	101	104	100	100 | 100	99 | 100 | 99 | 99	100
LD-HE					100 | 99 | 100 | 99	
LD-LC					99 | 98 | 99 | 99	
LD-HE(P)					100 | 100 | 100 | 100	
LD-LC(P)					98 | 99 | 98 | 98	

	Operations count									
Tool		HM2	HM3 (DCT)	HM3 (DST)	Tool 1 (JCTVC-F138)	Tool 2 (JCTVC-F282)	Tool 3 (JCTVC-F224) MD	Tool 4 (JCTVC-F294) RD	Tool 5 (JCTVC-F229) RD or fast	Tool 6 (JCTVC-F283) Reduced

Trans-form Size					8x8 MD DCT/ KLT	8x8 MD DCT/ DST	secondary 4x4	secondary ROT	2D Intra/Inter DST-II	-complex. 4x4 DST
4x4	Mults	0	48	64					+0 | 48	40
	Adds	80	96	120					+8 | 96	120
	Shifts	32	32	32					+0 | 32	56
8x8	Mults	0	352		1024	1024	+128	+240	+0 | 352	
	Adds	640	576		1024	1024	+128	+288	+32 | 576	
	Shifts	352	128		128	128	+32	+336	+0 | 128	
16x16	Mults	1408	3752				+128	+240	+0 | 3752	
	Adds	2624	3712				+128	+288	+128 | 3712	
	Shifts	1600	512				+32	+336	+0 | 512	
32x32	Mults	7424	21888				+128	+240	+0 | 21888	
	Adds	13440	25856				+128	+288	+512 | 25856	
	Shifts	7296	2048				+32	+336	+0 | 2048	

Note: JCTVC-F153 is another fast implementation of the current DST, whereas JCTVC-F283 changes the coefficients. Tool 6 was discussed again in that context, with no action.

The secondary transform of tool 3 has the problem that 16 bit implementation is not viable currently. There could be overflow cases where one additional bit is needed. Otherwise this appears to give a good tradeoff complexity vs. performance -> a revised version of the document contains the information that by applying a clipping operation to resolve this, results are not changed.

Some of the gain of tool 3 could be due to the fact that mode-dependent scans are currently not used for block sizes larger than 8x8. In this context, it is reported by the proponent that the gain is approximately half if the mode-dependent secondary transform is only applied to 8x8.

Tool 4 looks promising in terms of compression (though lower than reported last time due to the fact that it does not realize gain in the 4x4 case anymore), but the complexity/performance tradeoff of the current implementation is not reasonable.

Cascaded transforms, in general, increase the number of sequential multipliers which may be undesirable

Tool 1 (KLT basis) derived from 0.65 correlation model, better than tool 2 (DST), but may be slightly tweaked towards the test set. Further, the KLT would add yet another transform basis in the overall design, which may not be desirable considering the relatively small gain. The DST extended to 8x8 blocks gives almost no relevant gain.

Tool 5 is mostly relevant for inter coding, but it has too large increase in encoder runtime to justify the moderate gain.

Neither KLT or DST 8x8 are likely to be implementable in fast algorithms, but direct multiply is not seen as a problem.

5.7.2 Contributions

JCTVC-F138 CE7: Tool 1 - Mode dependent intra residual coding for 8x8 blocks [R. Joshi, P. Chen, M. Karczewicz (Qualcomm), A. Tanizawa, J. Yamaguchi (Toshiba), C. Yeo, Y. H. Tan, Z. Li (I2R)]

JCTVC-F141 CE7: Cross-check of Samsung's proposed Tools 2 (JCTVC-F282) and 6 (JCTVC-F283) [C. Yeo, H. L. Tan, Y. H. Tan (I2R)]

JCTVC-F224 CE7: Mode Dependent 2-step Transform for Intra Coding [Y. Shibahara, T. Nishi (Panasonic)]

JCTVC-F226 CE7: Cross Check Report for NHK's proposal (JCTVC-F229) by Panasonic [Youji Shibahara, Takahiro Nishi (Panasonic)]

JCTVC-F229 CE7.5: Performance analysis of adaptive DCT/DST selection [A. Ichigaya, Y. Sugito, S. Sakaida (NHK)]

JCTVC-F230 CE7: Cross Check Report for Panasonic's proposal (JCTVC-F224) by NHK [Atsuro Ichigaya, Yasuko Sugito (NHK)]

JCTVC-F281 CE7: Cross Check Report for Mode Dependent Intra Residual Coding for 8x8 blocks (JCTVC-F138) by Samsung [A. Saxena, F. Fernandes (Samsung)]

JCTVC-F282 CE7: Mode-Dependent 8x8 DCT/DST for Intra Prediction [A. Saxena, F. Fernandes (Samsung)]

JCTVC-F283 CE7: On fast implementation of 4-point DST Type-7 with 5 multiplications [A. Saxena, F. Fernandes (Samsung)]

JCTVC-F294 CE7: Experimental Results for the Rotational Transform [Zhan Ma, F. Fernandes, E. Alshina, A. Alshin (Samsung)]

JCTVC-F329 CE7: Cross check report of Samsung's proposal (Tool6 : JCTVC-F283) from Toshiba [A. Tanizawa, J. Yamaguchi (Toshiba)]

JCTVC-F510 CE7: Cross-check of JCTVC-F138 by Huawei [H. Yang, H. Yu (Huawei)]

JCTVC-F511 CE7: Cross-check of Panasonic's proposal JCTVC-F224 by Huawei [H. Yang, H. Yu (Huawei)]

JCTVC-F558 CE7: Crosscheck of tool 3 – Panasonic's mode dependent secondary transform (JCTVC-F224) [R. Joshi (Qualcomm)]

JCTVC-F559 CE7: Crossscheck of tool 4 - Samsung's rotational transform (JCTVC-F294) [R. Joshi (Qualcomm)]

JCTVC-F600 CE7: Cross check of JCTVC-F229, Performance analysis of adaptive DCT/DST selection [R. Cohen, A. Vetro, H. Sun]

JCTVC-F734 CE7: Cross-Check for Mode-Dependent 2-step transform for Intra Coding (JCTVC-F224) [Ankur Saxena, Yinji Piao, Elena Alshina, Felix Fernandes (Samsung)] [late reg. 07-13, upload 07-14 after opening]

5.7.3 Discussion and Conclusions

Results of the current CE do not currently indicate a need for inclusion of any of the additional elements concerning tools 1-5.

Continue CE7 on:

- Secondary transforms (JCTVC-F224, JCTVC-F554, JCTVC-F294) – implication of using a secondary transform must be more thoroughly assessed, to be able to judge whether an expected 0.7% BR reduction is worthwhile.
- Extension of DST/DCT for chroma (JCTVC-F553)

5.8 *CE8: Non-deblocking loop filtering*

5.8.1 Summary

JCTVC-F028 CE8: Summary report of Non-deblocking Loop Filtering [T. Yamakage, I. S. Chong, M. Narroschke] [upload 07-12]

A summary of core experiment 8 (CE8) on Non-deblocking loop filtering was reported. There are five Subtests in CE8,

- Subtest1: Enhance block level filter adaptation with directional features (three proposals, software checked),
- Subtest 2: Effectiveness of adaptive loop filtering scheme are evaluated for using fixed set of filters (one proposal),
- Subtest 3: Memory reduction schemes in ALF decoding (one proposal),
- Subtest 4: Complexity reduction and/or quality improvement (three proposals)
- Subtest 5: Effectiveness of chroma adaptive loop filtering scheme (two proposals).

These were evaluated based on the common conditions in JCTVC-E700 and additional conditions in JCTVC-E708. All mandatory results are verified by cross-checkers.

"Subtest 0" / "Homework" ALF on vs. ALF off comparison, as tabulated below:

		High Efficiency			
		AI	RA	LDB	LDP
ΔBD-rate	Class A	4.1	6.7		
	Class B	2.3	4.9	5.5	8.7
	Class C	2.1	3.0	3.7	3.8
	Class D	0.9	2.8	2.5	1.7
	Class E	3.5		7.7	11.5
	Overall	2.5	4.4	4.7	6.2
Enc. Time		82	94	95	93
Dec. time		75	81	81	79

Informally (very informally), it was reported that ALF seemed to never hurt subjective quality, and to sometimes substantially improve subjective quality.

5.8.2 Contributions

5.8.3 Subtest 1: Block level filter adaptation with directional feature (BADIR)

JCTVC-F301 CE8 Subtest 1: Block-based filter adaptation with features on subset of pixels [P. Lai, F. C. A. Fernandes, E. Alshina, I.-K Kim (Samsung)]

JCTVC-F223 CE8.1: Verification results of Samsung's Proposal (JCTVC-F301) [Faouzi Kossentini, Hsan Guermazi (eBrisk)]

JCTVC-F387 CE8.1: Cross-check result of Samsung's adaptive loop filter (JCTVC-F301) [T. Ikai, Y. Yasugi (Sharp)]

JCTVC-F321 CE8.1: Block based Adaptive Loop Filter by MediaTek, Qualcomm and Toshiba [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-F307 CE8 Subtest 1: Cross-check of MediaTek, Qualcomm and Toshiba's proposal (JCTVC-F321) on block based ALF and temporal prediction of ALF coefficients [P. Lai, F. C. A. Fernandes (Samsung)]

JCTVC-F516 CE8 Subtest 1: Cross verification of MQT's proposal by Intel [Y. Chiu, L. Xu, W. Zhang, Y. Han (Intel)]

JCTVC-F384 CE8.1:Block based Adaptive Loop Filter with flexible syntax and additional BA mode by Sharp and Qualcomm [T. Ikai (Sharp), M. Karczewicz, I. S. Chong (Qualcomm), Y. Yasugi, T. Yamazaki (Sharp)]

JCTVC-F067 CE8 Subtest 1: Crosscheck for Sharp and Qualcomm's Adaptive Loop Filter in JCTVC-F384 [C.-Y. Chen, Y.-W. Huang (MediaTek)]

General

Summary table results against HM3.0 16-pass anchor (mandatory) below

	JCTVC-F301 Samsung				JCTVC-F321 Toshiba/Qualcomm/MediaTek				JCTVC-F384 Sharp/Qualcomm			
	AI	RA	LB	LP	AI	RA	LB	LP	AI	RA	LB	LP
ΔBD-rate	0.1	0.2	0.2		0.0	−0.3	−0.3	−0.2	−0.3	−0.3	−0.4	−0.4
Enc. Time	99	100	100		100	101	100	101	101	100	100	101
Dec. time	96	98	98		100	105	101	102	102	100	101	102
Vertical taps	7				7				7			

Table for combination of JCTVC-F321 and JCTVC-F384 (from JCTVC-F522, outside CE contribution):

	HM3.0 16-pass				HM3.1-dev-adcs			
	AI	RA	LB	LP	AI	RA	LB	LP
ΔBD-rate	−0.3	−0.7	−0.6	−0.7	−0.2	−0.5	−0.6	−0.6
Enc. Time	100	99	101	103	101	101	101	99
Dec. time	98	108	104	104	99	102	102	103
Vertical taps	7				5			

The gains of these techniques therefore seem basically additive.

JCTVC-F384 reportedly introduces an extra mode for the encoder to choose from, thus increasing search complexity (in the absence of suitable fast decision-making techniques).

It was commented that it may be possible to improve upon the JCTVC-F301 design. However, such a proposal to improve it could be submitted in the future regardless of whether we take action now.

The text and software impact of JCTVC-F301 seems relatively minor.

Decision: Adopt JCTVC-F301 (a simplification of filter selection).

Regarding JCTVC-F321, it enables prediction of the coefficients from a previous frame based on a coded reference index. Actually, JCTVC-F321 has some other aspects as well, but the gain is mostly from this.

A second aspect of JCTVC-F321 involves having an increased number of pixel classification classes. The cross-checker reported the results separately in the spreadsheet results for JCTVC-F307. That aspect had little benefit, and increases complexity. That aspect was not adopted.

It must not violate the layering structure in the use of the reference index.

The proposal seems to enable more frequent use of ALF, as it reduces the per-picture cost of enabling it. Note that ALF has subjective benefits that likely exceed its objective benefit.

However, the benefit is rather small.

It was later suggested that the ability to choose the temporal prediction may somewhat help with encoder complexity (although this was not tested in the CE).

It was noted that using the PPS to send the coefficients already enables sharing of coefficients across frames.

Another aspect of JCTVC-F384 proposes a 2D class merging scheme rather than a 1D scan order based merging scheme. However, the benefit is very small, and the ordering in the edge direction dimension seems arbitrary.

No action was taken on JCTVC-F321 and JCTVC-F384.

It was noted that a slice parameter set scheme (JCTVC-E281 / JCTVC-F187) could also enable another type of sharing.

A participant suggested that rather than having a PPS index in the slice parameter set, there could be two indexes in the slice header – a PPS index and a slice parameter set index – each coded as ue(v).

Decision: Agreed – syntax and semantics was drafted in side activity for approval.

Can the APS index vary within a picture? Not for now.

See discussion of JCTVC-F747 for further notes relating to the APS.

5.8.4 Subtest 2: Adaptive loop filter with fixed set of filters

JCTVC-F285 CE8 Subtest 2: Parametric Adaptive Loop Filter [E. Maani, W. Liu (Sony)]

Parametric ALF is composed of a set of fixed filters which are classified based on their direction and strength for a CU. The number of filter sets in the implementation is 32 for luma and chroma, respectively. The number can be reduced to 12 or 24 depending on filter shape. Test 1 and 2 use 9x7 tap for luma and 5x5 tap for chroma, and ALF in HM3.0 and PALF may be switched CU by CU. Test 3 uses 9x5 tap for luma and 5x3 tap for chroma.

There were three sub-subtests in subtest 2.

Toshiba studied the source code for one of the three sub-subtests.

The ability to switch on a CU basis may be helpful in reducing encoder complexity.

Fixed filter tap values were partially (but not entirely) trained on the test set.

Decoder storage, about 400 * 10 bits each.

Initially, it was planned to have the filter values to be sent at the SPS level as well as at the PPS level and slice level (a hierarchy of overrides). This plan was then replaced by a later decision for an adaptation parameter set (discussed elsewhere in this report).

There is an analogy to default quant matrix values.

There are some symmetries in the current filter structure. These symmetries are not kept in the proposal, which could increase decoder complexity. This is undesirable.

It was planned that (eventually) we should have default values (TBD), but these should have the same shape/symmetry properties as currently exists for coded coefficients – unless justified by sufficient evidence. Further study on this topic was encouraged.

JCTVC-F163 CE8.2: Verification results of Sony Proposal JCTVC-F285 [T. Yamakage, T. Watanabe (Toshiba)] [late upload 07-06]

JCTVC-F170 CE8 Subtest2: Cross-verification on Sony Parametric Adaptive Loop Filter (JCTVC-F285) [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)] [late upload 07-11]

JCTVC-F312 CE8 Subset 2: Cross-Verification of Sony adaptive loop filter (JCTVC-F285) by Qualcomm [I. S. Chong, M. Karczewicz (Qualcomm)]

5.8.5 Subtest 3: Memory reduction in ALF decoding

JCTVC-F272 CE8 subtest 3: Line memory reduction for in-loop filtering [S. Esenlik, M. Narroschke, T. Wedi (Panasonic)]

The proposal reduces line memory requirements by using partially deblocked (only horizontally deblocked) samples at the LCU boundaries. In other words, at the bottom LCU boundary, the available partially deblocked samples are used as the input to SAO and ALF, instead of the fully-deblocked samples (horizontally and vertically deblocked), for which waiting and thus line memory would be necessary.

It was noted that there is a non-CE proposal that is related (JCTVC-F054).

This somewhat changes the prior intent of "parallel deblocking filtering" – changing the data flow between the deblocking filter and ALF processes.

The coding efficiency impact is basically negligible in PSNR terms.

It was asserted that this proposal improves subjective quality related to SAO. (There are also other proposals for fixing that issue.)

Regarding the proposed draft text: At first glance, the text appears to resemble an intended method of implementation rather than simply a specification of mathematical relationships.

Regarding the software: This introduce substantial changes in the software, introducing a line buffering scheme. It sounds as if the offered software differs from what we might want for reference software – i.e., readability, flexibility, and the ability to easily test alternative approaches.

The scheme seems to have technical merit, but the text and software do not seem mature.

No action, pending improved text and software (with review by software coordinators and text editors).

JCTVC-F054 is a somewhat competing proposal.

The group decided to set up a CE to compare JCTVC-F272 with JCTVC-F054 (which should include subjective study).

JCTVC-F521 CE8 Subset 3: Cross-Verification of Panasonic's adaptive loop filter (JCTVC-F272) by Qualcomm [I. S. Chong, M. Karczewicz (Qualcomm)]

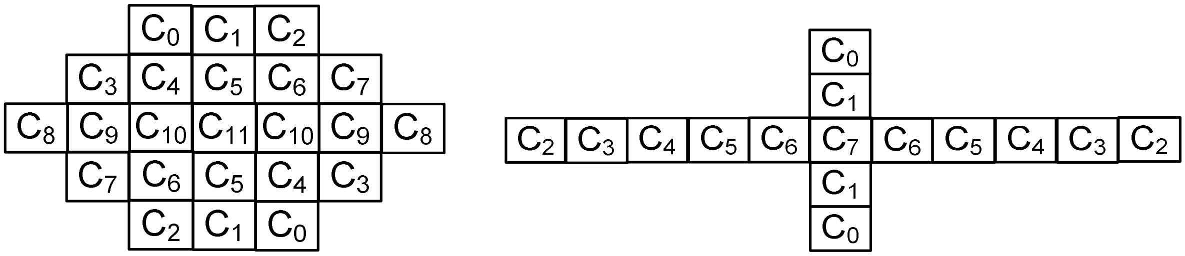
Software was studied as well as executed.

5.8.6 Subtest 4: Filter size and shape

JCTVC-F041 CE8 Subtest 4: Adaptive Loop Filtering Using Two Filter Shapes [F. Kossentini, H. Guermazi, N. Mahdi, M. A. Ben Ayed, M. Horowitz (eBrisk)]

ALF employs two filter shapes, diamond 7×5 with 12 coefficients (TI proposal) and Cross 11x5 with 8 coefficients (eBrisk proposal). This reduce the worst-case number of coefficients from current 20 (diamond 9x7) to 12. Also both are vertical size 5, thus reducing memory bandwidth.

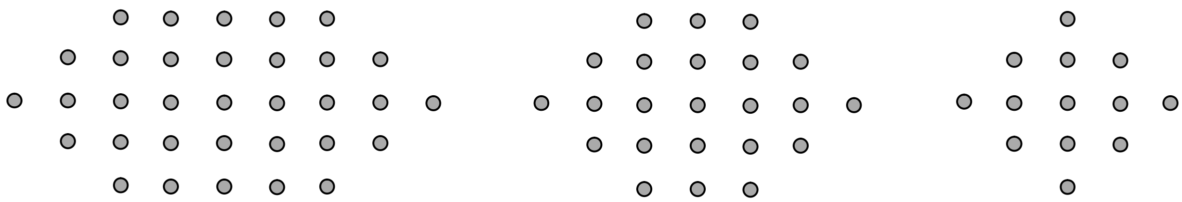
Same as in HM3.1-dev-adcs-adcs anchor, encoder determines filter shape first (using block-based classification), then determining the BA or RA, then CU-on/off control map.



[JCTVC-F305](#) CE8 Subtest 4: Cross-check of eBrisk proposal (JCTVC-F041) on adaptive loop filtering using two filter shapes [P. Lai, F. C. A. Fernandes (Samsung)]

[JCTVC-F234](#) CE8, Subset 4, Tool 3: ALF decode with reduced vertical filter size (JCTVC-E060) [M. Budagavi, V. Sze, M. Zhou (TI)]

Nx5-Set1 ALF filter set (5x5, 7x5, or 9x5) that reduces the vertical size of the filter to 5. Since this filter operate on only five lines instead of the original seven, the size of the line buffers goes down from 6 lines to 4 lines. This was compared with the HM3.0 anchor which adopts 5x5, 7x7, or 9x7 filter.



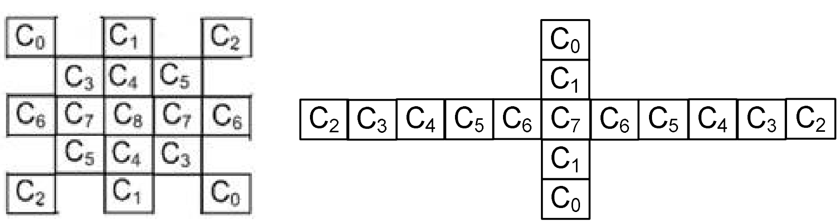
Nx5-Set 1

[JCTVC-F304](#) CE8 Subtest 4: Cross-check of TI's proposal (JCTVC-F234) on ALF decode with reduced vertical filter size [P. Lai, F. C. A. Fernandes (Samsung)]

[JCTVC-F303](#) CE8 Subtest 4: ALF using vertical-size 5 filters with up to 9 coefficients [P. Lai, F. C. A. Fernandes (Samsung), H. Guermazi, F. Kossentini (eBrisk)]

Two filter shapes, star-5x5 with 9 coefficients and cross-11x5 with 8 coefficients are used for luma ALF. This reduce the worst-case number of coefficients from current 20 (diamond 9x7) to 9. Also both are vertical size 5, thus reducing memory bandwidth.

Same as in HM3.1-dev-adcs-adcs anchor, encoder determines filter shape first (using block-based classification), then determining the BA or RA, then CU-on/off control map.



JCTVC-F324 CE8 Subset 4: Cross-Verification of Samsung and eBrisk adaptive loop filter (JCTVC-F303) by Qualcomm [I. S. Chong, M. Karczewicz (Qualcomm)]

JCTVC-F244 CE8: Samsung ALF (JCTVC-F303) crosscheck [M. Budagavi (TI)] [late upload 07-10]

General

High-efficiency test results:

	JCTVC-F041 eBrisk Anchor: HM3.1-dev-adcs {dia-7x5, cross-19x5}				JCTVC-F234 TI Anchor: HM3.0 {9x7, 7x7, 5x5}				JCTVC-F303 Samsung/eBrisk Anchor: HM3.1-dev-adcs {dia-7x5, cross-19x5}			
	AI	RA	LDB	LDP	AI	RA	LDB	LDP	AI	RA	LDB	LDP
ΔBD-rate	0.0	0.0	0.0	0.0	0.1	0.2	0.3		0.1	0.2	0.1	
Enc. Time	96%	97%	97%	97%					82%	92%	93%	
Dec. time	100%	100%	99%	99%	100%	93%	99%		98%	98%	97%	
Vertical taps	5				5				5			
Max# of coeff.	12				17				9			

Note that the anchor is different for different proposals in the table.

Each has a vertical extent of 5. The shapes are otherwise somewhat different.

JCTVC-F303 has the lowest complexity among these, from both the encoder and decoder perspective, and little penalty.

Decision: Adopt JCTVC-F303.

5.8.7 Subtest 5: Chroma filter size and shape

JCTVC-F042 CE8 Subtest 5: Adaptive Loop Filtering of Luminance and Chrominance Samples Using Same Filtering Shape, Structure and Map [F. Kossentini, H. Guermazi, N. Mahdi, M. A. Ben Ayed, M. Horowitz (eBrisk)]

Luma and chroma filter shapes are the same as those of HM3.1-dev-adcs, but with smaller extent. When CU adaptive luma filtering is applied, chroma filtering follows the luma filtering control.

JCTVC-F188 CE8.5: Verification results of eBrisk Video's Proposal JCTVC-F042 [T. Yamakage, T. Watanabe (Toshiba)]

Source code was studied as well as compiled and run.

JCTVC-F157 CE8.5: Unified Chroma Filter Shapes with Luma Shapes for ALF [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)]

The modification point from the HM3.0 software (5x5 rectangle shape chroma filter) is to use of a 7x7 diamond shape or RDO from 5x5, 7x7 and 9x7 diamond shapes.

JCTVC-F245 CE8 subtest 5: MQT chroma ALF (JCTVC-F157) cross-check [M. Budagavi (TI)] [late upload 07-10]

Source code was reviewed and confirmed that it was consistent with the description in JCTVC-F235.

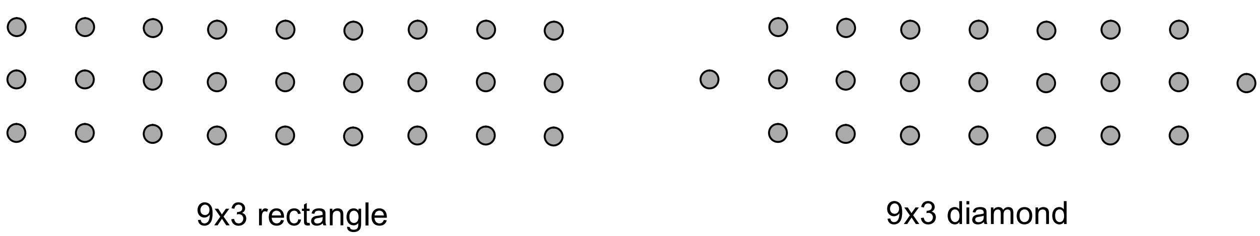
JCTVC-F454 CE8 subtest 5: Cross-check results for proposal JCTVC-F157 [S. Esenlik, M. Narroschke (Panasonic)]

Panasonic cross-checked 2 of the 3 variants of the proposal which are implemented using HM3.0 as the base. The recognized differences are as follows:

- Variant 1: 5x5 square filter shape of chroma ALF in HM3.0 is replaced by 7x7 diamond filter shape.
- Variant 2: 5x5 square filter shape of chroma ALF in HM3.0 is replaced by 3 diamond shaped filters (5x5, 7x7 and 9x9) and a rate-distortion optimization method is implemented for filter size decision.

JCTVC-F235 CE8, Subset 5, Tool 3: Chroma ALF with reduced vertical filter size (JCTVC-E287) [M. Budagavi, V. Sze, M. Zhou (TI)]

The contribution presents two ALF filters that reduce vertical size of chroma ALF filter. The following shows these filters, where all two filters have a vertical size of 3 instead of 5 in HM3.0.



JCTVC-F666 CE8.5: Verification results of TI's Proposal [Faouzi Kossentini] [late reg. 07-06, upload 07-09]

General

Table of results against HM3.0 16-pass High Efficiency anchor (mandatory)

	JCTVC-F042 eBrisk				JCTVC-F157 Toshiba/MediaTek/Qualcomm 7x7 diamond				JCTVC-F235 TI 9x3 rectangle			
	AI	RA	LDB	LDP	AI	RA	LDB	LDP	AI	RA	LDB	LDP
ΔBD-rate Y	0.2	0.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

ΔBD-rate U	−0.1	−0.5	−0.9	−1.1	−0.1	−0.4	−0.4	−0.4	0.1	0.3	0.1	
ΔBD-rate V	−0.1	−0.3	−0.8	−1.3	−0.1	−0.4	−0.5	−0.8	0.2	0.3	−0.2	
Enc. Time	102	101	101	101	100	100	100	100				
Dec. time	91	95	95	93	99	99	100	100	104	108	102	
Vertical taps	5				7				3			

continued:

					JCTVC-F157 Toshiba/MediaTek/Qualcomm 5x5, 7x7, 9x7 RDO				JCTVC-F235 TI 9x3 diamond			
	AI	RA	LDB	LDP	AI	RA	LDB	LDP	AI	RA	LDB	LDP
ΔBD-rate Y					0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ΔBD-rate U					−0.5	−0.9	−0.4	−0.7	0.1	0.3	0.2	
ΔBD-rate V					−0.6	−0.8	−0.7	−1.0	0.3	0.3	0.1	
Enc. Time					100	100	100	100	104	108	102	
Dec. time					101	100	101	100	94	91	95	
Vertical taps					7				3			

Decision: Use the same shapes as for luma (proposed in both JCTVC-F303, making the shapes consistent as recommended in JCTVC-F042 and JCTVC-F157). For chroma, send:

- an enable/disable flag
- if enabled, a flag that selects the shape

Further study may be desirable for shrinking the chroma region of support for 4:2:0 and 4:2:2.

Regarding the JCTVC-F042 proposal to control the chroma filtering together with the luma filtering for CU based decision-making – for further study.

It was remarked that there is some relationship between gains for AIF and ALF, and that the complexity of each of them may interact with the behaviour of the other.

5.8.8 Discussion and Conclusions

See above.

5.9 CE9: MV coding and skip/merge operation (37)

5.9.1 Summary

JCTVC-F029 CE9: Summary report of Core Experiment on MV coding and skip/merge operations [Y.-W. Huang, B. Bross, M. Zhou, W.-J. Chien, I.-K. Kim (CE coordinators)] [upload 07-13]

Some descriptions of CE plans were not fully precise, and some aspects were modified after the original CE plan was established.

Category 1: Unification of AMVP and Merge candidate lists

Three methods in that area were planned to be tested, and one was withdrawn, so UNI01 and UNI03 are the remaining candidates.

It was suggested to focus on the UNI03 method in this category.

JCTVC-F297 describes UNI03. The CE description of this scheme was somewhat vague, with details determined by a proponent in the interim – although the participants were satisfied with the result.

This was proposed as a harmonization / clean-up of the design with some complexity reduction and some minor gain (roughly 0.2%).

Category 2: Simplification of MVP list construction

It was suggested to select the SP01, SP04, SP06S2, SP07 simplification proposals.

Category 3: Improvements of coding efficiency

No improvements verified.

Category 4: Evaluation of inferred merge (a.k.a. "partial merge")

Relates to part of JCTVC-F465 (and JCTVC-F082).

It was remarked that the "PART14" scheme was not described in the CE plan.

Decision: Remove inferred merge

Decision: Add SPS flag to remove 4x4 inter prediction, and set the flag to disable 4x4 for common conditions (B. Bross responsible for delivery of the software change).

Remark: Will there be a perceptual effect from removing this?

Further study was suggested to determine whether that should be used in the future.

Category 5: Parsing robustness for AMVP and merge

Non-CE contributions JCTVC-F068 JCTVC-F341 JCTVC-F347 JCTVC-F402 JCTVC-F470 JCTVC-F474 were noted to be closely related.

ROB04 has two elements

- Replace redundant MVPs with some predefined values
- Something else is done to remove some redundant MVPs without using their values to identify them.

It was remarked that this scheme has some complexity issues

ROB02 is asserted to be simpler, although it has more coding loss.

ROB06, a combination of ROB04 and ROB02, has less loss, but was not a CE proposal.

A BoG coordinated by B. Bross was set up to review the parsing fixes and various other above-described aspects. See BoG report JCTVC-F744.

5.9.2 Contributions

JCTVC-F050 CE9: Results of Experiment SP04 [J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)]

JCTVC-F051 CE9: Results of Experiment ROB03 [J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)]

JCTVC-F052 CE9: Results of Experiment ROB04 [J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)]

JCTVC-F065 CE9: Results of Experiments UNI03, SP10, and SP11 [Y.-W. Chen, J.-L. Lin, Y.-W. Huang (MediaTek)]

JCTVC-F071 CE9: 4.4 Method for improving partial CU merge by merging inter NxN partitions [X. Zhang, S. Liu, S. Lei (MediaTek)]

JCTVC-F072 CE9: Results of Experiments for PART-series [X. Zhang, S. Liu, S. Lei (MediaTek)]

JCTVC-F080 CE9: Cross-check results on SP05, SP06, SP08, SP13 and PART16 [M. Zhou (TI)]

JCTVC-F082 CE9: A study on partial CU merge (PART13, PART18) [M. Zhou (TI)]

JCTVC-F083 CE9: Evaluation results on disabling TMVP from AMVP list construction (ROB05) [M. Zhou (TI)]

JCTVC-F084 CE9: Evaluation results on SP01, SP02, SP03 and SP14 [M. Zhou (TI)]

JCTVC-F088 CE9: Simplified AMVP design (SP06S1, SP06S2) [M. Zhou, M. Sinangil, V. Sze (TI), S. Park, J. Park, B. Jeon (LGE)]

JCTVC-F089 A study on simplification of spatial/temporal MVP scaling (CE9 SP01+SP06S2+SP07) [S. Park, J. PARK, B. Jeon (LGE), S. Sekiguchi (Mitsubishi), M. Zhou, M. Sinangil, V. Sze (TI)]

JCTVC-F113 CE9: Result of a simplified MVP list construction (SP06) [S. Park, J. Park, B. Jeon (LGE), S. Sekiguchi (Mitsubishi)]

JCTVC-F115 CE9 : crosscheck for SP09 [Hendry, J. Park, S. Park, B. Jeon (LGE)]

JCTVC-F127 CE9: Cross-check of TI's study on partial merge JTVC-F082 (PART18) [B. Bross (Fraunhofer HHI)] [late upload 07-04]

JCTVC-F144 CE9: Result of Subtest OPT01 [K. Kazui, S. Shimada, J. Koyama, A. Nakagawa (Fujitsu)]

JCTVC-F145 CE9: Cross-verification result of Subtest SP07 [K. Kazui, S. Shimada, J. Koyama, A. Nakagawa (Fujitsu)]

JCTVC-F166 CE9:Cross-verification on disabling spatial MVP scaling process for smaller PUs(SP01/02) (JCTVC-F084) [Y. Itani, S. Sekiguchi (Mitsubishi)]

JCTVC-F167 CE9:Cross-verification on optimization of MV prediction(OPT01) (JCTVC-F144)n of MV prediction(OPT01) [Y. Itani, S. Sekiguchi (Mitsubishi)]

JCTVC-F168 CE9:Modified AMVP Scaling Process(SP05) [Y. Itani, S. Sekiguchi (Mitsubishi)]

JCTVC-F169 CE9: Temporal vector restriction for small PUs (SP07/SP09/SP12) [Y. Itani, S. Sekiguchi (Mitsubishi)]

JCTVC-F205 CE9: Cross-check of ROB01 and ROB02 (JCTVC-F474) [B. Li (USTC), J. Xu (Microsoft)]

JCTVC-F213 CE9 4.4: Results and verifications for the inferred merge [Y. Suzuki, T.K. Tan (NTT Docomo)]

JCTVC-F297 CE9: Unified Merge and AMVP candidates selection (UNI03) [Y. Zheng, X. Wang, W.-J. Chien, M. Karczewicz (Qualcomm)]

JCTVC-F306 CE9: Crosscheck report of CE9-UNI01 (JCTVC-F380) [Y. Zheng (Qualcomm)]

JCTVC-F338 CE9: Results of temporal MVP restriction for small blocks (SP08, SP10, SP11) [H. Takehara, S. Fukushima (JVC Kenwood)]

JCTVC-F380 CE9: Test result of UNI01 [I.-K Kim, W.-J Han, JH Park (Samsung)]

JCTVC-F388 CE9: Cross-check report for SP03, SP06S1 and SP06S2 (JCTVC-F084, JCTVC-F088) [I.-K. Kim (Samsung)]

JCTVC-F391 CE9: Cross-check report for SP04 (JCTVC-F050) [I.-K. Kim (Samsung)]

JCTVC-F424 CE9: Skip/Merge Simplification with Reduced Candidate Set (SP13) [Y. H. Tan, C. Yeo, Z. Li (I2R)]

JCTVC-F474 CE9: Description of experiments ROB01 and ROB02 [G. Laroche, P. Onno, T. Poirier, C. Gisquet (Canon)]

JCTVC-F476 CE9: cross-check by Canon of experiment ROB03 and ROB04 from Mediatek [G. Laroche, P. Onno, T. Poirier (Canon)] [late upload 07-06]

JCTVC-F478 CE9: cross-check by Canon of experiment PART14 and PART16 from Mediatek [P. Onno, G. Laroche (Canon)] [late upload 07-06]

JCTVC-F512 CE9: Cross-check report for SP14 and ROB05 by Huawei [Q. Shen, H. Yu (Huawei)]

JCTVC-F631 CE9: Cross-check of Temporal vector restriction for small PUs JCTVC-F169 (SP12) [B. Bross (Fraunhofer HHI)] [late reg. 07-04, upload 07-04]

JCTVC-F713 CE9: Result about the combination of experiments ROB02 and ROB04 [G. Laroche, P. Onno, T. Poirier, C. Gisquet (Canon), J.-L. Lin, yiwen.chen@mediatek.com, yuwen.huang@mediatek.com, S. Lei (MediaTek)] [late reg. 07-11, upload 07-13]

JCTVC-F737 CE9: Cross-check of experiment ROB6 (JCTVC-F713) [J. Jung, J. Le Tanou (Orange Labs)] [late reg. 07-14 after opening, upload 07-15]

5.9.3 Discussion and Conclusions

5.10 CE10: Core transform design

5.10.1 Summary

JCTVC-F030 CE10: Summary report of Core Experiment on core transform design [P. Topiwala, M. Budagavi, I. Kim, R. Joshi (CE coordinators)] [upload 07-12]

Four core transform proposals were considered:

1. Cisco/TI (HM3.0, JCTVC-F446),
2. Samsung/FastVDO (JCTVC-F251),
3. FastVDO/Samsung (JCTVC-F363) different from JCTVC-F251 in 8 and 16 point transform,
4. Qualcomm (JCTVC-F352).

The summary report does not use a table that differentiates between 16 bit and 32 bit multiplies.

The first three proposals re-use existing quantization; the fourth proposal needs a quant. matrix.

Proposals 1, 2 and 4 have an embedded design, i.e. the smaller size transforms are included as building blocks of the next-larger size. 3 uses a different design (lifting) for 16 block sizes.

A summary of the previous BoG meeting produced by P.T. had previously been sent to the reflector and was also presented in this context. It was disputed whether this summary fully reflected the real opinions of individuals participating in the breakout.

Transforms cannot be judged in terms of RD performance as they are more or less equal (agreed). Data available for understanding implementation complexity:

JCTVC-F251 contains an analysis about itself, JCTVC-F352 and JCTVC-F446 (for hardware and software)

JCTVC-F446 contains analysis about itself for hardware

JCTVC-F447 contains analysis about JCTVC-F446 for software

JCTVC-F710 contains analysis about JCTVC-F251 and JCTVC-F446 for SIMD

As agreed on reflector, analysis was mainly done for the worst case of 32-point transform. This may be OK for the embedded design approaches. For JCTVC-F363, hardware implementation analysis data for the 16-point (lifting) transform would be missing.

5.10.2 Contributions

JCTVC-F241 CE10: Crosscheck of Samsung/FastVDO contribution on core transform - normal QP range (JCTVC-F251) [M. Budagavi (TI)]

JCTVC-F243 CE10: Cross-check of Qualcomm's contribution on core transform - low and high QP range (JCTVC-F352) [M. Budagavi (TI)]

JCTVC-F251 CE10: Full-factorized core transform test [E. Alshina, A. Alshin, I.-K. Kim (Samsung), P. Topiwala (FastVDO)]

JCTVC-F352 CE10: Scaled orthogonal integer transforms supporting recursive factorization structure [R. Joshi, Y. Reznik, J. Sole, M. Karczewicz (Qualcomm)]

JCTVC-F363 CE10: FastVDO/Samsung Core Transform Proposal [P. Topiwala, W. Dai, M. Krishnan (FastVDO), I. Kim (Samsung)]

JCTVC-F727 CE10: A Cross-check report for core transform proposal JCTVC-F363 High QP configuration Kiran Misra, Louis Kerofsky, Andrew Segall (Sharp) [late reg. 07-12, upload 07-13]

JCTVC-F560 CE10: Crosscheck of Samsung/FastVDO contribution on core transform - high/low QP range (JCTVC-F251) [R. Joshi (Qualcomm)]

JCTVC-F571 CE10: Cross-check report for FastVDO/Samsung's test JCTVC-F363 by Motorola Mobility [J. Lou, L. Wang (Motorola Mobility)]

JCTVC-F643 CE10: Cross-check report on scaled orthogonal integer transforms supporting recursive factorization structure (JCTVC-F352) [I.-K Kim (Samsung)] [late reg. 07-05, upload 07-06]

JCTVC-F731 CE10: Crosscheck of Samsung/FastVDO contribution on core transform - low QP range (JCTVC-F251) [D. Hoang (Zenverge)] [late reg. 07-13, upload 07-13]

JCTVC-F446 Core transform design for HEVC [A. Fuldseth, Gisle Bjøntegaard (Cisco), M. Sadafale, M. Budagavi (TI)]

JCTVC-F447 SIMD optimization of proposed HEVC core transforms [A. Fuldseth, L. P. Endresen, S. Selnes (Cisco), V. Arbatov, F. Franchetti (SpiralGen Inc. and Carnegie Mellon University), M. Püschel (ETH Zurich)]

JCTVC-F710 The result of SIMD implementation for Core Transforms [C. Kim, J.-Y. Choi, K.B. Pachauri (Samsung) [late reg. 07-11, upload 07-13]

5.10.3 Discussion and Conclusions

A BoG was asked to concentrate on getting common understanding of the implementation complexity of the different methods and report back.

JCTVC-F251 was briefly presented to convey an understanding of the way the hardware analysis was done. Its analysis was based on automatic RTL generation from C code (Catapult C). In contrast to that, the TI/Cisco analysis from JCTVC-F446 uses an optimized silicon compiler. The BoG was asked to try to identify whether the data collected would enable reaching a common understanding, and if not, to work on improving the investigation methods such that relevant evidence would be available by the next meeting. JCTVC-F447 was also briefly presented.

5.11 CE11: Coefficient scanning and coding

5.11.1 Summary

JCTVC-F031 CE11: Summary report of Core Experiment on coefficient scanning and coding [V. Sze, J. Chen, T. Nguyen, K. Panusopone, J. Sole (CE coordinators)] [upload 07-11]

This core experiment evaluated the coding efficiency and complexity impact of:

- Context modelling/selection for syntax elements related to transform coefficients in HE configuration
- Transform coefficient scanning order methods in the HE configuration; the LC configuration was also tested in one proposal.

The objectives of this CE included:

- Investigation of the impact of context selection schemes for transform coefficient coding on the coding efficiency and complexity
- Coding efficiency and complexity measurement of transform coefficient scanning order methods

5.11.2 Contributions

JCTVC-F128 CE11: Reduced neighboring dependency in context selection of significant_coeff_flag for parallel processing (JCTVC-E330) [V. Sze, M. Budagavi (TI)]

This contribution (JCTVC-E330 in Geneva) proposes reducing the neighboring dependencies in the context selection of significant_coeff_flag for positions in the top-most row and left-most column of a transform (i.e. the top and left edge). While the simplified context selection method in JCTVC-D260 (adopted for HM-2.0), eliminates the neighboring dependency on the most recently decoded significant_coeff_flag within a diagonal, this contribution eliminates the dependency when wrapping from one diagonal to another during zigzag scan. This modification was implemented in HM-3.0 and its coding efficiency was evaluated in the high efficiency configuration with a coding loss 0.1%, 0.1%, 0.0% for Intra and Random Access and Low Delay.

The proposal is to omit a neighbor at the turning points of the diagonal scan. BR is increased by 0.1%

JCTVC-F185 CE11: Cross-check result of TI proposal on context simplification of the significance map (JCTVC-F128). [C. Rosewarne, M. Maeda (Canon)]

JCTVC-F311 CE11.A: Cross checking of TI proposal JCTVC-E330 on context simplification of significance map [C. Auyeung (Sony)]

JCTVC-F129 CE11: Parallelization of HHI_TRANSFORM_CODING (Fixed Diagonal Scan) [V. Sze, M. Budagavi (TI)]

This contribution proposes the use of a fixed diagonal scan (JCTVC-C227) for the significance map to enabled parallel processing in conjunction with the use of the highly adaptive context selection for significant_coeff_flag. While the simplified context selection method in JCTVC-D260 (adopted for HM-2.0), eliminates the neighboring dependency on the most recently decoded significant_coeff_flag within a diagonal, dependencies on the previous position when moving from one scan line to another. The fixed diagonal scan proposed in this contribution eliminates this dependency. The fixed diagonal scan is only proposed when CABAC is used (i.e. HE configuration). Note: JCTVC-F134 provides results on supporting fixed diagonal scan for CABAC described in this contribution with the existing zigzag scan for CAVLC. The fixed diagonal scan was implemented in HM-3.0 and had coding efficiency impact of −0.1%, −0.1% and 0.0% for All Intra, Random Access and Low Delay for the High Efficiency configuration.

The proponents would recommend using this method (with bottom-left-to-top-right scan) rather than JCTVC-F128 as it does not require specific context switching and has slightly better performance.

Decision: Adopt fixed diagonal scan of significance map (bottom-up) as suggested in JCTVC-F129.

JCTVC-F293 CE11: Cross-check of TI's fixed diagonal scan (JCTVC-F129) [J. Sole (Qualcomm)]

JCTVC-F149 Cross-check of TI's proposal C227 on diagonal coefficient scans (JCTVC-F129) [C. Yeo, Y. H. Tan (I2R)]

JCTVC-F288 CE11: Unified scans for the significance map and coefficient level coding in high efficiency [J. Sole, R. Joshi, M. Karczewicz (Qualcomm)]

In JCTVC-E335, a unification of scans for significance map coding and coefficient level coding in high efficiency was proposed. This contribution analyses and shows the results of the technique in HM3.0. It consists of two parts. In the first one, the scan for the coefficient level coding is the same as the scan used for the coding of the significance map, but in reverse order, i.e., from the last significant coefficient to the first (DC). For this part, the BD-rate for AI-HE, RA-HE and LB-HE configuration is −0.05%, 0.07%, and −0.01%, respectively. In the second part, scans for significance map coding and coefficient level coding are both in the reverse order. For this case, the BD-rate for AI-HE, RA-HE, and LB-HE is −0.25%, −0.19%, and −0.07%, respectively.

Additional result is shown about combination with the diagonal scan of JCTVC-F129. This has not been cross-checked

Question: A new context initialization was used which may be the main reason for the gain in part 2 and no loss in case 1. Was this trained towards the test set?

Original contributors of the two different scans argue that usage was shown to be advantageous earlier, and potentially with tuned context initialization could reproduce such gain again. It is also mentioned that JCTVC-F124 and JCTVC-F569 may be related.

On request, JCTVC-F597 was also discussed in this context. It was argued that by re-ordering, a similar advantage in terms of computation time could be achieved as in JCTVC-F288. Another expert raises the opinion that a single scan (without need of reordering) would be beneficial for software implementation.

Breakout group (R. Joshi) will try to clarify this issue, and report back when other transform coefficient coding is discussed.

JCTVC-F136 CE11: Cross-check of Qualcomm's Unified scans for the significance map and coefficient level coding in high coding efficiency (JCTVC-E335 Part 2) [V. Sze (TI)]

(Another cross-check is in JCTVC-F134.)

JCTVC-F369 CE11:Cross-check report for Qualcomm's proposal JCTVC-F288 part2 [H. Sasai, T. Nishi (Panasonic)]

JCTVC-F451 CE11: Crosscheck - Reduced neighboring dependency in context selection of significant_coeff_flag for parallel processing (JCTVC-E330/JCTVC-F128) [T. Nguyen]

JCTVC-F597 CE11: Hardware complexity of large zigzag scan for level-coding of transform coefficients [C. Auyeung, T. Suzuki (Sony)]

See notes above in discussion of JCTVC-F288.

JCTVC-F607 CE11:Cross-check report for Qualcomm's proposal JCTVC-F288 part1 [J. Chen, V. Seregin (Samsung)]

5.11.3 Discussion and Conclusions

Adopt fixed diagonal scan of significance map (bottom-up) as suggested in JCTVC-F129, as recorded above. Otherwise, see under BoG report JCTVC-F753. Continue CE.

5.12 CE12: Deblocking filtering (22)

5.12.1 Summary

JCTVC-F032 CE12: Summary report of Core Experiment on deblocking filtering [A. Norkin, X. Guo, B. Jeon, M. Narroschke (CE coordinators)] [upload 07-13]

This contribution is a summary report on 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. Six proposals had been evaluated in the CE. All the proposals are based on HM3.0 and experiments are performed according to the common test conditions provided in JCTVC-E700. All results are verified by cross-checkers.

5.12.2 Contributions

JCTVC-F118 CE12: Ericsson's and MediaTek's deblocking filter [A. Norkin, K. Andersson, R. Sjöberg (Ericsson), Q. Huang, J. An, X. Guo, S. Lei (MediaTek)]

JCTVC-F189 CE12: Verification results of Ericsson/MediaTek's Proposal JCTVC-F118 [T. Yamakage, S. Asaka (Toshiba)]

JCTVC-F263 CE12: Cross-verification Results of Ericsson and MediaTek Deblocking Filter (JCTVC-F118) by SKT/SKKU [J. Yang, K. Won, B. Jeon (SKKU), J. Lim (SK Telecom)]

JCTVC-F401 CE12: Cross-check results of the deblocking filter of MediaTek and Ericsson (JCTVC-F118) [M. Narroschke (Panasonic)]

JCTVC-F609 CE12: Cross-verification of the Deblocking Filter Proposed by MediaTek and Ericsson (JCTVC-F118) [V. Seregin, J. Chen (Samsung)]

JCTVC-F143 CE12: Deblocking filter parameter adjustment in slice level [T. Yamakage, S. Asaka, T. Chujoh (Toshiba), M. Karczewicz, I. S. Chong (Qualcomm)]

JCTVC-F530 CE12: Cross-verification of deblocking filter parameter adjustment on a slice level (JCTVC-F143) by Ericsson [Andrey Norkin (Ericsson)]

JCTVC-F258 CE12: SK Telecom/SKKU Deblocking Filter [J. Yang, K. Won, B. Jeon (SKKU), J. Lim (SK Telecom)]

JCTVC-F218 CE12: Cross-verification of SK Telecom/SKKU's proposal JCTVC-F258 [M. Ikeda, T. Suzuki (Sony)]

JCTVC-F529 CE12: cross-check of SKT/SKKU deblocking filter (JCTVC-F258) by Ericsson [Kenneth Andersson, Andrey Norkin, Rickard Sjöberg (Ericsson)]

JCTVC-F625 CE12: Cross-verification of SKT/SKKU Deblocking Filter (JCTVC-F258) by ETRI [Sukho Lee, Seunghyun Cho, Nakwoong Eum] [late upload 07-05]

JCTVC-F198 CE12, Subset 1: Report of Deblocking for Large Size Blocks [Z. Shi (USTC), X. Sun, J. Xu (Microsoft)]

JCTVC-F264 CE12: Cross-verification Results of Microsoft Deblocking Filter (JCTVC-F198) by SKT/SKKU [J. Yang, K. Won, B. Jeon (SKKU), J. Lim (SK Telecom)]

JCTVC-F403 CE12: Cross-check results of the deblocking filter of Microsoft (JCTVC-F198) [M. Narroschke (Panasonic)]

JCTVC-F633 CE12: Cross-check of deblocking for large size blocks (JCTVC-F198 by Microsoft) [Jani Lainema, Kemal Ugur (Nokia)] [late reg. 07-04, upload 07-04]

JCTVC-F191 CE12: Results for decisions for deblocking [M. Narroschke, T. Wedi (Panasonic)]

JCTVC-F206 CE12: Cross-check of harmonized deblocking filter with additional chroma processing (JCTVC-F262) [J. Xu (Microsoft)] [late upload 07-12]

JCTVC-F217 CE12: Cross-verification of Panasonic's proposal JCTVC-F191 [M. Ikeda, T. Suzuki (Sony)]

JCTVC-F262 CE12: SK Telecom/SKKU Harmonized Deblocking Filter with Additional Chroma Processing [J. Yang, K. Won, B. Jeon (SKKU), J. Lim (SK Telecom)]

JCTVC-F580 CE12: Cross Check of Panasonic's Deblocking Decisions (JCTVC-F191) [G. Van der Auwera, I. S. Chong (Qualcomm)]

JCTVC-F611 CE12: Cross-verification of SK Telecom/SKKU Harmonized Deblocking Filter with Additional Chroma Processing (JCTVC-F262) [V. Seregin, J. Chen (Samsung)]

5.12.3 Discussion and Conclusions

Some proposals showed objective gains up to around 1%.

Similar decoder complexity measurements were reported.

Subjective viewing work was begun on Sunday. A question on anonymized viewing was directed to V. Baroncini (VB).

A viewing plan was worked out.

Created BoG (coordinator M. Zhou) with task:

- Work out viewing plan to make subjective improvement analysis
- Conduct anonymized subjective viewing (in coordination with V. Baroncini)
- Seek ways towards harmonization or simplification and make a set of suggestions to JCT

See BoG report discussion JCTVC-F763.

6 Non-CE Technical Contributions

6.1 Clarification and Bug Fix Issues

JCTVC-F694 HM3.2 fine granularity slice implementation issues to be clarified [A. Osamoto (TI)] [late reg. 07-09, upload 07-10]

Three software bugs and some spec bug(s) identified – Decision: fix.

JCTVC-F465 Experiments on tools in Working Daft (WD) and HEVC Test Mode (HM-3.0) [I.-K. Kim, E. Alshina, J. Chen, T. Lee, W.-J. Han, J. H. Park (Samsung), V. Sze, M. Budagavi, M. Zhou (TI)]

Track P day 1.

This contribution presents results of tests applied to several tools in the current WD and HM (3.0) to verify whether the included tool produced the intended effects. Each set of results have been cross-checked. Based on the results, this contribution recommended removal of the following tools as they do not show clear benefits in terms of coding efficiency, complexity and design consistency:

1. Center position of TMVP candidates;

2. Chroma codeword switch;
3. Direct coding of Intra DC coefficient in CAVLC mode;
4. Parallel deblocking filter decision;
5. Partial merge;
6. Planar prediction for chroma;
7. Adaptive switching on/off combined coding for CAVLC.

Various methods to simplify ALF-related tools were also investigated including:

8. Region-based ALF only;
9. Single pass ALF;
10. One filter only for ALF.

It is also recommended in this contribution that a tool experiment similar to TE12 for HM1.0 establishment stage be done before the current WD moves to committee draft (CD).

This contribution underlines the desire, also reported in the discussion of the software integration AHG report, that confirmation testing be performed immediately after integration of each adopted proposal to make sure it is providing the intended benefit.

Agreed principles:

- Confirmation of intended benefit is to be performed immediately after integration of the full set of adoptions from a meeting cycle (which implies having the ability to disable each adoption individually).
- Contributions of things to remove/simplify are to be treated in the same way as other proposals.

This contribution presents results of tests applied to several tools in the current WD and HM (3.0) to verify whether the included tool produced the intended effects. Each set of results have been cross-checked. Based on the results, this contribution recommends removal of the following tools as they do not show clear benefits in terms of coding efficiency, complexity and even for the design consistency: Center position of TMVP candidates; Chroma codeword switch; Direct coding of Intra DC coefficient in CAVLC mode; Parallel deblocking filter decision; Partial merge; and Planar prediction for chroma; Adaptive switching on/off combined coding for CAVLC. Various methods to simplify ALF-related tool were also investigated including: Region-based ALF only; Single pass ALF and One filter only for ALF. It is also recommend in this contribution that a tool experiments similar to TE12 for HM1.0 establishment stage be done before current WD moves to committee draft (CD).

Relates to the issue discussed previously in the context of the software AHG: There is no mechanism currently to perform a sanity check about integrated tools and their interaction. It should be implemented as mandatory exercise starting from this meeting, that after completion of the new software bundle the benefit of each integrated tool is proven again.

In general, it is agreed that an exercise of investigating benefit of tools is useful, and people should be encouraged to proceed on this. It is however doubted that an exercise like TE12 would be useful to achieve this. Instead, proposals for simplification or removal should be investigated in the usual process of CE.

The suggested specific recommended actions were allocated for consideration in the context of the relevant respective topics.

6.2 HM settings and common test conditions (5)

JCTVC-F270 On BD-rate calculation [J. Wang, X. Yu, D. He (RIM)]

An issue about BD-rate calculation was observed and studied for Class-A sequences. This contribution summarizes the BD-rate issue and presents some recent studies that follow some suggestions from the reflector.

As Nebuta and BQTerrace are the most problematic sequences, it is recommended that BD-rate results excluding Nebuta and BQTerrace are also reported for evaluation purposes (and checked to see whether these are consistent with the behaviour for other data), and that additional information on these sequences such as the PNSR-bit rate curves are to be checked when inconsistencies are observed.

A BD-rate calculation based on piece-wise cubic interpolation reportedly appears to be a practical fix to this problem (COM 16 - C.404, April 2008, implemented in the included file hm32piecewisecubic2.xls, which originally came on the group email reflector from Frank Bossen).

It was commented that the implementation of the piece-wise cubic interpolation method might benefit from some refinement, and that for at least some time it may be desirable to have both results reported.

Having this (a spreadsheet that computes both metrics, using a somewhat better implementation of the piece-wise cubic method) seems like it would be a useful step forward to accomplish by shortly after this meeting. F. Bossen volunteered to provide that. Tentatively, it seems that the piece-wise cubic method seems somewhat more reliable.

Observing the curve shapes can reportedly also be helpful. Nebuta and BQTerrace seem to exhibit the problem partly due to being noisy sequences.

The amount of overlap between the curve ranges can also have unusual effects, and reporting the amount of overlap may be beneficial.

An issue about BD-rate calculation was observed and studied for Class-A sequences. This contribution summarizes the BD-rate issue and presents some recent studies that follow some suggestions from the reflector. As Nebuta and BQTerrace are the most problematic sequences, it is recommended that BD-rate results excluding Nebuta and BQTerrace are also reported for evaluation purpose and additional information on these sequences such as the PNSR-bitrate curves are to be checked when inconsistency is observed. The BD-rate calculation based on piece-wise cubic interpolation also appears to be a practical fix to this problem. It is recommended to further investigate the use of the current BD-rate tool in evaluation of proposals.

One suggestion that was made on the reflector is looking at BD values without the critical sequences, another would be to use the suggested piecewise cubic interpolation which appears to come closer to reality.

A *.xls file implementing the piecewise cubic interpolation is attached (implementation may not be perfect yet according to a comment made by F. Bossen).

A reasonable exercise would also be to investigate how different interpolation methods match with a densely sampled PSNR curve.

One possibility could be to compute BD values with old method and with the cubic interpolator and use divergence between both as an indicator for unreliable results for certain test cases.

Some experts express the opinion that inclusion of more test points may not solve the problem.

Frank Bossen will provide a spreadsheet implementing the cubic method in addition to the current method shortly after the meeting.

JCTVC-F433 Reference Lists For Low Delay Settings [C. S. Lim, S. M. Thet Naing (Panasonic)]

This contribution provides an investigation report on construction of reference picture lists, and proposes a memory managing scheme for reference pictures under low delay constraints. The purpose of the investigation is to improve the coding efficiency of low delay settings by using a different set of reference pictures that includes more reference pictures that are of high quality. This contribution reports an average coding gain of 2.3% (HE) and 2.6% (LC) for low delay B settings and 2.2% (HE) and 2.3% (LC) for low delay P settings.

The suggestion was to use the two most recent high quality pictures plus the other two most recent (by temporal sequence) pictures, instead of four most recent pictures.

Does not increase the buffer requirements (in principle, but with current software implementation it would).

JCTVC-F493 proposes something very similar with similar gains.

Conclusion: Adopt this kind of change to LD settings in spirit.

Note: Current software uses hard-coded picture buffer management. In the future, this should be implemented by MMCO; JCTVC-F493 could be a solution on this.

A similar observation is reported in JCTVC-F493.

It was noted that this modification may (or may not) produce similar improvement in the JM context, which is desirable to study.

The group initially agreed, in principle, to adopt this non-normative modification to the common conditions. However, this adoption was later obsoleted following review of JCTVC-F519 and JCTVC-F701.

JCTVC-F519 Cross-check of reference lists for low delay settings (JCTVC-F433) [B. Li (USTC), J. Xu (Microsoft)] [late upload 07-12]

It was reported that the proposed reference frame setting brought more than 2% bits saving on average under the default test configuration. It was reportedly clear that changing the reference frame setting for low delay case can bring significant bit saving. Similar investigations were also reportedly presented in JCTVC-F701, where the improvement capacity by adjusting reference frames for low delay cases is analyzed.

JCTVC-F701 Encoding optimization to improve coding efficiency for low delay cases [J. Xu (Microsoft)] [late reg. 07-11, upload 07-12]

This document presents some encoder-only actions to improve the performance of the low delay configuration. Two methods are described: one is reference frame selection; the other is lambda and QP adjustment (bit allocation). The experimental results reportedly show that an average 9% bit rate saving can be obtained from that encoder only decision. The maximum bit rate savings is more than 19%.

Reference frame selection is similar as JCTVC-F433, here the nearest frame and one/three high-quality frame (in case of 2 /4 reference frames). Results for the case of 4 frames are slightly better than JCTVC-F433. Gain for 2 frames is higher.

Conclusion: For next LD settings, 3 high-quality frame plus the most recent additional frame shall be used (signalling still t.b.d.).

RDO optimization at sequence level – is this still low delay? Presumably not.

In principle, this means looking for frames that are more suitable as references.

It was remarked that this could also be done for RA – where this would be practical – this suggestion was encouraged to be investigated in further study.

JCTVC-F696 Suggested SCC Test Conditions [X. Zhang, O. Au, C. Pang, X. Wen] [late reg. 07-10, upload 07-13]

This document proposed common test conditions and software reference configurations recommended to be used for the screen content coding experiments conducted between the 5th and the 6th JCT-VC meetings and between the 6th and the 7th JCT-VC meetings. These common test conditions were also proposed for use in technical contributions related to SCC for the 7th JCT-VC meeting.

Addressed by BoG and its results review.

6.3 Source video test material

JCTVC-F228 A study of SCC test sequences [X. Zhang (HKUST)] [late upload 07-08]

This report provides the coding results of submitted test sequences for SCC ad-hoc group. Results by both HM3.0 and HM3.0 SDIP are provided. Compared to HM3.0, it is reported that the average BD-rate gain from HM3.0 SDIP for AI-HE, AI-LC, RA-HE, RA-LC, LB-HE, LB-LC, LP-HE and LP-LC are 8.0%, 9.1%, 5.8%, 6.6%, 3.3%, 3.9%, 3.1%, and 3.7% respectively.

Coding artifacts are more obvious at large QPs (36/42), nothing visible at QP 22.

Gain was higher for the more artificial sequences.

The version of SDIP still included 16x1 (which is not the case anymore).

Is the content challenging enough? The overall rate ranges for the graphics-only content seem to be much lower than for natural video. This is different for the sequences with mixed video and graphics.

In general, the suitability of PSNR and BD measurements must be assessed.

Breakout activity was requested to review sequences and identify test points.

JCTVC-F562 Updated Video Test Material Submission for "Screen Content" Coding Experiments: Scrolling Text, Overlays, Editing Window Switching and On-line Gaming [G. Cook, W. Gao, J. Zhou, H. Yu (Huawei Technologies)]

This contribution consists of a submission of twelve test sequences in response to JCTVC-D501, "Request for Video Test Material for 'Screen Content' Coding Experiments"; nine of the sequences are updates to previously submitted material and three are new sequences. The sequences consist of camera-view content with text overlays and scrolling text, and camera-view content with document editing, scrolling and window switching, high contrast text and gradient backgrounds and on-line gaming. The sequences were updated based on comments received at the previous meeting, and were asserted to follow the general guidelines given in JCTVC-D501. Simulations based on the test conditions agreed to by the Screen Content Coding Ad Hoc Group were made.

One computer graphics (CG) generated (games) sequence seems to be more challenging, includes effects such as edge alias and flickering apparently caused by cheap rendering (perhaps not completely state of the current art of rendering technology).

JCTVC-F726 Video Test Material Submission for Screen Content Coding X. Zhang, O. Au, C. Pang, X. Wen [late reg. 07-12, upload 07-13]

Did not need to be presented – was essentially included in JCTVC-F228 presentation.

JCTVC-F741 Test material update for screen content [Wenpeng Ding, Yunhui Shi, Baocai Yin] [late reg. 07-15, upload 07-16]

This contribution describes and introduces a set of test sequences for screen content which will be made available to JCT-VC and parent bodies by Beijing University of Technology. The test sequences are provided in both YUV4:2:0 and YUV4:4:4 formats. BJUT proposes these sequences for developing and testing HEVC in the JCT-VC.

6.4 Functionalities

6.4.1 Scalable coding

See also notes of joint meeting with MPEG and VCEG as recorded below.

Note: Some contributions related to temporal scalability (e.g. JTVC-F462 and JCTVC-F546) are discussed in the section on decoded picture buffering.

JCTVC-F290 Scalability Support in HEVC [D. Hong, W. Jang, J. Boyce, A. Abbas (Vidyo)]

This contribution proposes a scalability extension to the HEVC design. It applies to both intra and inter coding. The design attempts to minimize changes from the enhancement layer codec from the single layer HEVC codec, re-using existing tools exactly wherever possible. Experiments were performed for 2-layer spatial scalability with a 1:2 ratio in each dimension, although the method may be used for any resolution ratio between the layers, including no resolution change for CGS, or different scaling factors in the two dimensions. The contribution reports BD-rate gains vs. simulcast of 17.9% for Intra HE, 16.3% for Intra LC, 16.1% for RA HE, 15.5% for RA LC, 11.4% for LD HE, and 11.1% for LD LC. The proposed scalability extension may also be used with a mixed codec design, with an H.264/AVC base layer and scalable HEVC-based enhancement layer.

Method reportedly similar to SVC: Enhancement layer in “Difference mode” with base-layer upsampling (using DCTIF) and “sample mode” (without base-layer referencing). Gains were reportedly similar as for use of the JSVM for intra and RA.

Contribution noted (information about reported method with some aspects which are outside the scope of the current technical work of JCT-VC).

High layer syntax must be constructed such that it is extensible. It was suggested that the first byte of the NAL unit should be kept unchanged in any extension.

JCTVC-F292 Metrics for evaluation of scalable coding [J. Boyce (Vidyo)] [late upload 07-07]

The contribution provided input to the definition of test and evaluation conditions for the planned scalability extension to HEVC, for coding efficiency comparison to simulcast and single layer coding. The same raw experimental data provided in the JCTVC-F290 contribution is presented using three different analysis methods. The contribution recommended one analysis method, in which the simulcast high resolution and scalable enhancement layer Y-PSNR values are matched.

In general, it would be desirable to know how scalable coding performs in comparison versus single layer and simulcast. For proper comparison, it is suggested that the base layer should be the same as simulcast.

JCTVC-F096 Scalable structures and inter-layer predictions for HEVC scalable extension [H. M. Choi, J. Nam, D. Sim (Kwangwoon Univ.)]

This contribution reports an investigation about two kinds of scalable structures and inter-layer predictions for a HEVC scalable extension. Two kinds of structures are single- and multi-loop designs. In the contribution, two different inter-layer predictions which can be applied to two scalable structures are proposed. An inter-layer texture prediction (ILTP) is a scheme to predict PU of the enhancement layer from the corresponding block of a reference layer. For the other inter-layer prediction, a generalized inter-layer reference frame (GILR) will be presented. In this contribution, each scalable structure is evaluated with two inter-layer predictions. The single-loop scalable structure with ILTP gives on average BD bit rate reduction about 14% in all intra case for luma signals, compared to simulcast only for the enhancement layer. The multi-loop scalable structure with ILTP also gives the similar RD performance. For the single- and multi-loop scalable structures with the GILR, a coding gain of approximately 20% is reportedly observed on average in BD bitrate for all-intra case, compared to simulcast for the enhancement layer.

Contribution noted (information about reported method with some aspects which are outside the scope of the current technical work of JCT-VC).

JCTVC-F618 Resampling filters for scalability and screen content applications [W. Dai, M. Krishnan, P. Topiwala (FastVDO)]

Discussed in Track B: Alternative coding modes

Spatial resampling filters are in wide use in image and video processing applications, as there is often a mismatch between the native resolution of coded video data and that of target displays. Spatial resampling is even used within the context of video coding itself, such as in spatial scalability, where a mixed representation requiring multiple resolutions is an explicit part of the coding architecture. In SVC for example, resampling filters are standardized (more specifically, the upsampling filter, needed in the decoder, is standardized). Note that no matter how well designed, the use of resampling filters nearly always involves a loss of information (when applied in contexts other than perfect reconstruction filter banks), which one naturally wishes to minimize. Resampling filters are also regularly used with little notice for color space representations, as most video codecs take YUV 4:2:0 as input, whereas the native representation of acquired video is typically RGB (4:4:4). Similarly to spatial resampling, there is information lost in the color space resampling to YUV 4:2:0. In fact, for certain applications, working in fully 4:4:4 may be justified. In the development of HEVC, 4:4:4 coding is already part of the mandate, although progress in this area has yet to begin. The use of 4:4:4 and 4:2:0 has recently emerged as a possible issue on the reflector for the coding of screen content video in HEVC. Likewise, scalability is also of current interest in the development of HEVC and future potential extensions. In this proposal, spatial filters are described which can potentially provide improved quality for both spatial resampling, as well as chroma sampling.

The contribution was just for information purposes. It was currently not to be considered, as it is not required to specify normative upsampling filters. In general, only one side needs to be considered as normative (typically the upsampling filter).

JCTVC-F488 Requirements for Scalable extension of HEVC [E. François, S. Lasserre, F. Le Leannec (Canon)]

This contribution aims at proposing requirements in the context of the ad-hoc group on requirements for the scalable extension of HEVC, established in March 2011. The intent is to bring inputs related to mobile and video capture devices. In particular, requirements related to complexity are discussed.

6.4.2 Very low delay

JCTVC-F147 Industry needs of very low delay coding [K. Kazui, A. Nakagawa, J. Koyama (Fujitsu)]

This was not a specific technology proposal; it was only an expression of desire for low latency support.

It was commented that a clear technical requirement was needed. For example, high frame rates (without excessive out-of-order encoding) can provide very low delay.

For example, area refresh with constrained intra prediction and constrained encoder MV search area and high frame rate – if implemented well – can basically do this.

It was commented that often, delay is a product implementation issue rather than a specification issue.

Further study is encouraged to see if there is some room for improvement.

6.4.3 Interlace

JCTVC-F194 Proposal on the support of interlace format in HEVC [S. Sekiguchi, K. Sugimoto, H. Sakate (Mitsubishi)]

See notes elsewhere in this report from joint meeting session.

6.5 Loop Filtering

6.5.1 Deblocking filter

The initial review of the contributions in this area was delegated to BoG activity led by M. Zhou.

JCTVC-F044 Improving Deblock-filter Performance with SKIP-CU [M. Sadafale (TI)]

JCTVC-F219 Cross-verification of TI's proposal JCTVC-F044 [M. Ikeda, T. Suzuki (Sony)]

JCTVC-F053 Deblocking Filter with Reduced Pixel Line Buffers for LCU-based Processing [C.-W. Hsu, J. An, X. Guo, J.-L. Lin, Y.-W. Huang, S. Lei (MediaTek)]

JCTVC-F531 Cross-verification of MediaTek's line buffer reduction proposal (JCTVC-F053) by Ericsson [Andrey Norkin (Ericsson)] [late upload 07-12]

JCTVC-F120 Simplification of Chroma Deblocking Filter in JCTVC-F118 [Q. Huang, J. An, X. Guo, S. Lei (MediaTek)]

JCTVC-F210 Cross-check of simplified filtering decision for chroma deblocking filter (JCTVC-F120) [J. Xu (Microsoft)] [late upload 07-12]

JCTVC-F175 Signalling of boundary filtering strength of deblocking filter for intra [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]

JCTVC-F214 Parallel deblocking improvement [M. Ikeda, J. Tanaka, T. Suzuki (Sony)]

JCTVC-F267 Cross-verification Results of Sony's Parallel Deblocking Improvement (JCTVC-F214) by SKT/SKKU [J. Yang, K. Won, B. Jeon (SKKU), J. Lim (SK Telecom)]

JCTVC-F445 Cross-check of Parallel deblocking improvement (JCTVC-F214) by Sony [M. Sadafale (TI)]

JCTVC-F465 Item 4 (Parallel deblocking filter decision) of Experiments on tools in Working Daft (WD) and HEVC Test Mode (HM-3.0) [I.-K. Kim, E. Alshina, J. Chen, T. Lee, W.-J. Han, J. H. Park (Samsung), V. Sze, M. Budagavi, M. Zhou (TI)]

Item 4: Parallel deblocking filter decision.

Addressed in JCTVC-F763. Put into a CE.

JCTVC-F215 Vertical tap length reduction to reduce line memory in deblocking filter [M. Ikeda, T. Suzuki (Sony)]

JCTVC-F444 Cross-check results for Sony's proposal JCTVC-F215 [S. Esenlik, M. Narroschke (Panasonic)]

JCTVC-F256 Improving Deblock filter efficiency [M. Sadafale (TI)]

JCTVC-F220 Cross-verification of TI's proposal JCTVC-F256 [M. Ikeda, T. Suzuki (Sony)]

JCTVC-F359 Deblocking filtering modification for constrained intra prediction [J. Lee, S.-C. Lim, H. Y. Kim, J. S. Choi (ETRI)]

JCTVC-F651 Cross-check report on JCTVC-F359 by ETRI [V. Wahadaniah, C. S. Lim (Panasonic)] [late reg. 07-05, upload 07-07]

JCTVC-F405 Deblocking filter using adaptive weighting factors [M. Narroschke, A.-K. Seifert (Panasonic)]

JCTVC-F774 Cross check of JCTVC-F405 [G. Van der Auwera (Qualcomm)] [late reg. 07-21, upload 07-21]

JCTVC-F484 Improving Worst-Case performance of Deblock filter [Mangesh Sadafale (TI)]

JCTVC-F722 Cross-verification of TI's JCTVC-F484 on improving worst case performance of deblock-filter V. Seregin, J. Chen (Samsung) [late reg. 07-12, upload 07-12]

6.5.2 Adaptive loop filter ("Wiener")

JCTVC-F076 ALF coefficient prediction [K. Andersson (Ericsson)]

Prediction of filter coefficients – adds some complexity – very small gain. Used for the chroma in current HM. (There is only one filter in the chroma case). Predicts the value of center tap based on the value of other taps, and codes the difference.

For luma, the filter tap values are predicted from other filter values.

Might be helpful to keep in mind in the future, but let's not tinker with it in this way at the moment. Other aspects should be stabilized before worrying about this.

JCTVC-F161 Complexity Scalable ALF [M. Li, P. Wu, Z. Li, W. Zhang (ZTE)]

Proposes to have varying complexities of ALF that can be enabled (e.g., for different profiles or for particular picture patterns).

Benefit was shown relative to LC (where the anchor does not use ALF).

A participant remarked that the PPS is not the right place to put syntax with a larger scope.

The idea of a "slice parameter set" was also noted.

It was remarked that the current syntax is flexible enough already to support some forms of this.

The motivation was described as partly a matter of "decoder complexity scalability".

Contribution noted.

JCTVC-F209 Cross-check of complexity scalable ALF (JCTVC-F161) [J. Xu (Microsoft)] [late upload 07-12]

JCTVC-F179 An improvement on pixel classification for ALF based on edge direction [K. Sugimoto, K. Miyazawa, A. Minezawa, S. Sekiguchi, T. Murakami (Mitsubishi)]

Performs Laplacian edge detection to control filter selection. The proposal suggests changing the number of categories for the selection. Gain is small, but it was suggested that further study might uncover a benefit from optimizing the selections.

JCTVC-F271 Grid displacements for in-loop filtering [S. Esenlik, M. Narroschke, T. Wedi (Panasonic)]

This contribution proposes a method to reduce the complexity of the LCU- (Largest Coding Unit) based processing of Sample Adaptive Offset (SAO) and Adaptive Loop Filter (ALF) operations via displacements in the filter grids. With the contribution the “Filter Design Window” in the encoder and “Filter Application Window” in decoder are matched in order to achieve uniformity in filtering within a “Filter Application Window”. Moreover the new placements of the ALF and SAO grids reduce the line memory requirement for in-loop filtering by 3 lines, which corresponds to 25% reduction.

It was noted that this applies only to the "region based ALF" scheme, and may not help the worst case since the worst case may not use that ALF scheme – it could use CU based ALF

The goal is to save decoder complexity.

The proposal was somewhat modified between versions of the proposal during the meeting.

Further study in a CE was suggested.

JCTVC-F683 Cross-verification of Panasonic's proposal JCTVC-F271 [M. Ikeda, T. Suzuki (Sony)] [late reg. 07-07, upload 07-08]

Software was analyzed as well as operated.

JCTVC-F320 Subjective tests on ALF and SAO [O. G. Sezer, M. Budagavi (TI)]

This contribution presents results of informal subjective tests conducted on two loop filtering operations in HM-3.0: SAO and ALF. Test videos were presented at their actual frame rates to the viewers. Four configurations were tested using low delay B high efficiency (LB-HE) condition: HM-3.0 Anchor v/s SAO-off+ALF-off, HM-3.0 Anchor v/s SAO-off, HM-3.0 Anchor v/s ALF-off, HM-3.0 Anchor v/s ALF-Luma-off. Overall, the subjective difference between the HM-3.0 Anchor and the test configurations is less than expected. Among these four configurations, ALF-Luma-off gave subjective results closest to the HM-3.0 Anchor. This contribution requests that JCTVC conduct subjective testing of ALF and SAO in a core experiment setting to evaluate the subjective gains provided by the tools and decide on the minimal set of configurations that best provide subjective quality improvements so that the minimal set can be included in the final standard.

The report is not from a large rigorous study.

The impression is that SAO provides a larger visual gain than ALF; when SAO is enabled, ALF is not providing very substantial further improvement.

Some other participants indicated that they had done some similar experiments and not reached the same conclusion.

The BoG coordinated by M. Zhou (JCTVC-F763) was asked to try to do some informal investigation of this during the meeting.

Further study was encouraged.

JCTVC-F342 ALF Complexity Analysis [T. Hellman (Broadcom)]

This submission examines the implementation complexity of the adaptive loop filter (ALF). It reports that the worst-case ALF complexity, as presently specified, is on the order of 130 operations (multiplies and adds) per luminance pixel, or roughly 16 billion operations per second for an HD video stream. It compares this complexity to that of the inverse transform and motion compensator, and recommends study of ways to reduce this complexity.

The proponent indicated that the changes being adopted at this meeting is making substantial progress at reducing the burden.

JCTVC-F498 Adaptive Loop Filter Merge in Temporal Domain [X. Zhang, R. Xiong, S. Ma, W. Gao (Peking Univ.)]

This contribution proposes a temporal adaptive loop filter (ALF) merging method. The proposed method utilizes decoded ALF parameters from prior frames to implement the adaptive loop filtering. The usage of whether prior decoded filter bank or the current filter bank in HM3.0 is signaled in the bitstream. Compared with HM3.0, the proposed method reportedly achieves 0.3%, 0.2%, and 0.2% bit rate reductions for HE-RA, HE-LD, and HE-LD (P), respectively. The encoding time is reportedly increased by 2%, while the decoding time is reportedly increased by 2~5%. Coding results are confirmed by Microsoft with JCTVC-F207.

Similar to JCTVC-F321, but a bit less flexible regarding which picture to obtain prior coefficients from.

JCTVC-F207 Cross-check of adaptive loop filter merge in temporal domain (JCTVC-F498) [J. Xu (Microsoft)] [late upload 07-13]

JCTVC-F542 ALF with low latency and reduced complexity for HEVC [A. Fuldseth, G. Bjøntegaard (Cisco)]

The document describes an ALF for low latency applications. Preliminary simulation results are presented.

ALF as specified in HM 3.0 brings a coding gain of typically 4-6% measured in BDR. The operations are mainly performed on a frame basis. This may lead to additional latency caused by the coding process. This makes ALF less attractive for low (sub-frame) delay real time applications like video conferencing. Furthermore ALF represent a considerable implementation complexity. The present document therefore describes some ideas and initial simulation tests on an ALF version that could be useful in connection with low latency applications.

HM 3.0 perform ALF on a frame basis. According to the present document ALF is performed on smaller units. 64x64 and 128x128 luma pixels have been used. This will be referred to as an ALF-unit.

The ALF coefficients are quantized more coarsely than in HM 3.0. This is mainly in order to save coding bits since coefficients may have to be sent for every ALF-unit. For the 5x5 diamond shape structure 7 ALF coefficients are calculated. With the coarse quantization, especially the DC response of the filter may suffer. To overcome this only 6 out of 7 coefficients are quantized and transmitted. The last coefficient – representing the center position of the filter is calculated to give a final DC response of 1.

Calculation and quantization of a set of filter coefficient is performed for an ALF-unit. Then an RD test is made to decide if the filter shall be used. 1 bit is used to signal whether the ALF is enabled or disabled. If the outcome of the RD test is positive, filtering is performed with dequantized filter coefficients. No further switch between filters is performed.

	HM3.0-ALF			64x64 blocks			128x128 blocks		
	BDR	BDR-low	BDR-high	BDR	BDR-low	BDR-high	BDR	BDR-low	BDR-high
Average	-3.9	-3.3	-4.5	-1.1	−0.1	-2.0	-2.0	-1.7	-2.4

The proponent was asked about subjective quality, and indicated that subjective quality is what led to the interest in the subject.

The scheme, as proposed, is substantially less complex and has much more compact source code than the current ALF design.

Further study in a CE was suggested.

JCTVC-F522 Enhancing block/region based Adaptive Loop Filter by MediaTek, Qualcomm, Sharp and Toshiba [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), T. Ikai, A. Segall, T. Yamamoto, Y. Yasugi, T. Yamazaki (Sharp)]

This contribution presents a merged version of two CE8 subtest 1 proposals (JCTVC-F321 and JCTVC-F384), which aims to improve block/region adaptive loop filter (ALF).

JCTVC-F321 proposes temporal coefficient prediction and BA enhancement, and JCTVC-F384 proposes flexible class representation and additional block-based adaptive mode. It is reported both proposals improve coding gain, and the gain of both proposals are additive. Coding gains of 0.3%, 0.7%, 0.6% and 0.7% in HE-AI, RA, LB, and LP were reported. The decoding time increased by 3% on average with no changes in encoding time.

See discussion above in sections discussing JCTVC-F321 and JCTVC-F384.

JCTVC-F182 Cross-check on ALF proposal JCTVC-F522 [K. Sugimoto, S. Sekiguchi (Mitsubishi)] [upload 07-16]

Coding results were confirmed by Mitsubishi.

JCTVC-F465 Item 8 (Region-based ALF only) of Experiments on tools in Working Daft (WD) and HEVC Test Mode (HM-3.0) [I.-K. Kim, E. Alshina, J. Chen, T. Lee, W.-J. Han, J. H. Park (Samsung), V. Sze, M. Budagavi, M. Zhou (TI)]

Item 8: Region-based ALF only.

Just for information – for further study – no action, although it would be interesting to reduce the number of modes.

JCTVC-F465 Item 9 (Single pass ALF) of Experiments on tools in Working Daft (WD) and HEVC Test Mode (HM-3.0) [I.-K. Kim, E. Alshina, J. Chen, T. Lee, W.-J. Han, J. H. Park (Samsung), V. Sze, M. Budagavi, M. Zhou (TI)]

Item 9: Single pass ALF.

Information on 1 and 2 pass behaviour within the context of HM4 is requested (do in CE8).

JCTVC-F465 Item 10 (One filter only for ALF) of Experiments on tools in Working Daft (WD) and HEVC Test Mode (HM-3.0) [I.-K. Kim, E. Alshina, J. Chen, T. Lee, W.-J. Han, J. H. Park (Samsung), V. Sze, M. Budagavi, M. Zhou (TI)]

Item 10: One filter only for ALF.

For further study.

6.5.3 Adaptive loop filter ("other")

JCTVC-F047 Modifications of in-loop filter based on non-local means filter [M. Matsumura, Y. Bandoh, S. Takamura, H. Jozawa (NTT)]

This contribution reports the performance of a technique that utilizes an adaptive denoising filter as the in-loop filter of HM codec. In the proposed method, a denoising filter called non-local means (NLM) filter is added in the in-loop filter process of the encoder/decoder in addition to deblocking, ALF, and

SAO filters of HM3.0. The proposal was implemented in HM3.0 software (for High Efficiency) to evaluate its performance. Compared to the anchor of HM3.0, the average BD-rate gains were reported as "intra (Y: −1.0%, U: −0.9% and V: −1.2%)", "random access (Y: −1.0%, U: −2.2% and V: −2.1%)" and "lowdelay B(Y: −1.2%, U: −2.8% and V: −3.3%)", and "lowdelay P (Y: −1.3%, U: −3.2% and V: −3.9%)", respectively. And the average decoding time increased 7–11%. The maximum gain was about "lowdelay P (Y: −1.5%, U: −9.2% and V: −8.8%)" for the sequence "BasketballDrill".

Consistently more gain in chroma than luma.

It was noted that this does not seem to provide gain for Nebuta, which seems odd because that is a noisy sequence.

It was noted that this adds more line buffering.

The proponent indicated that the subjective quality

At the last meeting, it was suggested to test applying this as a pre-processing filter rather than making it part of the decoder.

Considering a post-processing filter may also be an alternative.

Further study was encouraged, although we are reluctant to add more filters and more line buffers to the design.

JCTVC-F323 Cross-check for NTT's proposal on in-loop filter based on non-local means filter (JCTVC-F047) [T. Yoshino, K. Kawamura, S. Naito (KDDI]

JCTVC-F054 Adaptive Loop Filter with Zero Pixel Line Buffers for LCU-based Decoding. [C.-Y. Chen, C.-Y. Tsai, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek)]

When the adaptive loop filter (ALF) in HM-3.0 is enabled, seven additional luma line buffers and seven additional chroma line buffers are asserted to be required for LCU-based decoding. In this contribution, ALF with padding at virtual boundaries was proposed to remove all the line buffers. When the deblocking filter (DF) in HM-3.0 was used, the luma and chroma virtual boundaries were LCU row boundaries upward shifted by four and two pixels, respectively. The general concept was to process a to-be-filtered pixel on one side of a virtual boundary without using any pixel from the other side. Repetitive padding was used to replace pixels from the other side. In comparison with HM-3.0, no line buffer was needed, and BD-rates were reportedly 0.1%, 0.1%, and 0.2% for HE-AI, HE-RA, and HE-LD, respectively, where a positive number means loss while a negative number means gain.

A boundary handling technique is applied to try to avoid visible line boundaries.

It was reported that no visual artifacts seem to be created with the scheme.

It was also proposed to replace the 9x7 diamond filter by the 9x9 diamond filter for luma and to always use the 7x7 diamond filter instead of the 5x5 square filter for chroma. Corresponding BD-rate were 0.1%, −0.1%, and −0.4% reportedly for HE-AI, HE-RA, and HE-LD, respectively. In addition, a boundary smoothing technique was proposed to remove possible visual artifacts near virtual boundaries, and corresponding BD-rates were 0.1%, 0.0%, and −0.2% reportedly for HE-AI, HE-RA, and HE-LD, respectively. All the experiments reportedly achieved no change in run time.

JCTVC-F272 is a somewhat competing proposal.

This seems to be a simpler approach than JCTVC-F272.

See additional notes in discussion of JCTVC-F272.

JCTVC-F367 Cross-Verification of MediaTek's proposal on adaptive loop filter (JCTVC-F054) by Qualcomm [I. S. Chong, M. Karczewicz (Qualcomm)

JCTVC-F389 Cross-check result of MediaTek's adaptive loop filter for LCU-based decoding (JCTVC-F054) [T. Ikai, Y. Yasugi (Sharp) [late upload 07-05]

JCTVC-F665 Verification results of MediaTek's ALF with zero pixel line buffers JCTVC-F054 [T. Yamakage, T. Watanabe (Toshiba)] [late reg. 07-06, upload 07-11]

JCTVC-F055 Sample Adaptive Offset with Zero Pixel Line Buffers for LCU-based Decoding [C.-M. Fu, C.-Y. Chen, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)]

Similar to JCTVC-F054, but applied to SAO. To be considered in CE along with JCTVC-F272 and JCTVC-F254.

JCTVC-F366 Cross-Verification of MediaTek's proposal on sample adaptive offset (JCTVC-F055) by Qualcomm [I. S. Chong, M. Karczewicz (Qualcomm)]

JCTVC-F056 Sample Adaptive Offset with LCU-based Syntax [C.-M. Fu, C.-Y. Chen, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), I. S. Chong, M. Karczewicz (Qualcomm)]

In HM-3.0, 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%, 0.1%, 0.1%, 0%, 0%, and 0.1% bit rate increases for HE-AI, HE-RA, HE-LD, LC-AI, LC-RA, and LC-LD, respectively, with almost the same encoding and decoding times when the algorithm of deriving localized SAO parameters was unchanged.

The scheme is preliminary at this stage, as no coding gain is shown and the proposal seems to increase decoding complexity. Further study may result in some improvement.

JCTVC-F439 Cross-check of MediaTek's and Qualcomm's proposal on Sample Adaptive Offset (JCTVC-F056) by Samsung [E. Alshina (Samsung)] [late upload 07-07]

JCTVC-F057 Sample Adaptive Offset for Chroma [C.-M. Fu, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek), S. Park, B. Jeon (LGE), A. Alshin, E. Alshina (Samsung)]

Sample adaptive offset (SAO) for luma was adopted in HM-3.0. In this contribution, the same techniques of band offset (BO) and edge offset (EO) used for luma were applied for chroma. The three components were independent, and each component had its own partitions and offsets. It was reported that SAO reduced Cb bitrates by 2.0%, 3.3%, 4.6%, 1.8%, 2.7%, and 6.3%, and Cr bitrates by 2.9%, 3.9%, 5.9%, 2.4%, 2.8%, and 7.6% for HE-AI, HE-RA, HE-LD, LC-AI, LC-RA, and LC-LD, respectively, while encoding and decoding times were almost unchanged. A small loss (averaging approximately 0.1% was reported in the luma).

The gain for luma SAO was approximately 2-3%.

Decision: Adopted (pending no objection relating to text and software quality – no objection was raised).

It was remarked that SAO in general needs significant code clean-up, and those interested in that feature volunteered to help.

JCTVC-F364 Cross-Verification of MediaTek's proposal on sample adaptive offset of chroma (JCTVC-F057) by Qualcomm [I. S. Chong, M. Karczewicz (Qualcomm)] [initial version rejected as placeholder; corrected version late upload 07-06]

JCTVC-F058 Sample Adaptive Offset with PPS-level Syntax [C.-M. Fu, C.-Y. Tsai, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)]

In HM-3.0, the sample adaptive offset (SAO) parameters are adapted at picture level. However, when a picture contains multiple slices, the entire SAO information is always sent in the first slice header, which is undesirable for parallel processing of multiple slices. In JCTVC-E045, a solution to a similar problem for adaptive loop filter (ALF) was adopted into HM-3.2. Therefore, by analogy with JCTVC-E045, this contribution proposed to add an option of moving SAO parameters to the picture parameter set (PPS). The option could be enabled for multiple slices per picture or disabled for single slice per picture by using a flag in PPS, and the flag could be shared by SAO and ALF. Compared with the SAO syntax coded in the first slice header, the proposed PPS-level SAO syntax reportedly showed no difference in BD-rate and run time under JCTVC-E700 common test conditions with 1500-byte slices per picture.

Decision: Use adaptation parameter set for SAO parameters (see JCTVC-F747).

JCTVC-F700 Cross-check of MediaTek's Sample Adaptive Offset (JCTVC-F058) [T. Yamazaki, T. Ikai, Y. Yasugi, T. Yamamoto (Sharp)] [late reg. 07-11, upload 07-14]

JCTVC-F093 Sample Adaptive Offset with Padding at LCU, Slice, and Image Boundaries [C.-M. Fu, C.-Y. Tsai, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)]

In the adaptive loop filter (ALF) process of HM-3.2, padding is used at slice and image boundaries. In the sample adaptive offset (SAO) process of HM-3.2, skipping is used at largest coding unit (LCU), slice, and image boundaries. This contribution proposed to replace the skipping technique used in SAO by the padding technique as a unification between ALF and SAO. Simulation results reportedly showed no change of BD-rates and run times. Moreover, it was reported some visual artifacts of the skipping technique could be removed.

Visual artifacts were observed in the Kimono sequence, which are asserted to be removed by this technique.

It was remarked that ALF should be applied to the left and right boundaries of the LCU rather than padding them or skipping them. This seemed like a good suggestion.

See notes below in discussion of JCTVC-F232.

JCTVC-F365 Cross-Verification of MediaTek's proposal on sample adaptive offset (JCTVC-F093) by Qualcomm [I. S. Chong, M. Karczewicz (Qualcomm)] [initial version rejected as placeholder; corrected version late upload 07-06]

JCTVC-F232 SAO LCU boundary processing [M. Budagavi (TI)]

Sample adaptive offset (SAO) processing in HM-3.0 is done in an LCU-independent way. As a result, during edge offset type of SAO processing, the top and bottom row and/or left and right column of LCU are not SAO processed. This is reported to result in grid line type of noticeable visual artifact in Kimono HM-3.0 encoding. This contribution presents techniques for SAO processing at LCU boundary to eliminate the grid line type of visual artifact. The techniques presented do not use additional line buffer. Two of the techniques presented do SAO processing in LCU-independent fashion. All the techniques are reported to have BD-Rate of 0.0% for common conditions.

Three variations to resolve this were described in the contribution.

Related proposal JCTVC-F093.

The main difference between this proposal and JCTVC-F093 seems to be in regard to the vertical processing at the top and bottom edges.

Remark: Somewhat less bad in HM 3.2.

Remark: Kimono is the only sequence this is happening in (within the common conditions).

Remark: Consider the interaction between the deblocking filter and SAO (e.g., switch their order). Response: That has (objective) coding efficiency loss.

Remark: The line buffers are (currently) in there anyway, so perhaps just apply the SAO the same way everywhere for now (including at LCU boundaries), and work out how to deal with this in a more unified way in the future.

Decision: Agreed to apply SAO the same way at LCU boundaries (that are not slice boundaries) as at interior of LCU.

Also establish a CE for further study.

JCTVC-F442 Cross-check for SAO LCU boundary processing (JCTVC-F232) by Samsung [E. Alshina (Samsung)]

JCTVC-F396 Improvement of Sample Adaptive Offset with modified bit accuracy and restricted offsets [T. Yamazaki, T. Ikai, Y. Yasugi, T. Yamamoto (Sharp)]

In this contribution, a bit accuracy modification and offset range restriction in Sample Adaptive Offset (SAO) were proposed.

- The proposed bit accuracy is 10 bits rather than 9 bits as in HM-3.0.
- An offset range restriction of 4, 5, or 6 bits is proposed depending on SAO bit accuracy.

With the proposed offset range, the memory usage can reportedly be reduced up to 40% compared to HM-3.0 when internal bit depth is 10 bits. It is reported that the bit accuracy modification and offset range restriction have negligible effect on the coding efficiency in the normal QP range (22-37) while it achieves up to 0.2% gain in lower QP range (12-27).

Decision: Adopted.

JCTVC-F693 Crosscheck for Sharp's SAO in JCTVC-F396 [C.-Y. Tsai, Y.-W. Huang (MediaTek)] [late reg. 07-09, upload 07-14 after opening]

6.6 Block structures and partitioning

JCTVC-F070 Sub-8x8 PU coding with fixed reference index [M. Zhou, M. Budagavi (TI)]

DDR bandwidth has become increasingly a bottleneck for chip designs targeted for HD/UHD video applications. However, in the current HM3.0 design, PUs down to 4x4 block size can have their own reference index, which essentially increases the decoder memory bandwidth requirements when compared to AVC. A simple algorithm is tested to qualify the benefit of having the reference index granularity down to 4x4 blocks. In the tested algorithm all the 8x4, 4x8 and 4x4 PUs are fixed to having reference index equal to zero, and reference index is not encoded into bitstream for sub-8x8 blocks. The simulation results reveal that the loss by constraining the reference index for sub-8x8 blocks to zero is fairly limited. On average BD-rate increase of 0.3% in RA-HE, 0.5% in RA-LC, 0.2% in LB-HE and 0.4% in LB-LC, respectively, is observed for common test conditions with four reference frames. It is recommended to conduct further study on this topic for reduction of memory bandwidth requirements of motion compensation.

4x4 does not exist anymore.

Losses are mainly observed for the smaller picture sizes (class C and D, the latter is 0.8%).

Further study was suggested.

JCTVC-F116 Cross-verification results of TI’s Sub-8x8 PU coding with fixed reference index (JCTVC-F070) by LG [Hendry, S. Park, B. Jeon (LGE)]

JCTVC-F107 Redundancy removal of residual information for CAVLC in merge 2Nx2N [J. Park, B. Jeon (LGE)]

In the current HM, skip mode and merge mode for 2Nx2N PU size (2Nx2N_MRG) share the same motion representation method. The difference between the two modes is whether the residual information is sent or not. Hence, no_residual_data_flag in CABAC coding is inferred to be equal to 0 when CU is coded with 2Nx2N_MRG mode (in S/W, not in W/D). However there is no such consideration for CAVLC coding. In a similar spirit as with the CABAC case, this contribution proposed a change in cbp_and_split_transform syntax. Applying this change reportedly brings 0.1% BD-rate reduction for both random access and low delay configurations.

It was reported that the no_residual_data_flag inference is in the software but not in the WD - this must be checked and corrected if it is the case.

The other item (CAVLC) could be an issue, but it was suggested that there may be other solutions. It was suggested to check offline with X. Wang and report back on this, and then was later confirmed OK.

Decision: Adopted (both aspects).

JCTVC-F371 Cross-check report for LGE's proposal JCTVC-F107 [H. Sasai, T. Nishi (Panasonic)]

JCTVC-F192 A study on addition of 64x64 transform to HM 3.0 [Y. Sugito, A. Ichigaya, S. Sakaida (NHK), K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]

This contribution proposes addition of 64x64 transform to HM 3.0. 64x64 transform improves the coding efficiency of higher resolution images – providing an average reported gain around 0.5% for sequences of Class A and B (peak is 2.6%). The results of encoding and decoding time are up to 3% increase compared with HM 3.0.

Question: Is the gain more due to 64x64 luma or 32x32 chroma?

Should it be studied to just to use 32x32 chroma transform?

In general, with most sequences, the gain is small, such that a revision of the previous decision (small gain vs. high implementation cost in hardware) is not adequate.

One expert remarked that a similar tendency of increased gain by 64x64 transform was observed with other SHV sequences (not in the current test set).

JCTVC-F690 Cross check by Canon on Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode from Qualcomm (JCTVC-F302) [G. Laroche (Canon)] [late reg. 07-08, upload 07-11]

JCTVC-F418 Joint coding of CU splitting flag and inter modes based on HM 3.1 [W. Zhang (ZTE)] [late upload 07-08]

In HM 3.1, there is up to eight cases could be summarized for CU splitting flag and inter modes. A joint coding method which is different to CU-depth dependent and counter-based adaption (JCTVC-D370, JCTVC-E143) was proposed. As test results reported, it has saved about 0.6% BD-rate for CAVLC configurations.

In this proposal, the representing method of CU splitting flag and inter modes had been unified both in CAVLC and CABAC. And about 0.1% BD-rate deviation was observed for coding efficiency of CABAC comparing to HM 3.1. It's also proposed that IPCM could be enabled in intra slice while CU size greater than 16x16 and in inter slice while CU size greater than 8x8 (min CU) with a loss of 0.1% BD-rate in AI-LC configuration only.

Refers also JCTVC-D275, JCTVC-E072 and JCTVC-E258

The proposal introduces new tables for the joint mode (16 instead of 4 tables).

Where does the gain come from? Cross-checkers are not able to explain.

For HE, very often slight loss is observed – there is no good reason to use the same method

There is some dependency on the previous slice (parsing dependency) – this is not desirable and could explain some of the gain

No action.

JCTVC-F117 Cross-verification results of ZTE's inter mode coding (JCTVC-F418) by LG [Hendry, J. Lim, B. Jeon (LGE)] [late upload 07-11]

JCTVC-F279 Cross-check Report for ZTE's Proposal JCTVC-F418 [Z. Zhou, S. Liu (MediaTek)] [late upload 07-13]

JCTVC-F578 RQT with rectangular transform unit support [K. Panusopone, X. Fang, V. Kung, L. Wang (Motorola Mobility)]

This contribution describes a simplification for residual tree with rectangular transform unit. The proposed method aims to minimize change in reference software and syntax while maintaining coding performance.

New type: Nx2N and 2NxN TU; joint split flag for first level, normal RQT starting from second.

Some gain reported, but not using common test conditions.

Contribution noted.

JCTVC-F596 The effect of LCU size on coding efficiency in the context of MTU size matching [M. Horowitz, S. Xu (eBrisk Video), E. S. Ryu, Y. Ye (InterDigital Communications)]

This contribution contains information showing the effect of LCU size on coding efficiency in the context of encoding with a maximum transmission unit (MTU) size constraint. Results were presented comparing a simulation configured to use 1500-byte slices and a separate simulation using 1500-byte slices and tiles, each against an HM 3.0 anchor that was configured to use one slice per picture. Separate simulations were run for each of three LCU sizes: 16x16, 32x32, and 64x64. Results show that the coding efficiency loss of 1500-byte per slice relative to the single slice anchor grows with decreasing LCU size. In addition, simulations featuring 1500-byte slices and tiles show higher coding efficiency in nearly all cases than those where only 1500-byte slices were used. It is also noted that gains using tiles and 1500-byte slices relative to using 1500-byte slices only increase with decreasing LCU size.

Analyzes the tradeoff between MTU size and LCU size. Combination slice+tile is usually causing less coding loss than slices alone (loss does not grow with LCU size any more). Fine granularity slices (as available in HM3.3) were not considered, which also would solve the problem.

6.7 Motion compensation operation and interpolation filters

BoG activity planned (T. Suzuki)

6.7.1 Interpolation filters and MV precision

JCTVC-F216 An Adaptive Interpolation Filtering Technique [F. Kossentini, N. Mahdi, H. Guermazi, M. A. Ben Ayed, M. Horowitz (eBrisk)]

JCTVC-F242 Bilinear chroma interpolation for small block sizes [K. Ugur, J. Lainema (Nokia), K. Kondo, T. Suzuki (Sony)]

JCTVC-F468 An Adaptive Interpolation Filtering Technique [F. Kossentini, N. Mahdi, H. Guermazi, M. A. Ben Ayed, M. Horowitz (eBrisk)]

JCTVC-F719 Cross-check report for Qualcomm's JCTVC-F585 on Luma/chroma interpolation precision [J. Chen (Samsung)] [late reg. 07-12, upload 07-12]

JCTVC-F599 On Chroma interpolation filters [Koohyar Minoo, Jian Lou, Ajay Luthra]

JCTVC-F685 Cross-check of JCTVC-F599: Chroma interpolation filters [Jinwen Zan, Dake He] [late reg. 07-07, upload 07-15]

JCTVC-F730 Cross-check for Motorola's Proposal (JCTVC-F601) on Sub-pixel Interpolation [Z. Zhou, S. Liu (MediaTek)] [late reg. 07-13, upload 07-16]

JCTVC-F602 Cross-check for combined interpolation filter design (JCTVC-F468) by Samsung [E. Alshina (Samsung)] [late upload 07-12]

JCTVC-F601 Joint sub-pixel interpolation for bi-predicted motion compensation [K. Minoo, J. Lou (Motorola Mobility)]

This document proposes an interpolation scheme for temporal prediction of PUs (prediction units), when bi-prediction is used. In such cases the optimal filter per reference list would depend on the joint sub-pixel offsets. For example if four sub-pixel offsets per reference block/list can be indicated for prediction of each PU, then a set of up to 16 pairs of filters can be designed to optimally conduct a bi-prediction motion compensation for that PU. This scheme in intended to be used to increase the coding efficiency of video compression schemes, or alternatively to reduce the complexity of motion-compensation, in terms of memory access bandwidth and/or number of operations performed for sub-pixel interpolation filtering.

Proposes different (likely shorter) filters for biprediction versus uniprediction.

With 8 taps for unipred (as in current design) and 6 for bipred, roughly no loss in coding efficiency was reported.

With further shortening to 4 tap for bipred, some loss was observed.

If the bipred filters are made 8 taps or by using improved 6 tap filters, potentially some coding gain may be observed.

Further study was encouraged.

JCTVC-F125 Progressive MV Resolution [J. An, X. Li, X. Guo, S. Lei (MediaTek)]

This contribution proposes a progressive MV resolution (PMVR) method, which allows adaptation among different MV resolutions. In PMVR, MV resolution is not explicitly signaled with specific syntax but progressively adjusted based on the magnitude of MV differences. It is reported that 1.0% luma BD-rate reduction is obtained on average for all four inter configurations (RA-HE, RA-LC, LB-HE, and LB-LC). Moreover, it is also reported that average encoding time is reduced by 5% while average decoding time is increased by 2%. For LP-HE and LP-LC configurations, average luma BD-rate reduction is reportedly 2.8% with similar encoding and decoding times.

Has tuning parameters sent by the encoder, and adjustments that depend on QP of reference pictures.

Requires more interpolation filter kernels, equivalent to 1/8 pel MV support.

A substantial amount of the gain comes from BQSquare, which tends to show benefit from high-precision motion in general. It was remarked that B pictures is another way to get that benefit, as it enables pseudo-1/8 pel motion.

It was asked whether the result had been compared with the previously proposed AMVRES scheme (proposed by Qualcomm).

It was noted that another related proposal had also been submitted.

A participant remarked that other such methods seemed simpler.

The proposal seemed to require a significant amount of pseudo-code to compute MVD.

It was noted that just changing the interpolation filter can help for the P picture cases.

To be further studied in a CE.

JCTVC-F567 Adaptive resolution on motion vector difference [W.-J. Chien, P. Chen, X. Wang, M. Karczewicz (Qualcomm)]

This contribution presents a coding method to signal the resolution of the motion vector differences. The motion accuracy of the motion vector difference can be adaptively selected to be 1/4th pel or 1/8th pel and signaled via a motion resolution flag. A joint coding of motion resolution flag and motion vector difference are also proposed. Simulation results reportedly show an average 0.4% BD-rate saving on the high efficiency configurations and an average 0.6% BD-rate saving on the low complexity configurations.

Uses some thresholds that are transmitted.

Gain is about half that reported for JCTVC-F125.

The additional gain may come from the support of a switching point between 1/4 and 1/2 pel in the other scheme.

Roughly conceptually similar to (part of JCTVC-F125) and similar elements to JCTVC-F471.

JCTVC-F692 Crosscheck for Qualcomm's Proposal JCTVC-F567 [J. An, X. Guo (MediaTek)] [late reg. 07-09, upload 07-21]

JCTVC-F471 Picture Adaptive 1/8-pel Motion Compensation Method [T. Sugio, T. Nishi (Panasonic)]

In this contribution, a picture-adaptive 1/8-pel motion compensation method was proposed. In the proposed method, For P slice, 1/8-pel motion compensation is enabled and all reference pictures are referred using 1/8-pel motion vectors. On the other hand, for B slice, 1/8-pel motion compensation is enabled but all reference pictures are referred using 1/4-pel motion vector in order not to increase overhead to signal motion vector difference. Experimental results reportedly showed 2.5% BR saving for HE and 2.0% BR saving LC on average in LD P scenarios. It also reportedly showed 0.3% BR saving for HE and 0.4% BR saving in the RA scenarios, and 0.2% BR saving for HE and 0.3% BR saving for LC on average in the LD B scenarios relative to the HM3.0.

1/16 pel for chroma when 1/8 pel used for luma.

Difference between LP and LB is reportedly about 6%.

Internal increase of MV precision for predictor.

Biggest difference for BQTerrace, BQSquare, PartyScene.

Closely related to JCTVC-F125 and JCTVC-F567.

JCTVC-F682 Cross check for Picture Adaptive 1/8-pel Motion Compensation Method (JCTVC-471) by Samsung [E. Alshina (Samsung)] [late reg. 07-07, upload 07-07]

JCTVC-F616 Cross-check of MediaTek's proposed JCTVC-F125 on Progressive MV resolution [W.-J. Chien (Qualcomm)] [late upload 07-05]

6.7.2 Intermediate rounding and clipping issues

JCTVC-F318 On the precision of interpolation processing [T. Chujoh, T. Yamakage (Toshiba)]

In this contribution, the precision of interpolation processing is discussed. The current HEVC Test Model (HM) uses 8-tap filter coefficients with 6-bit precision for luminance pixels and 4-tap filter coefficients with 6-bit precision for chrominance pixels and a high accuracy bidirectional prediction method. It is alleged that there are problems about precision of interpolation processing. Some rounding and clipping are introduced for 16-bit input and output specification; however since the filter coefficients and tap-length are under consideration in CE3, the design might be changed in the future. It is proposed for all intermediate rounding and clipping to be removed. If there is no intermediate rounding and clipping, the order of operation for interpolation processing is changeable. This can expand the implementation possibility of encoder and decoder. In that case, even with 14-bit pixel input, all outputs do not exceed singed 32-bit integer.

Proposes, for current purposes, the removal of all intermediate rounding and clipping and right shifting.

The contribution does not necessarily assume that the design would stay that way in its final form.

It was remarked that this could cause a problem with testing of high-precision interpolation coefficients since doing that would cause overflows.

JCTVC-F637 Cross-check report for JCTVC-F318: on the precision in MC process [K. Kondo, T. Suzuki (Sony)] [late reg. 07-05, upload 07-05]

JCTVC-F480 Unified design for motion compensation filter [C. Kim, S. Jeon (Samsung)]

This contribution presents a scheme for handling right shifting in the motion compensation process. This differs from JCTVC-F318 by including some right shifting before bipredictive averaging and in the unipred case.

It also differs somewhat from JCTVC-F537.

JCTVC-F537 On the motion compensation process [F. Bossen (Docomo USA Labs)]

This contribution proposes two modifications to the motion compensation process to simplify the process by removing rounding operations and to ensure that all data after each of the vertical and horizontal filtering passes fits in 16-bit memory. With these modifications, simplified and corrected reference software and text are proposed in which the proposed code is several thousand lines of code shorter than the current one, and the text is also shortened. The proposed modifications have a negligible impact on coding efficiency (all reported average BD-rate differences for luma are 0.0%) and on run times (98-103%). Commonalities exist with the proposals described in JCTVC-F480 and JCTVC-F585, which were independently developed. A confirmation of the performance reported in JCTVC-F480 is provided, as well as a comparative analysis.

Avoids violations of 16 bit range.

Avoids some cascaded rounding.

Handles aspects related to higher bit depth samples.

Significantly simplifies the software and text.

Decision: Adopted.

JCTVC-F733 Modification to JCTVC-F537: 16-bit bi-prediction interpolation process [M. Coban, P. Chen, M. Karczewicz (Qualcomm)] [late reg. 07-13, upload 07-13]

Discusses certain aspects relating to issues in JCTVC-F537.

JCTVC-F738 Cross-check of Qualcomm's contribution on 16-bit bi-prediction interpolation process (JCTVC-F733) [A. Fuldseth (Cisco)] [late reg. 07-15, upload 07-20]

JCTVC-F585 Luma interpolation precision [Muhammed Coban, Peisong Chen, Marta Karczewicz (Qualcomm)]

Discusses certain aspects relating to issues in JCTVC-F537.

6.7.3 Weighted prediction and illumination compensation

JCTVC-F265 Weighted Prediction [P. Bordes (Technicolor)]

This document presents results of Weighted Prediction (WP) and an associated analysis tool implementation into HM. This report is an AHG18 outcome.

WP has been designed to compensate illumination variation in video sequences. It is part of the AVC standard and this feature is useful in video encoder and video splicing applications in particular.

Experimental results of WP and the analysis tool have been made on fade sequences generated with a fading tool provided in AHG18.

It was reported that WP in explicit mode has a gain in the range of 17-28% (depending on the configuration) for the test sequences with linear fade when weights are known in advance, and in the range of 15-29% (depending on the configuration) when the WP analysis tool is used.

The difference from AVC in the chroma is to center around 128 rather than 0 and make adjustments for precision of the computations; otherwise the proposal is essentially the same as in AVC.

This contribution focuses on explicit prediction, and there was a prior contribution to the Geneva meeting that focused on implicit prediction (with test results).

Text and software were provided in the contribution.

The provided software did not at first appear to be sufficiently "clean".

The provided text seems to be somewhat disconnected from a contextual relationship with the draft standard – just being a separate section without connections to the remainder of the document.

The proponent suggested using software from JCTVC-F326 (software to be uploaded) rather than this contribution.

It was remarked that the high-precision averaging may not be implemented correctly in the software.

The weights for explicit weighting were placed syntactically at the slice header level (as in AVC).

It was remarked that the slice parameter set concept may be useful for sending the weights.

Text and software seem adequate to enable integration, although some further improvement of the software is needed from the proponent. Decision: Adopted.

JCTVC-F436 AHG18: Cross-check report of Weighted Prediction, proposal JCTVC-F265 [R. Boitard, L. Guillo (INRIA)]

JCTVC-F331 Cross check report of Technicolor's proposal of JCTVC-F265 for Weighted Prediction from Toshiba A. Tanizawa (Toshiba) [A. Tanizawa (Toshiba)]

JCTVC-F326 Explicit Weighted Prediction with simple WP parameter estimation [A. Tanizawa, T. Chujoh, T. Yamakage (Toshiba)]

This document presents experimental results for Weighted Prediction (WP) with a simple WP parameter estimation scheme. WP has been designed to compensate illumination variation in video sequences and included in the AVC standard. This feature is effective for video splicing process used in video authoring system and can get significant coding gain for fading sequences.

In this document, a WP parameter estimation method based on alpha-blending model is discussed in order to derive WP parameters under 1-pass encoding conditions. This method uses only spatial image characteristics and its computational cost is asserted to be negligible. The experimental results in HM software version 3.0 under common test conditions are reported. The WP using 1-pass encoding scheme has a large reported gain of 17% to 31% on average (up to 61% for Low delay P structure) for the test sequences with linear fade provided in the WP AHG. It is reported that the WP does not have a big impact on coding efficiency for the regular test sequences.

JCTVC-F457 AHG18: Cross-check report of Explicit Weighted Prediction with simple WP parameters estimator, proposal JCTVC-F326 [P. Bordes (Technicolor)]

JCTVC-F397 Weighted Prediction with Parameter Estimation [S. Takamura, Y. Bandoh, S. Matsuo, K. Kamikura, H. Jozawa (NTT)]

(Information document – experiment report.)

This report summarizes the performance evaluation of the weighted prediction tool using fade parameter estimation. For faded sequences in the low delay configuration, WP with given parameter (ground truth) provided 18-29% gain (Y), WP with estimated parameter provided 17-28% gain (Y). Encoding complexity was 100-128% while decoding complexity was 82-107%. The same estimation method as used in JCTVC-F326. Reference to estimation method: Hirofumi Aoki and Yoshihiro Miyamoto, "An H.264 weighted prediction parameter estimation method for fade effects in video scenes," Proc. ICIP 2008, pp. 2112-2115, Oct. 2008.

JCTVC-F417 Pixel Based Illumination Compensation [Chan-Won Seo, Jong-Ki Han (Sejong Univ.), Jeongyeon Lim (SK telecom)]

This contribution describes a pixel based illumination compensation scheme to compensate illumination changes. The Weighted Prediction (WP) proposed at the last meeting has been designed to compensate illumination variation at the slice level and it was tested with fade sequences. The WP is useful but it may be not effective for natural sequences whose brightness varies locally. The IC scheme proposed in this contribution derives IC parameters at CU-level. The IC parameters are applied to a block or some pixels adaptively. Coding gains are reportedly about 0.2% and 0.3% for random access and low delay coding configurations, respectively.

It was noted that SAO and WP and ALF and DC coefficients also have effects that can somewhat overlapping effects.

In its present form, the proposal doesn't seem to be providing an adequate tradeoff. Some kind of further improvement would be needed to justify further consideration.

JCTVC-F361 Cross-verification of Sejong Univ.'s proposal on pixel based illumination compensation [Y. Jeon, B. Jeon (LGE)] [late upload 07-12]

6.8 Motion Vector Coding (33)

6.8.1 Decoder-side estimation

JCTVC-F500 Report of self-derivation of motion estimation techniques at video decoder side on HM3.0 [Y. Chiu, W. Zhang, L. Xu, H. Jiang (Intel)]

This contribution provides test result for the Self Derivation of Motion Estimation (SDME) techniques on HM 3.0 reference software. Test results of skip-mode only rounded-candidate based SDME has been provided for bi-prediction mode at prior JCT-VC meetings, and this test on HM3.0 continues to confine the candidate motion vectors within a predefined range in order to quantize the impact of the memory access bandwidth in checking multiple candidate motion vectors.

- The test results of Skip-mode only rounded-candidate based SDME with 8-point MV refinement have reported that an overall 1.2% BD bitrate reduction (up to 2.5%) for RA/HE category under the common test conditions with an overall 5% encoding time increase and an overall 13% decoding time increase.
- The test results of Skip-mode rounded-candidate based SDME without MV refinement have reported an overall 0.5% BD bitrate reduction (up to 1.3%) for the test of RA/HE category with an overall 2% increase in encoding time and approximately no increase in decoding time.

The decoder complexity increase (and memory bandwidth increase) continues to be a serious concern.

JCTVC-F724 Cross-check for JCTVC-F500 [M. Yang (Huawei)] [late reg. 07-12, upload 07-14]

JCTVC-F735 Cross-check of Intel's proposal (JCTVC-F500) on self-derivation of motion estimation at decoder side [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)] [late reg. 07-14, upload 07-16]

The software and algorithm was studied as well as run, and were reported to match the description.

6.8.2 MV Coding

JCTVC-F105 On MVP list pruning process [Y. Jeon, B. Jeon (LGE)]

Discussed in BoG coordinated by B. Bross.

JCTVC-F086 Cross verification of LGE's proposal JCTVC-F105 on MVP pruning process [M. Zhou (TI)]

JCTVC-F099 Performance report of temporal motion vector prediction [H. Aoki, K. Chono, Y. Senda (NEC)]

Discussed in BoG coordinated by B. Bross.

JCTVC-F374 Cross-verification report of JCTVC-F099 by JVC Kenwood [S. Fukushima (JVC Kenwood)] [late upload 07-05]

JCTVC-F142 Improvement on derivation process for luma motion vector prediction [K. Kazui, S. Shimada, J. Koyama, A. Nakagawa (Fujitsu)]

This contribution proposed two modifications of the derivation process for luma motion vector prediction in WD3.0. Firstly, the rounding process in the equations for scaling motion vector was modified. Secondly, the derivation process for temporal luma motion vector prediction was modified so that a motion vector predictor is chosen among two motion vectors in a collocated picture.

The coding gain of the proposed scheme for BQSquare sequence is reportedly up to 2.0%. The average coding gain for Class D sequences for RA HE and RA LC is reportedly 0.9%. The overall coding gains for random access configurations and low delay configurations are reportedly 0.5% and 0.1%, respectively, for both HE and LC. Additional computational complexity both in encoding and decoding is reportedly negligible.

This has two modifications, but most of the gain is from one of them.

That modification is to round toward zero when applying MV scaling.

Decision: Adopt this aspect.

The other part was not adopted.

JCTVC-F183 Cross-verification report on Fujitsu's proposal (JCTVC-F142) on AMVP [K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)]

JCTVC-F373 Merge based MVD transmission [S. Fukushima, M. Ueda, K. Arakage, S. Sakazume (JVC Kenwood)]

Discussed in BoG coordinated by B. Bross.

JCTVC-F427 Consideration on Temporal Predictor [K. Sato (Sony)]

Discussed in BoG coordinated by B. Bross.

JCTVC-F626 Cross-verification result of JCTVC-F427 proposed by Sony [K. Kazui (Fujitsu)] [late reg. 07-04, upload 07-04]

JCTVC-F575 Simplification of MVP Design for HEVC [Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)]

Discussed in BoG coordinated by B. Bross.

JCTVC-F587 Reduction of reference picture list checking for temporal motion vector prediction [I.-K Kim, W.-J Han, JH Park (Samsung)]

Discussed in BoG coordinated by B. Bross.

JCTVC-F657 Cross verification of Samsung's proposal JCTVC-F587 on Reduction of reference picture list checking for temporal motion vector prediction [M. Zhou (TI)] [late reg. 07-05, upload 07-07]

JCTVC-F465 Item 1 (Center position of TMVP candidates) of Experiments on tools in Working Daft (WD) and HEVC Test Mode (HM-3.0) [I.-K. Kim, E. Alshina, J. Chen, T. Lee, W.-J. Han, J. H. Park (Samsung), V. Sze, M. Budagavi, M. Zhou (TI)]

Item 1: Center position of TMVP candidates

Discussed in BoG coordinated by B. Bross – will be tested in CE9.

JCTVC-F081 CE1: Evaluation results on A.09, A.13-16 and an alternative solution [M. Zhou (TI)]

This contribution is relevant to CE1, and is discussed above in that context, but also contains a new proposal. The new proposal is the same as (or strongly similar to) item 1 of JCTVC-F465, and was asserted to be suitable as a cross-check of that proposal. Placed under consideration in BoG coordinated by B. Bross.

JCTVC-F341 Decoder Performance Restrictions due to Merge/MVP Index Parsing [T. Hellman, Y. Yu (Broadcom)]

Discussed in parsing robustness BoG coordinated by B. Bross.

JCTVC-F372 Bi-derivative merge candidate [H. Takehara, S. Fukushima, H. Nakamura (JVC Kenwood)]

In merge mode, motion information used for motion compensation is indicated only by signalling the index of merge candidates. The merge candidates are discussed in this contribution in cases where some candidates are not available.

In this proposal, additional merge candidates are created by using motion information of current merge candidates without additional access to other blocks.

It was reported that the proposed technique provides 0.2% BD-rate gain for RA settings and 0.7% gain for LB settings with 3% encoder runtime increase and 1% decoder runtime increase.

The encoder runtime increase is due to an increase in the average number of merge candidates to be evaluated.

The same concept is reportedly proposed in JCTVC-F470.

Should be studied in relation to the MVP candidate list construction discussion. Discussed in BoG coordinated by B. Bross.

JCTVC-F419 Unification of derivation process for merge mode and MVP [H. Nakamura, S. Fukushima, M. Nishitani (JVC Kenwood)]

This contribution presents simplifications of derivation process for merge mode and motion vector predictor (MVP). In this proposal, the positions of the spatial neighbors that can be used as merging candidates are as same as the positions of the spatial MVP candidates. That is unification of the location of spatial neighbors for merge mode and MVP. In addition, the proposed techniques attempt unification of the derivation process for merge mode and MVP. This proposal tries to reduce the number of candidates in the spatial derivation process to reduce the number of times of comparison in the removal process.

The proposed technique reportedly provides 0.1-0.2% BD-rate loss for random access, and 0.0-0.2% loss for low delay.

Two sub-proposals are in the contribution. Discussed in BoG coordinated by B. Bross.

6.8.3 Motion/Mode Data Storage

JCTVC-F472 Modified motion data storage reduction method [T. Sugio, T. Nishi (Panasonic)]

In this contribution, a modified motion data storage reduction method was proposed. It was proposed that a representative motion data was searched among 4x4 blocks according to encoding order. Experimental results reportedly showed 0.06% BR saving for HE and 0.04% BR savings for LC on average in the RA scenarios, and 0.1% BR saving for HE and 0.2% BR saving for LC on average relative to HM3.0+bugfix146.

Related to JCTVC-E231.

The proposal involves some extra work for the decoder. Because of this, and because the gain is rather small, stability of the current design seems like a higher priority.

JCTVC-F482 Verification result of Qualcomm and NEC's Temporal QP Memory Compression (JCTVC-F499) [M. Shima (Canon)] [late upload 07-08]

JCTVC-F060 Reducing Line Buffers for Motion Data and CABAC [T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)]

Line buffers of 10.7 Kbytes are asserted to be required to store motion and CABAC context data of upper largest coding units (LCUs) for real-time decoding of 4Kx2K video in hardware when HM-3.0 is considered. In this contribution, for reducing motion line buffer size, a motion data compression method was proposed. For reducing CABAC line buffer size, CABAC context formation processes of several syntax elements were modified to avoid using upper block data and to only use left block data when the upper block belongs to the upper LCU. Simulation results reportedly showed that the motion data compression and the modified CABAC could achieve 56% and 74% reductions of motion and CABAC line buffers with 0.0% and 0.1% bit rate increases when the motion data compression ratio is 2:1 and 4:1, respectively. No encoding or decoding time increase was reported.

The initial suggested conclusion was that this is considered desirable, but should not be included yet at this stage of maturity – pending stabilization of other aspects such as spatial MV prediction.

Decision: The 2:1 variation was later included in the BoG recommendation JCTVC-F744, and was agreed to be adopted. However, during integration work after the meeting, it was noticed that the text and software submitted for the proposal actually also modified the boundary strength classification decisions made in the deblocking filter process, which could potentially have an impact on subjective quality. However, subjective evaluation was not done in Torino. It was then agreed (after the meeting) that rather than adopting this technique into the design at this time, it should be further studied in the CE12 Core Experiment on Deblocking Filtering to ensure that it does not have any adverse effect on the deblocking filter.

JCTVC-F670 Cross-check of Mediatek's Reducing Line Buffers for Motion Data and CABAC (JCTVC-F060) [V. Sze (TI)] [late reg. 07-06, upload 07-14 after opening]

6.8.4 Reference picture list management

JCTVC-F549 Coding with a single, unified reference picture list [D. Flynn, N. Šprljan, M. Mrak (BBC)]

The HM software has been modified to support coding with a single unified reference picture list. The concept of reference pairs is introduced, where a pair consists of either two references (bi-predictive coding) or one reference and a null element (uni-predictive coding). The pairs are ordered and a single codebook is used for coding, which avoids separate L0 and L1 indexing. The main benefit of this solution is that the selection of reference frames in bi-prediction is not restricted to all combinations of reference frames from two lists (as per WD3). Instead, it is suggested that we could now use a smaller, equal or larger set of reference frame combinations. This solution reportedly reduces the number of lines in both the WD and HM, while providing a marginal RD performance increase of ~0.1% when the software is configured to emulate the equivalent of the HM-3.0 reference pairs.

Default list construction and reference list modification schemes are needed for this.

The number of possible pairs is large when there is a large number of pictures in the buffer (on the order of the square of the number of pictures in the buffer). For example, in AVC there can be N=16 pictures in each list, which would produce N+(N^2)/2 = 144 combinations for uni-prediction and bi-prediction.

Combining this with explicit weighted prediction might need some thought.

The proponent indicated that the proposal is not necessarily fully mature at this stage (although there is no coding loss with the common conditions).

A cross-checker said that the implementation is straightforward and simplifies the software.

It was suggested that the parsing method may cause entropy decoding difficulties and loss robustness issues.

Establish an AHG to think further about this.

JCTVC-F645 Cross-check report on Coding with a single, unified reference picture list (JCTVC-F549) [I.-K Kim (Samsung)] [late reg. 07-05, upload 07-06]

JCTVC-F655 Cross-check report on unified reference picture list (JCTVC-F549) [J. Jung, J. Le Tanou (Orange Labs)] [late reg. 07-05, upload 07-11]

JCTVC-F573 The construction of combined list for HEVC [S. Fang, Y. Yu, L. Wang (Motorola Mobility)]

This contribution proposes a default list construction order for the combined list for uni-prediction (as in the current design). It is reportedly more efficient if there are multiple consecutive non-reference pictures, without increasing complexity.

The first element is to suggest that the default uni-prediction list order is to order by increasing POC distance. If multiple pictures have equal temporal distance, average QP is used as a tie-breaker.

Remark: The second aspect requires specification of a QP averaging computation.

Remark: If you lose a slice, the average QP becomes wrong, and list construction for subsequent pictures becomes impossible.

Remark: Using POC also has a loss resilience issue, as the loss of a picture may result in the loss of its POC.

Remark: Reference picture list modification can be used to provide robust ordering.

Measured benefit is very small.

Can consider this idea (and refinements of it) in the AHG that studies reference picture list construction.

JCTVC-F627 Cross-check of Motorola Mobility's proposal on combined reference list construction (JCTVC-F573) [C. Yeo (I2R)] [late reg. 07-04, upload 07-04]

6.9 Inter Mode Coding

JCTVC-F069 Parallelized merge/skip mode for HEVC [M. Zhou (TI)]

The current HEVC merge/skip mode design is highly sequential and introduces dependency among neighboring PUs, which can reportedly 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 average loss is 6.0% in RA-HE, 6.3% in RA-LC, 7.7% in LB-HE and 8.8% 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 was 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 3.9% in RA-HE, 4.2% in RA-LC, 5.5% in LB-HE and 6.4% in LB-LC can be achieved for 32x32 block level parallel ME when compared to an example modified (non-common-conditions) usage of the current HM3.0 design.

It was noted that the reported gain is specialized to an assumption of a particular encoder algorithm model.

It was also noted that this proposes to add extra work at the encoder to accommodate a particular type of assumed encoder model.

The loss (relative to common conditions) for using the proposal is reported as:

Parallel ME (merge/skip) level 2N x 2N **(LCU = 64x64)**	**RA-HE (%)**	**RA-LC (%)**	**LB-HE (%)**	**LB-LC (%)**
64 x 64	3.7	3.6	4.1	4.4
32 x 32	2.1	2.1	2.2	2.4
16 x 16	0.8	0.7	0.5	0.7
8 x 8	0.1	0.0	−0.1	0.0

This is better than the loss for the same encoder structure without the proposal, reported as:

Parallel ME level 2N x 2N **(LCU = 64x64)**	**RA-HE (%)**	**RA-LC (%)**	**LB-HE (%)**	**LB-LC (%)**
64 x 64	8.5	9.3	10.0	12.4
32 x 32	6.0	6.3	7.7	8.8
16 x 16	2.7	2.7	3.5	3.7
8 x 8	0.4	0.5	0.4	0.5

It was remarked that the merge/skip design is not really finalized yet, so that even if we might like this, it may be an over-optimization to a particular instantiation of a moving target at this stage.

This (or something like it) may be desirable to keep in mind for consideration in the future work.

It was suggested to include this in a CE.

JCTVC-F208 Cross-check of parallelized merge/skip mode (JCTVC-F069) [B. Li (USTC), J. Xu (Microsoft)]

JCTVC-F465 Item 5 (Partial merge) of Experiments on tools in Working Daft (WD) and HEVC Test Mode (HM-3.0) [I.-K. Kim, E. Alshina, J. Chen, T. Lee, W.-J. Han, J. H. Park (Samsung), V. Sze, M. Budagavi, M. Zhou (TI)]

Item 5: Partial merge.

Has been taken care of (JCTVC-F082).

JCTVC-F325 Modified temporal MV derivation process for merge/skip mode [T. Shiodera, A. Tanizawa, T. Chujoh, T. Yamakage (Toshiba)]

This contribution proposed a modified derivation process of temporal merge/skip mode in B-slice and presents associated experimental results. The temporal merge/skip mode was introduced in latest HM test model. This can reportedly reduce an overhead of motion information by reusing temporal motion information in the current prediction unit. However, when two kinds of motion information used for bi-prediction refer same reference block, it is noted that that the prediction value for bi-prediction is identical to one for uni-prediction. In this contribution, two modifications for derivation process of temporal merge/skip mode in B-slice are proposed to be introduced in order to improve both complexity and coding efficiency. The first modification is to change inter prediction processing from bi-prediction to uni-prediction in order to reduce the computational complexity of the redundant motion compensation process. The other one is to change the derivation process of list 1 motion information for temporal merge/skip mode in B-slice, in order to avoid deriving same motion information in the current PU. This modification can reportedly improve coding efficiency.

Experimental results reportedly show that the proposed methods can achieve an average luma BD-rate gain of 0.2% and 0.3% for the LB-HE and LB-LC cases, respectively. Average decoding times are reportedly 98% and 96% for LB-HE and LB-LC cases, compared with the common condition anchor, respectively.

The first aspect is something the decoder might be able to do on its own, by simply recognizing that bi-prediction will obtain the same results as uni-prediction and is therefore unnecessary to be applied. This could perhaps be a desirable thing to include in our reference software if suitable source code is provided that does not harm the readability of the software – the decision on that is delegated to the software coordinator and software development AHG.

The second aspect provides a small amount of coding gain (0.2-0.3%) in the LB case. It was remarked that there were some bugs in the relevant part of the version of the software that was used, so we may not be able to rely on these results.

Further study was encouraged to determine how this may work in the HM4 context.

JCTVC-F356 Motion compensation 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 was closely related to JCTVC-F325.

This contribution reports that roughly 30% and 5% of the areas of forward B-Slices are observed to have identical motion information within each PU, under HM3 LD and RA configuration, respectively. It was indicated that when the L0 and L1 motion information is the same, the L1 interpolation process and the weighted averaging process in HM3 could be bypassed for complexity reduction.

The idea of integrating the decoder-only optimization scheme into the reference software, as described in the section discussing JCTVC-F325, was also relevant to this contribution. Results of this technique were provided in this contribution as "method A" (with a reported decoding time savings around 4% in the LB case).

Several slightly different methods were presented for handling the same-motion cases.

A significant percentage of predictions in the LB case are bipredictions that can degenerate to unipredictions if recognized. As a decoder-only non-normative trick, the decoder can take advantage of this. We should try to ensure in the future that the prediction generated by uniprediction will be the same as the prediction generated by biprediction with identical parameters.

JCTVC-F712 Additional results on JCTVC-F356 (MC complexity reduction) [H. Y. Kim (ETRI), K. Y. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee, J. S. Choi (ETRI)] [late reg. 07-11, upload 07-13]

This contribution provides two additional results related to JCTVC-F356 (Motion compensation complexity reduction for bi-prediction). The goal of this is to improve coding efficiency when the collocated motion information of a bi-predicted Merge/SKIP PU are identical.

In Method-A, in this case the neighboring PUs are searched for a non-zero motion vector. If such an MV is found, it is used as mvL1Col. In Method-B, Method-A and Method-2 of JCTVC-F356 are combined for motion compensation complexity reduction. The combined method reportedly achieves average coding gain of 0.3% and 0.5% for LD-HE and LD-LC configurations, respectively.

A participant suggested to, instead of looking for an MV that is zero, look for one that is different from what would otherwise be inferred.

This could potentially be considered as part of a continuation of CE9.

JCTVC-F769 Cross Check of JCTVC-F712 [D. Flynn (BBC)] [late reg. 07-20, upload 07-20]

JCTVC-F725 Cross-verification of JCTVC-F356 by Nokia [K. Ugur, O. Bici (Nokia)] [late reg. 07-12, upload 07-15]

JCTVC-F729 A Cross-check report for JCTVC-F325 proposal on modifying temporal MV derivation process for merge/skip mode Kiran Misra, Andrew Segall (Sharp) [late reg. 07-12, upload 07-12]

6.10 High-level syntax and slice structure

6.10.1 High-level syntax and systems usage of bitstreams

JCTVC-F541 Syntax to express a constraint on reordering latency [G. J. Sullivan (Microsoft)]

(Presentation chaired by J. Boyce.)

This contribution proposes 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.

No limitation of latency in existing frame reordering syntax. Proposes new syntax in VUI in SPS. Allows low delay decoders to allow to output frames more quickly. Not intended to impact the normative decoder behavior. Only impacts output order. Questions were raised about the interaction with the bumping HRD. May need to change the HRD description.

Application specifications may want to place limits on the value of the new syntax element.

Software was not available. Text is available. We don't have VUI yet in the spec.

Promising concept. Experts need more time to consider.

JCTVC-F158 Resolution switching for coding efficiency and error resilience [T. Davies (Cisco)]

A method for changing the resolution of frames within a sequence without causing an IDR or new SPS to be sent is proposed. Frames may be predicted across resolutions by re-scaling reference pictures in a similar manner to H.263 Annex P. The purpose is to allow video communications to use re-scaling to adapt seamlessly to adverse network conditions. It is remarked that in HEVC Intra frames are relatively more expensive than in AVC, and forcing the use of Intra frames can worsen losses and increase delays. It is reported that predicting instead of inserting an IDR frame when down-scaling gives average gains of 5.4–5.6% in Low-Delay common conditions, with 15.6–16.4% gain in Class E. When the size of intra frames is reduced to emulate a video conferencing model, average gains of 6.9–7.4% are reported, with 20.5–21.6% gain in Class E.

Basically conceptually analogous to H.263 Annex P (without the general warping).

Fast start by sending a lower-resolution I frame.

Restricted (as tested) to 1:2 and 2:1 with particular 4-tap filtering.

Temporal MV prediction is disabled across resolutions.

A particular method was used for how to measure the BD effects, and with assumptions about QP relationships.

The PSNR was measured on the downscaled picture relative to a downscaled original picture.

Different methods of trying measure the impact would produce quite different measurements.

This is more than just high-level syntax – it is a substantial additional coding tool.

Somewhat similar to a scalable coding layer switch.

A participant asked whether it is clearly better to switch down the resolution rather than to just increase the QP. The proponent said that it is better in perceptual terms, although perhaps not so much in PSNR, depending on the resolution relationship, bit rate assumptions, etc.

It was remarked that an effort in the IETF called RTCweb (http://tools.ietf.org/wg/rtcweb/) has included related discussions, with general scaling ratios.

It was remarked that this has some relationship with scalability (and perhaps JCTVC-F618 in particular).

It was generally supported that it is desirable to try to do something to avoid I frames for resolution switching.

Further thought seems to be needed to determine what is really needed. A participant suggested trying to think further about that before trying to adopt a particular approach. It was suggested that this may be more potentially useful in some applications than others. Some participants indicated that this is not really a change of scope but is simply a candidate way of addressing existing requirements.

For further study (e.g. AHG).

JCTVC-F551 Cross-check report for JCTVC-F158 on resolution switching [A. Gabriellini, M. Mrak (BBC)] [late upload 07-05]

The software was checked as well as run. No extra analysis or commentary was provided.

JCTVC-F201 High-level Syntax: Temporal Information Decoding Refresh [B. Li (USTC), J. Xu (Microsoft), H. Li (USTC)]

(Presentation chaired by J. Boyce.)

Temporal MVP brings some bit rate savings to HEVC, but can break parsing robustness. The parsing problem has been analyzed in many proposals. This contribution proposes a mechanism to provide correct MV at some recovery point as a tradeoff between coding efficiency and MV accessibility.

The contribution proposed a concept referred to as a "temporal MVP IDR" (TIDR), to reset the state of temporal motion vector prediction for all pictures in the DPB.

A 0.4% bit rate loss was reported using the proposed method, using TIDR every 8 frames.

A TIDR access unit type defined. A new NAL unit type value can be added.

A participant asked what is the normative decoder behaviour. The response was to reset to ensure that no temporal vectors are available anymore.

It was remarked that this should probably be restricted to frames with temporal_id equal to 0.

No text was provided for the decoding process change.

A participant suggested using a flag in the slice layer instead.

This contribution is potentially related to contribution JCTVC-F427.

The contribution has identified a problem. Further study encouraged.

JCTVC-F135 Analysis of Multi-core Processing approaches [V. Sze, M. Budagavi, M. Zhou (TI)]

(Information contribution.)

Low power and high frame rate/resolution requirements for future video coding applications reportedly make the need for parallelism in the video codec implementation ever more important. Several methods have been proposed to enable high-level parallelism on multi-core architectures. This contribution describes the differences between regular slices, entropy slices, interleaved entropy slices/wavefront parallel processing, and Tiles. It provides an analysis of these tools based on throughput, coding efficiency, implementation complexity, and latency.

A comment made during the presentation is that "tiles" (according to some proposals, at least) do not have as much header-level overhead as may have been assumed in this analysis).

JCTVC-F491 High level syntax for scalability support in HEVC [T. Rusert, R. Sjöberg, P. Fröjdh, Z. Wu (Ericsson)]

This contribution proposes high-level syntax changes to HEVC aiming at making inclusion of future scalability extensions straightforward without changing the NAL unit headers. It is proposed to introduce a fixed-length NAL unit header that includes seq_parameter_set_id, such that all VCL and non-VCL NAL units that are associated with a certain scalable layer are assigned the same value of seq_parameter_set_id. Furthermore, it is proposed to introduce syntax for signalling of both dependencies between scalable layers and properties of the respective layers into the SPS. Thus according to the proposed scheme, the seq_parameter_set_id serves as general scalable layer identifier, whereas the associated SPSs indicate both dependencies between layers and respective layer properties. Consequently, it is proposed to move temporal_id (which is carried in the NAL unit header in the current HM design) into the sequence parameter set. The proposal claims these changes make it possible to signal dependencies within scalable video representations in an extensible way. It also claims that new scalability extensions can be defined and used together with old ones.

Proposes a 3-byte NAL unit header.

Adding an SPS index in the NUT. Removing the temporal layer ID from the NUT (instead placing that in the SPS). Also proposes to remove output_flag (instead placing that in the slice header).

It was remarked that this would require parsing of SPS content to understand what to do with the bitstream. Possibly the SPS index could double as a priority ID.

The proposed NAL unit type just contains forbidden_zero_bit, nal_ref_idc, nal_unit_type, and sps_id (16 bits).

Further study was encouraged.

JCTVC-F714 High-level syntax mismatches between WD and HM [Q. Shen, Y.-K. Wang (Huawei), K. Sühring (Fraunhofer HHI)] [late reg. 07-11, upload 07-11]

This document provides an analysis of high-level syntax related mismatches, including both syntax mismatches and behavior mismatches, between the HEVC WD (JCTVC-E603_d8) and the reference software HM-3.2.

The v3 submission was reviewed.

It was agreed that generally, the draft should reflect our design intent; the software can deviate as necessary for aspects not yet implemented such as ref pic marking and ref list construction. Particular aspects:

- use_mrg_flag – reflect decisions recorded elsewhere.
- POC issues – not important to align at this time.
- deblock control – keep the AVC-like syntax, add remarks in WD and ref software flagging for further work.
- cu_qp_delta_enabled_flag – ue(v), 0 = no delta QP, 1 = LCU, 2 = (LCU/2)x(LCU/2), etc.

Decision: Agreed.

6.10.2 Supplemental information

JCTVC-F289 On VUI syntax parameters [M. Haque, A. Tabatabai, T. Suzuki (Sony)]

This document discusses the VUI parameters defined in AVC. The AVC VUI syntax structures are shown in a tabular form with some remarks about their possible usage in HEVC context.

The contribution basically advocates reuse of all AVC VUI except any relating to field coding (e.g., pic_struct_present_flag). It was agreed that relative chroma grid positioning should be included (not field-specific). max_bits_per_mb_denom needs further study – we plan to leave that out for now.

Decision: Agreed (adjusted as described above, as a starting point).

Should also investigate SVC related VUI to identify any additional needs.

JCTVC-F291 Picture Orientation Information [D. Hong, J. Boyce, S. Wenger (Vidyo)]

This contribution proposes to include in the bitstream the picture orientation information of each coded picture. This contribution follows on the prior JCTVC-E280 and provides the flexibility to change picture orientation on a picture level, even for non-IDR pictures. Some video capturing devices capture pictures in an orientation different from the orientation needed for rendering and the encoding side can save the compute needed to properly rotate the pictures by signalling the picture orientation information to the decoding end, and thus, deferring the rotation process to the rendering module; for rendering, many systems use hardware GPUs that also support picture rotation. Additionally, a picture may be coded in a certain orientation for improved coding efficiency. In the low-complexity setting, utilizing the ability to change picture orientation between 0 and 90 degrees, the contribution reports (0.6%, 0.9%, 1.1%), (0.6%, 0.4%, 0.8%), and (0.1%, 0.2%, 0.4%) (Y, Cb, Cr) BD-rate gain for intra only, random access, and low delay, respectively. Individual sequence BD-rate gains for the low-complexity setting were reportedly as high as (3.4%, 3.2%, 4.4%), (2.8%, 2.1%, 3.9%), and (0.3%, 2.1%, 2.5%) for intra only, random access, and low delay, respectively.

Not just display hint information, but also as a coding tool.

Which sequence gave 3.4%? Answer: Traffic.

Fast method provided almost the same amount of gain.

Proposes to change the motion compensation process and temporal MV prediction process in response to changes in the indicated rotation.

A display hint SEI (as in JCTVC-E380) seems easier to justify than the normative decoding process modification.

Some prior notes from review of JCTVC-E280:

- It was noted that this is not really a proposed "decoder processing" scheme, but rather some "display helper information".
- It was remarked that some similar issues were discussed previously in JCTVC-C224.
- It was remarked that performing an image rotation at the encoder side could also add delay.
- It was remarked that the orientation information is a property of the video, which could mean that it is advantageous to convey the information in a tightly-coupled fashion with the video bitstream.
- It was remarked that having this information at both the video and system layer could occur, and there would need to be some prioritization in the event of multiple indicators.
- It was remarked that such a concept is not specific to HEVC, and could be considered for AVC as well.
- It was remarked that doing it in SEI would allow the indicator to change dynamically, and that angles other than 90 degree increments should perhaps be considered, as the display process can choose to quantize that to 90 degree increments if it so chooses. Other more elaborate possibilities were also discussed.

It was remarked that a flip bit may also be beneficial to add in such an SEI message.

We are favorably inclined to add an SEI message such as this, but it is not our priority at the moment.

Let's defer such consideration of new SEI messages (not per JCTVC-E346) for a couple of meeting cycles.

6.10.3 Parameter sets and slice header

JCTVC-F131 Modifications to slice header termination for low delay encoding [V. Sze, M. Budagavi, A. Osamoto (TI)]

SAO and ALF are performed in the last stage of video coding; however, SAO and ALF parameters are inserted in the slice header which is before the slice data (generated from earlier stages of video coding). This inconsistency between order of processing and order of data transmission under the current that slice header format implies that at the encoder CABAC and EPB insertion must be performed after SAO and ALF, which can be an issue for low delay encoders. This contributions proposes that 1) CABAC should be terminated after slice header to enable CABAC encoding as syntax elements are produced; 2) the slice header should be byte aligned to enable EPB insertion as bits are being produced; 3) we should ensure that last byte in slice header is non-zero, as this allows slice header and slice data to be easily stitched together without changing slice data. This modification was implemented in HM-3.2 and its coding efficiency was evaluated with ALF on for both HE and LC: 0.0% AI-HE, 0.1% RA-HE, 0.1%, LD-HE, 0.0% AI-LC(ALF on), 0.0% RA-LC (ALF on), 0.0% LD-LC(ALF on); and ALF off for both HE and LC: 0.0% AI-HE (ALF off), 0.1% RA-HE(ALF off), 0.1% LD-HE(ALF off), 0.0% AI-LC, 0.0% RA-LC, 0.0% LD-LC.

Byte alignment issues:

- Proposes byte alignment after slice header (with CABAC termination and also for CAVLC).
- Add RBSP trailing bits (or equivalent without the minimum single bit found using that) for achieving the byte alignment:

Decision: Agreed.

These decisions were pending review of JCTVC-F377.

See notes under JCTVC-F377.

JCTVC-F393 Cross-check report on TI's slice header termination for low delay encoding (JCTVC-F131) [I.-K. Kim (Samsung)]

JCTVC-F187 Comments on Slice Common Information Sharing [M. Li, P. Wu (ZTE)]

Prior related contribution JCTVC-E281.

Relates to discussion for JCTVC-F321 and JCTVC-F384.

See also notes relating to JCTVC-F747.

JCTVC-F377 Arithmetic coding in high level syntax [T. Suzuki (Sony)] [late upload 07-07]

In WD3, some syntax elements, ALF and SAO parameters, are encoded in the slice header layer by arithmetic coding. However, it was asserted that the slice header layer is often handled by firmware, not hardware, in many HW implementations. Since the resources of firmware are limited, CABAC arithmetic coding was asserted to be too difficult for processing in firmware. The contribution proposed the following:

- Not to use arithmetic coding in high level syntax (slice header and higher layers);
- To move ALF and SAO parameters to the top of the slice data;
- Or move SAO parameters to the end of slice header;
- And/or move the syntax to initialize CABAC (slice_type and slice_qp_delta) to the beginning of the slice header.

It was suggested to add RBSP trailing bits (or equivalent) for achieving the byte alignment also before the ALF switch flags (when present): Decision: Yes.

A potential slice syntax structure was discussed to be as follows:

- Header stuff (all non-CABAC header syntax here, includes PPS index and slice parameter set index)
- ALF when present:
    - RBSP trailing
    - CABAC ALF switch flags (ending with CABAC flush)
- RBSP trailing bits
- Slice data
- RBSP trailing
- CABAC zero word (when present)

Decision: Yes (neglecting any superseding impact relating to the adaptation parameter set usage per JCTVC-F747).

See additional notes under JCTVC-F131.

The slice parameter set syntax was documented in a revision of JCTVC-F747.

See also the section discussing JCTVC-F747.

JCTVC-F399 Restart of CABAC after coding of ALF and SAO slice header data [M. Narroschke, T. Wedi, S. Esenlik (Panasonic)]

Typically, ALF and SAO control parameters are estimated after the determination of the syntax elements to code the blocks of a slice. In order to allow decoders a convenient block-by-block decoding including the application of ALF and SAO, the control parameters of ALF and SAO are coded before the slice block data within the slice header. In HM3.2, the slice block data is coded dependently on the ALF/SAO control parameters in one arithmetic codestream. Thus, the encoder needs to buffer all syntax elements of the slice block data until the ALF and SAO control parameters are estimated and coded. Afterwards, the buffered syntax elements are coded. Thus, the encoding is associated with the two problems: Large buffer and delay. In order to overcome these two problems, it is proposed to restart CABAC after the coding of the ALF/SAO control parameters by the use of a cabac_restart_flag, which is coded in the terminating mode within the slice header. By a restart of CABAC, all block data of a slice is coded independently from the ALF/SAO control parameters. As a consequence, the syntax elements of slice block data can be coded without delay and without being buffered until the ALF/SAO control parameters are estimated and coded. The influences on the coding efficiency and on the encoder and decoder run times are negligible. It is proposed to adopt the proposed technique into the next version of the HM.

Moving the ALF and SAO data to the slice parameter set fixes this for the parameters, but not the CU level control data for ALF.

Remark: Consider the delay implications of the positioning of the ALF control data.

Question: Where are the on/off flags and filter selection indicators sent? The on/off flags are in the slice header. Filter selection is implicit (for luma).

Suggestion: Do not use the single initial flag found in the WD – always restart CABAC and flush to byte align. Finalization of flag status to reflect the intent.

Question: Is there a way to code filter control data using CAVLC? Yes.

Essentially adopted; see above discussion under JCTVC-F131 and JCTVC-F377.

JCTVC-F469 Syntax improvement for fine granularity slices [C. Kim, Y. Park (Samsung)]

The fine granularity slices was adopted at the last meeting through the BoG report of JCTVC-E483. The adopted syntax structure reportedly looks somewhat unsuitable for recursive coding_tree() representation. In this proposal a modified fine granularity slice syntax and process is proposed to make the syntax fit for quadtree structure.

Currently we send slice_granularity (16x16, 32x32, 64x64) in PPS, and slice_address in slice header.

The proponent proposed a different syntax.

The benefit of the proposal did not seem clear to the group. It was commented that this seems to be sending some additional bits and syntax elements in the slice header.

For further study.

JCTVC-F503 Results on slice header modifications [N. Ouedraogo, P. Onno (Canon)]

This contribution presents results of some experiments conducted by implementing the modifications around the slice header introduced in JCTVC-E222 at the Geneva JCT-VC meeting. This technical proposal introduces two main modifications. A first modification consists of gathering some coding parameters of slice headers in a dedicated NAL unit. A second modification adds some additional parameters within this new NAL unit. Some coding efficiency results targeting a streaming scenario are reported (under certain assumptions).

Proposes to move almost all slice header syntax into a different NAL unit shared by all slices of a picture, including picture-specific parameters such as frame_num.

This proposed additional NAL unit is basically a repeatable picture header (as tested).

Benefit reported approximately 1% on average (more in some classes, less in others).

For further study (esp. in relation to new slice parameter set).

JCTVC-F523 Improvements of SPS syntax [V. Drugeon (Panasonic), T. Wedi (Panasonic)]

The current high-level syntax in the working draft (JCTVC-E607) is different from the one in the software (HM3.2). In a first step, this contribution analyzes discrepancies between working draft and software as well as shortcomings in the SPS (Sequence Parameter Set) syntax. In a second step, an implementation and text is provided that synchronizes the SPS syntax in the software and the working draft and that is asserted to solve problems related to the signalling of the picture size.

The current SPS syntax of WD sends width and height in luma samples as u(16).

We agree that the current syntax does not does not necessarily represent what we ultimately want to have, but at the moment it is not clear what exactly we would want – and the current WD seems adequate for our experiments.

For further study.

JCTVC-F747 Adaptive slice parameter set (APS) [S. Wenger, J. Boyce] [late reg. 07-16, upload 07-17]

This document was submitted at the request of the JCT-VC (submitted as a proposal document, although also somewhat of a BoG report) after discussions at the meeting prompted consideration of the previously-proposed concept of a slice-layer-activated adaptation parameter set (APS). Provided in the document were syntax and semantics, as well as pointers to documents providing more information on the utility of slice parameter sets – the predecessor proposal in the spirit of the APS. Syntax, semantics and decoding process are based on JCTVC-E603-d8. (The authors also took the liberty to comment on and/or remove leftover text from AVC that doesn’t seem to apply to HEVC, nor is likely in their subjective opinion to apply in the future.)

It was noted that the ALF and SAO parameters don't (at least currently) change within a picture.

It was noted that JCTVC-F542 (Cisco) may be relevant.

In further discussion, the following points were initially agreed:

- To define such a new NAL unit.
- For the draft to say that the index must stay the same for the picture.
- For the index to the APS to go in the slice header.
- For the index to the PPS to go in the APS.

However, after further discussion, it was decided that we would use two indices in the slice header, and a new version of JCTVC-F747 was provided to reflect this.

The new version of JCTVC-F747 was reviewed on Wednesday.

Decision: Adopted (the revised version).

6.10.4 Tiles

JCTVC-F335 Tiles [A. Fuldseth (Cisco), M. Horowitz, S. Xu (eBrisk Video), A. Segall (Sharp), M. Zhou (TI)]

This contribution proposes a coding technique called tiles, similarly to what was previously presented in JCTVC-E408. The use of such tiles partitions a picture into rectangular segments. Tile partitioning comprises establishing vertical and horizontal boundaries that partition a picture into columns and rows respectively. Column and row boundaries break prediction mechanisms (e.g., intra prediction and motion vector prediction) in the same way as slice boundaries unless indicated otherwise. Intersecting column and row boundaries delineate rectangular regions called tiles, each containing an integer number of LCUs. LCUs are processed in raster scan order within tiles and tiles are processed in raster scan within a picture. Results from three experiments are presented comparing coding efficiency for tiles against an identically configured encoder using slices with LCUs processed in raster scan-order within a picture. It was reported that the use of such tiles provide 1.7%, 3.1%, and 4.8% coding gains for Intra, Random Access, and Low Delay, respectively, relative to some example configurations of the HM using slices that were asserted to be relevant (not the common conditions).

One difference from JCTVC-E408 is in regard to what happens for "equal" divisions into tiles, for which QP and cabac_init_idc are initialized from the slice header of the slice containing the first CU in the tile.

Draft text was provided.

Note that tiles are not analogous to slice groups and are not analogous to slices. Slices can cross tile boundaries and tiles can cross slice boundaries.

A proposed flag determines whether the entropy coding (and basically all other dependencies) is reset at the start of each tile boundary. CABAC gest flushed and padded to a byte boundary when the flag indicates independence.

A basic intent is to enable encoder-side parallelism.

Loop filtering crosses the tile boundaries. Is there a flag proposed for that? Currently, no (just applied always across tile boundaries).

It was noted that we also have slices and entropy slices, so there is a concern that we may end up with too many multi-CU packing and dependency structures in a way that would make support for all of them impractical.

The reported bit rate savings was suggested to be primarily due to avoiding the need to send more slice headers.

JCTVC-F547 Cross-check of Tiles (JCTVC-F335), experiment #1 [R. Sjöberg, P. Wennersten (Ericsson)] [late upload 07-08]

Cross-checker reported consistent results for the experiment that was checked (#1). The software was reportedly studied and determined to match the technical proposal design.

JCTVC-F589 Cross check report of JCTVC-F335 Tiles [M. Coban (Qualcomm)] [late upload 07-06]

Cross-checker reported consistent results for the experiment that was checked (#2).

JCTVC-F140 Support of very low delay coding in tile [K. Kazui, S. Shimada, J. Koyama, A. Nakagawa (Fujitsu)]

Past contributions JCTVC-B031, JCTVC-C021 and JCTVC-D054 proposed the high-level syntax and semantics based on vertical intra MB line refresh scheme. JCTVC-E061 asserted that the proposed high-level syntax and semantics are needed to satisfy the requirement for real-time video transmission applications with minimal loss of coding efficiency.

This contribution proposes a modification of "tiles" similar to the tile proposal at the 5th JCT-VC meeting, modified for support of very low delay video coding.

It was proposed to allow the LCU scan within a slice to be in raster scan order within the picture rather than in raster scan order within each tiles.

A form of special handling of tile boundaries – e.g. for independence of deblocking and intra prediction, was discussed.

Some other ideas for flexibility of the use of tiles and scanning were presented.

In addition to very low delay, the proponent suggested that there might be parallel processing benefits to be developed from these ideas.

The ideas presented here seemed somewhat preliminary, and in need of further development and testing.

Further study, including experimental design and statistical analysis of test cases, was encouraged.

JCTVC-F594 New results for parallel decoding for tiles [K. Misra, A. Segall (Sharp)]

This contribution presents results for JCTVC-E412, which extended “Tiles” (JCTVC-E408) to support decoder parallelization. Decoder parallelization is realized by signalling tile entry points in the bitstream. A decoder is then able to enter the bitstream at the beginning of a tile. The signalling is used as tiles does not use a header and thus cannot be located in the bitstream by a decoder (without completely parsing the bitstream). The approach supports sending tile entry points explicitly in the slice header or using markers in the bitstream. The bit rate overhead for signalling locations explicitly in slice headers is reportedly AI_HE: 0.0%, AI_LC: 0.0%, RA_HE: 0.1%, RA_LC: 0.2%, LD_HE: 0.5%, LD_LC: 0.5% (not based on common conditions, but according to a described experiment design is adjusted for relevance to the technology). The bit rate overhead for signalling using markers is AI_HE: 0.1%, I_LC: 0.1%, RA_HE: 0.6%, RA_LC: 0.7%, LD_HE: 1.8%, LD_LC: 1.7%.

Scheme 1: send location information in the slice header.

Scheme 2: send entry marker patterns (e.g., 0x000002) in the bitstream.

The SEI approach discussed at the preceding meeting was further discussed, and the possibility of something like an SEI message that could fall between slices in NAL unit order. This would be a somewhat higher overhead approach.

The scheme proposed was the same as that of the previous meeting.

JCTVC-F749 Cross-check of new results for parallel decoding for tiles (JCTVC-F594) [M. Horowitz, S. Xu (eBrisk)] [late reg. 07-16, upload 07-16]

The software was studied and generally considered clearly written. The results (so far, with at least 2/3 complete) matched.

6.10.5 Wavefront parallel processing

JCTVC-F063 Wavefront Parallel Processing with Tiles [C.-W. Hsu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)]

This contribution extended the concept of wavefront parallel processing (WPP) in JCTVC-E196 and applied it to tiles in JCTVC-E408 for parallel processing. In experiment results designed by the contributor (not using the common conditions), it was reported that the proposed WPP with tiles was 0.5% and 0.6% better than tiles and WPP respectively when two parallel threads were used, was 0.8% and 0.5% better than tiles and WPP respectively when three parallel threads were used, and was 1.2% and

0.5% better than tiles and WPP respectively when four parallel threads were used, in terms of BD-rates. In addition, the number of causality checks of the proposed WPP with tiles was less than 16%, 22%, and 33% of that of WPP for class A (2560x1600), class B (1920x1080), and class E (1280x720), respectively.

Further study was encouraged.

JCTVC-F450 Cross-check of MediaTek's contribution on wavefront parallel processing with tiles (JCTVC-F063) [A. Fuldseth (Cisco), M. Zhou (TI)]

JCTVC-F274 Wavefront parallel processing for HEVC encoding and decoding [C. Gordon, F. Henry, S. Pateux (Orange FT)]

This contribution describes a method to perform parallel encoding and decoding of video using HEVC. LCU lines that are processed in parallel by encoding/decoding threads. In order to limit performance degradation, a wavefront pattern of processing ensures that spatial and motion vector dependencies are fully preserved, as recommended in JCTVC-D073. In addition, a single additional probability buffer is used to synchronize CABAC probabilities down the second LCU column. The average BD-rate degradation is +0.7% (all-intra +0.2%, random access +0.7%, low delay +1.2%). This contribution also describes a parallel software implementation of the HM3.0 decoder using wavefront parallel processing. The average decoding time compared to anchors (sequential HM3.0) on larger sequences (classes A, B, E) is reportedly 55% with 2 decoding threads and 33% with 4 decoding threads. This contribution also describes a combination of wavefront parallel processing with tiles from JCTVC-E408.

Previously proposed in JCTVC-E196.

Entry point indicators are proposed to be added in slice syntax.

Enables parallelism in both encoder and decoder.

Transcoding is possible between parallel and non-parallel entropy coding (without full decode).

Draft text was provided. It was reported that software can be provided on request.

A participant asked about the complexity penalty for a non-parallel decoder – the answer was that it is one CABAC context per LCU line vertically.

A participant commented that the memory bandwidth requirements on the encoder and decoder may be high.

JCTVC-F486 Cross-check - Wavefront Parallel Processing for HEVC Encoding and Decoding (JCTVC-F274) [A. Henkel (Fraunhofer HHI)] [late upload 07-04]

Tested "experiment 1" on impact on RD performance.

JCTVC-F527 Cross-check of JCTVC-F274 from Orange Labs [V. Drugeon (Panasonic)] [late upload 07-08]

Studied the software and identified a couple of small issues. Tested "experiment 3" on wavefront processing inside of tiles.

JCTVC-F588 Cross-check report of JCTVC-F274 wavefront parallel processing [M. Coban] [upload 07-14 after opening]

Did not study the software. Tested "experiment 2" on multithreaded decoding.

JCTVC-F275 Wavefront and CABAC Flush: Different degrees of parallelism without transcoding [G. Clare, F. Henry, S. Pateux (Orange FT)]

In JCTVC-F274, wavefront parallel processing (WPP) is proposed for parallel encoding and decoding. WPP consists of synchronizing the CABAC probabilities of the first LCU in each line from the second LCU of the line above, while maintaining inter-block dependencies. Parallel encoding and decoding are reported to have an average BD-rate degradation of +0.7% (intra +0.2%, random access +0.7%, low delay +1.2%). In WPP, converting a compressed video from a given level of parallelism to another is an entropy transcoding operation. In the present contribution, it is proposed to combine WPP with a flush and re-initialization of the internal state variables of CABAC at the end of each line of LCUs. Thus, each line of LCUs is compressed into a "chunk" of bits that is independent from the desired level of parallelism. Consequently, it is asserted that converting a bitstream from a given level of parallelism to another can be achieved either by re-ordering the chunks in the bitstream or providing chunk entry points as SEI messages. Using this approach, the reported average BD-rate degradation is +0.9% (intra +0.2%, random access +0.9%, low delay +1.6%).

This proposal is a combination of wavefront parallel processing with end-of-line CABAC flush.

Considers transcoding between different levels of parallelism.

In this proposal CABAC is flushed at the end of each LCU row (without byte aligning), producing separate chunks of data for each.

These chunks can be rearranged to support different levels of parallel processing.

It was suggested that byte aligning might be desirable.

But it is necessary to keep track of where each chunk begins in the bitstream, which is not included in the bit costs reported here. This is suggested to be stored in an SEI message (that is not delivered to the terminating end-point decoder).

It is not actually necessary to represent the chunk sizes/location with extra data – if removed, they can be re-identified by parsing the bitstream. But it is necessary to at least know how much parallelism is in the current form of the bitstream (and probably you would have the N entry points at least, although that is not really necessary.

The decoder needs (only) N entry point indicators for N parallel structured decoding.

A non-parallel encoder could deliver a parallelizable bitstream (and vice versa, and changes between any M-parallel encoding and N-parallel decoding).

The CABAC flush impact is reportedly about 0.2%.

Remark: Especially useful when the parallelism of the decoder is known to the encoder/server, but it may not really be common to have that knowledge.

JCTVC-F351 Cross-check report on Orange-FT wavefront parallel processing (JCTVC-F275) [Hendry, J. Park, S. Park (JCTVC-F275)] [late upload 07-11]

Discussion

Existing:

- Slices
- Entropy slices

Proposed:

- Tiles (JCTVC-F335)

  - With and without some tile-crossing coding dependencies (flag in JCTVC-F335)
  - Tiles with entry point identifiers for decoder parallelism (JCTVC-F594)
- Wavefronts (JCTVC-F274)
  - Wavefronts with end-of-row CABAC flush (JCTVC-F275)

No text was (unfortunately) available for the combination of tiles and wavefronts. However, the relationship was considered to be understood.

Decision: Adopt both tiles and wavefronts, with the sub-bullet variants (not in common conditions).

6.10.6 NAL unit header

JCTVC-F463 On NAL unit header [Y.-K. Wang (Huawei)]

This document presented the following proposals:

1) Dropping forbidden_zero_bit from the NAL unit header;

Remark: It was also envisioned as an error flag that could be set when a problem was detected to flag error conditions for the decoder.

Remark: Define a special "bad NAL unit type" to indicate errors?

Remark: Making it reserved would let us use it later if desirable.

Remark: That had something to do with distinguishing from MPEG-2 Systems start codes.

The group agreed to keep it zero because of MPEG-2 Systems.

2) Changing nal_ref_idc (2 bits) in the NAL unit header to nal_ref_flag (1 bit);

Decision: Adopt (and absorb it into the nal_unit_type).

3) Unification of the NAL unit header to be a fixed-length 2-byte header;

Further study of this was encouraged.

4) A sub-bitstream extraction process utilizing the unified NAL unit header.

Further study of this was encouraged.

6.10.7 Decoded picture buffering

JCTVC-F381 Clean decoding refresh definition and decoding process [T. K. Tan, A. Fujibayashi (NTT Docomo)]

This contribution proposed a change to the decoding process relating to "clean decoder refresh".

It proposes to define a "CDR reset picture".

The special decoding process aspect of the proposal did not seem to be strictly necessary. See additional notes below relating to JCTVC-F464 and JCTVC-F759.

JCTVC-F464 On CDR picture [Y.-K. Wang (Huawei), M. M. Hannuksela (Nokia), Y. Chen (Qualcomm)]

This document proposed some changes to clarify the definition of clean decoding refresh (CDR) picture, including a change of term to “clean random access” (CRA), as well as other editorial changes.

It was suggested that this is only an editorial refinement of the definition previously agreed.

A problem was pointed out in the proposed wording during the discussion (again, a matter of clarification of the intent rather than dispute over the intent).

An improved definition was suggested to be conceptually structured as follows:

- "XYZ" pictures = pictures that have both decoding order and output order greater than or equal to that of the CDR picture
- XYZ pictures shall not refer to non-XYZ pictures

(Some clarification of "refer to" was suggested to potentially be needed.)

Decision: This was agreed.

Further study regarding whether to make the decoder ref pic list construction and/or ref pic marking processes depend on this.

A BoG (coordinated by Y.-K. Wang) was asked to further refine the definition consistent with this and was asked to think about the potential decoding process dependency. The concept of "lagging pictures" was also later discussed and fixed in the development of this definition. See notes relating to the BoG report JCTVC-F759.

JCTVC-F604 Detection of CDR for random access [Y. Park, K. P. Choi, C. Kim (Samsung)]

The clean decoding refresh (CDR) picture as a new type of random access points was introduced to HEVC and the discussion related to CDR was proposed in JCTVC-E400. In this proposal, a specific method is proposed to detect the current status of whether the decoder is performing random access into a position in a different CVS or is conducting normal play when a CDR picture is decoded.

The contribution proposed inserting a discontinuity counter into the slice header and SPS.

It was remarked that this counter may create some problems, e.g., regarding very long bitstreams or splicing.

It was remarked that a system may have some other way to indicate this to the decoder. However, the proponent indicated that it may be desirable to not need to depend on such an external signal.

For further study.

JCTVC-F493 Absolute signalling of reference pictures [R. Sjöberg, J. Samuelsson (Ericsson)]

This document contains a proposal regarding the reference picture processes in HEVC. It is proposed that pictures that should be available for reference are described in an absolute manner in the slice header of a picture instead of in a relative manner (through MMCO and sliding window process). It is further proposed that buffer operations (picture marking) is performed directly after parsing of the first slice header of a picture instead of after the picture has been decoded.

The document claims that the proposed changes improves error resilience, simplifies temporal scalability and enables decoding at a minimum number of decoded picture buffer slots.

The proposal removes frame_num, instead uses only POC, includes a buffer description in the slice header (or a reference to a table of such descriptions sent in the PPS). Removes MMCO commands.

The proposal uses temporal_id to identify relevant pictures.

Question: Can a lower layer picture mark an upper layer picture as unused for reference?

The encoder includes all of the higher temporal layer pictures in the buffer description.

The proposal has a variation in which buffer descriptions are moved into the PPS.

The proposal does not support pictures held in the buffer for a long time (beyond max POC wrap) before output.

The group considered the proposal very interesting.

It was suggested to put the buffer description in a slice parameter set / adaptation parameter set.

Do we have syntax and semantics and decoding process? Partial, not complete.

It was suggested to establish and AHG to examine, analyze, identify any needs for clarification, and produce a (single) clarified text specification (not necessarily including all features).

It was asked whether we should make a source code branch for this, and agreed that yes, we should do that.

JCTVC-F681 Cross-check of Ericsson proposal JCTVC-F493 by Sony [Y. Morigami, K. Sato (Sony)] [late reg. 07-06, upload 07-12]

Did not study the source code – just ran some simulations.

JCTVC-F460 Getting rid of non-existing pictures [Q. Shen, Y.-K. Wang (Huawei)]

This document proposed to remove the processes for generating and handling of "non-existing" pictures in the HEVC decoding process. The proposed changes include a change to the frame_num semantics, some alternative changes to the reference picture list construction process, and some changes to the reference picture marking process. Assuming that in HEVC the hypothetical reference decoder (HRD) process is specified basically the same as AVC; then those HRD texts mentioned "non-existing" pictures are also proposed to be changed. An example of such changes to the HRD process is also provided, for information.

The proposal suggests that now that we have temporal_id, we may not need the "non-existing" pictures concept.

It is primarily a proposal to simplify the specification (rather than the actual implementation).

This proposal would be obsoleted if the JCTVC-F493 proposal is adopted. Further study was encouraged in case something closer to JCTVC-F493 is not adopted.

JCTVC-F461 Reference picture loss/error detection [Y.-K. Wang, Q. Shen (Huawei)]

This document proposes to conditionally mandate the use of reference picture list modification (RPLM) commands for construction of reference picture lists, to enable decoders detect reference picture losses/errors when gaps_in_frame_num_value_allowed_flag is equal to 1, for applications in error-prone environments. The proponent indicate that if the proposal of unconditionally mandating RPLM commands in Section 6.2 of JCTVC-F460 is agreed, then this proposal can be ignored.

This proposal would be obsoleted if the JCTVC-F493 proposal is adopted. Further study was encouraged in case something closer to JCTVC-F493 is not adopted.

JCTVC-F462 On reference picture marking [Y.-K. Wang (Huawei)]

This document proposes some changes to the reference picture marking process. Specifically, it is proposed that, at any access unit, only reference pictures with an identical or greater value of temporal_id may be marked as "unused for reference". When "non-existing" pictures are involved, it is proposed to be assumed that "non-existing" pictures have the greatest possible value of temporal_id, i.e., 7.

The first aspect seems like just a clarification of the existing intent. Agreed.

The second aspect we are less sure about, but it would be obsoleted if the JCTVC-F493 proposal is adopted. Further study was encouraged in case something closer to JCTVC-F493 is not adopted.

JCTVC-F546 Sliding Window Improvement for Temporal Scalability [Y. Chen, P. Chen, M. Karczewicz]

Duplicate content to part of JCTVC-F462. See notes on JCTVC-F462.

6.11 Quantization

6.11.1 Delta QP

JCTVC-F046 Efficient binary representation of cu_qp_delta syntax for CABAC [K. Chono, H. Aoki (NEC)]

This contribution presented a binary representation of cu_qp_delta syntax for CABAC based on a truncated unary binarization process. The presented binary representation was asserted to offer the following advantages over the current unary binary representation:

- Halve the maximum length of cu_qp_delta bin strings;
- Reduce the average length of cu_qp_delta bin strings by 43%; and
- Enable to truncate the last redundant 0-bins of bin strings of cu_qp_delta values -26 and 25.

Simulation results for CE4 Subtest 2 common test conditions reportedly showed:

- Average BD-rate improvements of 0.04% for all intra setting, 0.04% for random access setting, and 0.09 for low delay settings; and
- Average cu_qp_delta rate reductions of 1.00% for all-intra setting, 1.44% for random access setting, and 1.73% for low delay settings.

No particular questions or comments were made during the presentation of this. It was noted that JCTVC-F422 is similar. Further discussion notes are recorded below in the section discussing JCTVC-F422.

JCTVC-F181 cross-check of (JCTVC-F046) [K. Sugimoto, S. Sekiguchi (Mitsubishi)] [late upload 07-12]

JCTVC-F422 Improvement of delta-QP Coding [K. Kondo, K. Sato, J. Xu (Sony)]

At the 5th JCT-VC meeting, Sub-LCU-Level delta-QP coding had been adopted. A QP prediction method similar to the one in AVC was adopted, but there have been several proposals on other types of QP prediction. One of the topics of CE4 is investigation of such other types of QP prediction.

This proposal contains two modifications of Sony’s prior proposal on CE4: 1) modification on the definition of neighboring QP availability, and 2) entropy coding of delta-QP.

Together with Sony’s CE4 proposal 2.3.e, the proposed method 1) reported provides gain by −0.21%, −0.14%, −0.24%, −0.23%, −0.35% for AI_HE, AI_LC, RA_HE, RA_LC, LD_HE, and LD_LC conditions respectively compared with the CE4 anchor. The proposed method 1) + 2) + provides gain by −0.25%, −0.26%, −0.45% for AI_HE, RA_HE and LD_HE conditions, respectively.

The proposed method 1) is also tested on top of combination of CE4: 2.3.g + 2.3.f + 2.3.e, which is suggested as a best combination among CE4 subtest2 proposals other than the temporal QP prediction. Additional gain is obtained by 0.01%, 0.00%, −0.05%, −0.01%, −0.11% and −0.11% with AI_HE, AI_LC, RA_HE, RA_LC, LD_HE and LD_LC conditions, respectively.

Unlike the NEC proposal, the results investigated here are using the restriction to QP+/-6

The NEC proposal in addition guarantees by the truncation that the range of QP is kept valid. (Is this necessary? It is.)

There was a suggestion to confer in BoG activity and come back with a unified proposal.

The result of this discussion was presented Sat. morning in breakout report document JCTVC-F745.

Decision: Adopt unified solution from JCTVC-F046 and JCTVC-F422 as documented in JCTVC-F745.

JCTVC-F481 Verification result of Sony's Improvement of delta-QP Coding (JCTVC-F422) [M. Shima (Canon)] [late upload 07-08]

JCTVC-F174 Signalling of Max and Min QP in slice [K. Sugimoto, S. Sekiguchi (Mitsubishi)]

This contribution proposes signalling of maximum and minimum QP values (MaxQP, MinQP) in a slice at the slice header. By signalling these two values, the range of delta QP (dQPrange) within a slice is also specified. A modified indexing of delta QP according to MaxQP, MinQP and dQPrange is used with a modified binarization table of CABAC or a modified VLC table of CAVLC. The proposed scheme is implemented onto modified version of HM-3.0 software used as the base software for CE4, and simulations are conducted using common test configurations of CE4 with MaxCuDQPDepth=3 to evaluate the performance of the proposed scheme. It is reportedly confirmed that the proposed scheme achieves delta QP bit rate reduction of 2.6, 3.5 and 4.4% for AI-HE/RA-HE/LB-HE configurations and 8.2%, 10.3% and 11.0% for AI-LC/RA-LC/LB-LC respectively.

Actual gain 0.1% for HE, 0.3% for LC. It would be necessary to implement the truncated code decoding method.

Further study was recommended. (CE4 continuation?)

JCTVC-F652 Cross-check report on Mitsubishi's proposal: Signalling of max and min QP in slice (JCTVC-F174) [K. Chono, H. Aoki (NEC)] [late reg. 07-05, upload 07-06]

JCTVC-F277 Method for deriving Chroma QP from Luma QP [X. Zhang, S. Liu (MediaTek)]

This contribution reports a couple of methods for deriving Chroma QP from Luma QP. Experimental results reportedly show an average of more than 4.85% and 2.8% BD-rate decrease for Chroma, with an average of 0.3% and 0.15% BD-rate increase for Luma for RA and LD configurations, respectively. Both encoding and decoding time remain the same. No subjective quality degradations had reportedly been observed. Additionally, a "chroma_qp_index_offset" is proposed to add in the picture parameter set RBSP syntax.

The method shifts bits from luma to chroma. The BD rate of luma and chroma are not directly comparable.

Question: What was the design criterion behind the tables? Subjective improvement? No.

JCTVC-F492 A table-based delta QP coding method [R. Sjöberg, J. Sun, P. Wennersten, A. Norkin (Ericsson)]

This document claims to reduce the bit cost for coding delta QPs when adaptive QP methods are used. In order to reduce the amount of bits spent on delta QPs, a QP table based algorithm is proposed for further study. Bit-rate reductions up to 1.2% are reported in the document based on simulations of captured TV bitstreams encoded by six different AVC broadcast encoders. The document proposes the described algorithm to be studied further in JCT-VC, preferable in a CE.

Investigated various AVC bitstreams from TV, and found that delta-QP bitrate is on average 3%.

Interesting results, but the advantage in HEVC would still need to be proven. In the current CE4b test conditions, it may not be the same.

JCTVC-F495 Higher granularity of quantization parameter scaling and adaptive delta QP signalling [J. Chen, T. Lee (Samsung)]

The current HEVC Test Model employs a quantization parameter (QP) scaling scheme which is the same to the AVC standard. In AVC, the quantization step size increases by approximately 12.25% with each increment of QP which reportedly leads to an average around 19% and up to 44.2% bit increase. It was suggested that for the purpose of rate control, the 12.25% increment may be too coarse for some applications. This contribution proposes to use a higher granularity of the QP scaling in HEVC test model. In addition to higher granularity, the contribution also proposes to specify a dQP_scale value at the slice or picture level to support the tradeoff between dQP bits overhead and fine rate/quality control.

The assumption here is that rate control change QP is performed at the slice level; however with the option to change QP at the CU level this may not be relevant. A disadvantage would be that signalling of dQP becomes more costly.

The dQP scaling would allow to either increase or decrease the current QP stepping.

Not much interest was expressed on this when presented. Also refer to JCTVC-D041, which suggested something similar.

JCTVC-F590 Cross check report of JCTVC-F495 [Muhammed Coban (Qualcomm)] [late upload 07-09]

JCTVC-F577 QP adaptation at sub_CU level [K. Panusopone, A. Luthra, X. Fang, L. Wang (Motorola Mobility)]

This contribution provides the results of an experiment that shows that the characteristics of the local activity in a picture changes at a level finer than the CU size. This indicates that the granularity for QP adjustment at a level finer than CU, as currently allowed in HEVC, is needed to allow more flexibility in adapting QP to the nature of local statistics. It is recommended to set up a set of experiments to study this further and make appropriates changes in the syntax.

Request to allow QP adaptation at TU level based on the observation that activity (as measured by the TM5 method used in CE4) changes at such level.

JCTVC-F610 Fine granularity QP offset [X. Wang, R. Joshi, G. Van Der Auwera, M. Karczewicz (Qualcomm)]

A method for sending offset values to modify the quantization step size at the slice level is proposed. The step-size change is signaled as a percentage of the original quantization step-size, resulting in much higher granularity compared to what could be achieved through a QP change. The BD-rate for RA-HE and LB-HE configurations is −0.5% and −0.9%, respectively. The BD-rate for RA-LC and LB-LC configurations is −1.1% and −1.8%, respectively. When 'Nebuta' and 'BQTerrace' are excluded from the BD-rate calculations, the BD-rate for RA-HE, LB-HE, RA-LC and LB-LC configurations is −0.9%, −1.0%, −1.1%, and −1.9%, respectively.

Results are for the case RDOQ on. The method implicitly also has a similar effect as changing the QP, assigning 1xoffset to level 1, 2xoffset to level2 etc.

It is observed that the proposed method most significantly reduces the rate of B pictures. Could similar performance be achieved by re-allocating QP?

Several opinions are expressed that having something as adaptive quantization offset in the design is desirable. Particularly, it could help in case of RDOQ off.

However, based on the current data it is difficult to decide about which proposal is the best choice (CE4: RIM and Mediatek or Qualcomm which comes as a modification of RIM). Conditions that allow comparison (no implicit RD specific optimization, no implicit QP adaptation) should be defined -> BoG.

JCTVC-F720 Cross-check of Qualcomm's fine granularity QP offset (JCTVC-F610) by Institute for Infocomm Research [Y. H. Tan, C. H. Yeo (I2R)] [late reg. 07-12, upload 07-14]

JCTVC-F663 On cu_qp_delta range constraint [K. Chono, H. Aoki (NEC)] [late reg. 07-06, upload 07-09]

The current entropy coding method for cu_qp_delta syntax cannot map a signed syntax element value to the code number without redundancy when the absolute value of the minimum negative value differs substantially from that of the maximum positive value. However, new entropy coding methods presented in JCTVC-F174 and JCTVC-F46 enable to map a signed syntax element value to the code number without redundancy even when the absolute value of the minimum negative value differs substantially from that of the maximum positive value. If the new methods are integrated into the HM design, it was suggested that the current cu_qp_delta range constraint in the WD draft text, "–(26+ QpBdOffsetY / 2) to +(25+ QpBdOffsetY / 2), inclusive," may not be appropriate. A straightforward cu_qp_delta range constraint, "– (| 0 − QPY,PREV |) to + (51 − QPY,PREV), inclusive" would be appropriate. It is recommended that JCT-VC experts review this contribution and discuss the appropriate cu_qp_delta range constraint in the HM design.

Contribution noted. No specific discussion.

JCTVC-F499 Temporal QP Memory Compression [M. Coban, M. Karczewicz (Qualcomm), H. Aoki, K. Chono (NEC)]

This contribution presents a temporal QP memory compression scheme that is complementary to the temporal QP prediction method of JCTVC-F103. Temporal QP memory compression reduces the amount of storage requirements for QP values in reference frames. The memory reduction results in less than 0.1%, 0.2% and 0.3% average BD-rate increase for 4x, 16x and 64x memory reductions, respectively for MinCUDQPSize of 8x8. Coding gain relative to storage requirement is more than that of temporal MV prediction.

Effective bitrate reduction (with 16x16 QP value storage) is 0.5–0.9% in the different inter configurations (highest for LD)

JCTVC-F481 is a cross-check.

This introduces further dependencies over time. For intra CU, only spatial prediction is used.

Further study in a CE was suggested.

6.11.2 Quantization matrices

JCTVC-F362 Proposal to support quantization matrix in HEVC [T. Suzuki, A. Tabatabai (Sony), M. Zhou, V. Sze (TI)

In this contribution, a quantization matrix that is simply extended AVC method is proposed to include in HM as a starting point of further investigation. Because of large block size transform and quantization, data size of quantization matrix can be large, and hence efficient encoding method to support quantization matrix is desired. The requirements and the current practices of quantization matrix are summarized in JCTVC-E056. During the discussion in Geneva, it was generally agreed that HEVC should have some form of quantization matrix capability. In this contribution, an extended AVC quantization matrix method is proposed to include in HM4. It consists of the followings.

- Encoding of matrices in SPS and PPS
- Support 4x4, 8x8, 16x16 and 32x32 matrices
- DPCM + signed exp-Golomb code
- AVC inverse quantization process

This method is implemented in HM 3.0 and the source code is attached to this contribution. The enhancement methods of the quantization matrix can be investigated based on this method. The quantization matrix should be disabled in common test condition if adopted.

Overhead is extremely high (in class D 5x video rate), as the proposal in the presented results uses random values and suggests to change these at every frame. This seems to be unreasonable.

There was agreement that quantization matrices should be included, and an “AVC like approach” should be used as a starting point (although this would not be used in the default setting). M. Karczewicz was asked to check the suggested solution and report back.

Default setting of these matrices must still be clarified -> the suggested solution was not considered reasonable.

One possibility would be to use the AVC matrices as starting point for 4x4 and 8x8, interpolated versions for the larger sizes? It should also be tested what the impact of the frequency of change is (only once per sequence, each xxth frame etc.). It may also be unrealistic that quantization matrices would be used with high QP values.

For further study in a CE.

JCTVC-F085 Further study on compact representation of quantization matrices [M. Zhou, V. Sze (TI)]

Due to large block size transform and quantization used in the HEVC, carrying the quantization matrices in bitstream could lead to a significant overhead. In this document, a quantization matrix compression algorithm is proposed to achieve compact representation of quantization matrices for HEVC. Test results reportedly revealed that the algorithm provided up to 13-15x more compression when compared to the AVC quantization matrix compression method if all the compression tools are enabled. The contributor suggested to adopt the AVC quantization method into the test model, and start a CE on this subject to specify a compact quantization matrix representation format for efficient carriage of quantization matrices in HEVC.

JCTVC-F475 Enhancement of quantization matrix coding for HEVC [J. Tanaka, Y. Morigami, T. Suzuki (Sony)]

Proposed requirements and reported current practices of quantization matrix are summarized in JCTVC-E056. In existing coding standards, e.g. MPEG2 and AVC, quantization matrix is introduced to improve subjective quality. Quantization matrix is widely used in consumer and professional video products, e.g. video cameras, Blu-Ray Disc, etc.

Data size of quantization matrix, especially for large CU, is asserted to be large, and efficient encoding method to support quantization matrix is advocated by the proponent.

If compression mode is DPCM mode only, as in AVC, it allegedly needs many bits. JCTVC-E073 was proposed in Geneva meeting. In the contribution, a coding method of the quantization matrix is proposed. Compared with AVC, the proposed method allegedly improves coding efficiency about 36.7% in average BD-rate. Coding efficiency is reportedly improved in all sequences and increased encoding time is small.

Conclusion: Start CE on quantization matrices as part of the quantization CE. It may not be necessary to include the AVC matrices in WD; an HM branch may be sufficient for the purpose of the CE.

6.11.3 Dequantization

JCTVC-F257 About clip operation removal from de-quantization part of HM [E. Alshina, A. Alshin (Samsung)]

This contribution proposes a restriction for quantized coefficient values depending on QP and transform size. If the encoder doesn't generate quantized coefficients with a magnitude over this limit then clip operation is not used in the de-quantization part of HM transform. No overflow of 16 bits buffer is guaranteed in this case (provided the encoder behaves as specified).

In principle it is possible to impose normative restrictions on the coefficients, and that would be advantageous to reduce decoder complexity. However there are doubts (see JCTVC-F449 below).

The question is raised whether also cases of potential higher than 10 bits extensions have been considered.

Further study was suggested.

JCTVC-F449 Cross-check of Samsung's contribution on clip operation removal from de-quantization part of HM (JCTVC-F257) [A. Fuldseth (Cisco)]

Comments from the cross-checker:

> "Some form of clipping is needed if one wants to limit the dynamic range of the input to the inverse transform, which I believe is a reasonable assumption.
>
> The current quantization/transform design of HM3.0 is so that clipping only occurs in 'extreme' cases:
>
> Near worst case dynamic range of input to the forward transform.
>
> Quantizer that rounds in the 'wrong direction'.
>
> I am unsure whether that situation will ever occur with the current test conditions/sequences.
>
> The proposal moves clipping from after the dequantizer to before the dequantizer which allows for doing clipping in the encoder only. This touches on a more general topic on how to express a limitation on the dynamic range in the HEVC standard:
>
> In the decoding process (e.g. clipping after the dequantizer), or
>
> By imposing constraints on the bitstream (e.g. limitations on the level).
>
> Theoretically one might think that clipping might have slightly less effect if done after the dequantizer (because of higher fidelity), especially at high QP values. I am not sure if that is significant though."

General conclusion on quantization:

Continue CE4 on previous subtests 2 & 3, and quant matrices as new subtest.

A general problem in CE4 is still the realistic scenario of test conditions (granularity and amount of QP changes, realistic quant. matrices) – to be further discussed in the preparation of CE description – a BoG was created to discuss this further. See notes elsewhere.

6.12 Alternative coding modes

JCTVC-F150 Inter modes for screen content coding [W. Zhu, W. Ding, Y. Shi, B. Yin (Beijing Univ. Tech.)]

This contribution introduces two inter coding tools (InterBCIM and InterRSQ) for screen content coding. The two inter coding tools are implemented into the HM2.0 software. The experimental results reportedly show that the bit rate saving tested on screen content is 20% or 3.36 dB improvement on average.

Inter RSQ is, in principle, transform bypass and PCM. This is said to be useful for high rates.

Only 3 sequences were tested.

JCTVC-F200 Improvements of the BCIM modes in screen content coding [C. Lan (Xidian Univ.), J. Xu, G. J. Sullivan, F. Wu (Microsoft)]

This document presents improvements of BCIM (Base Color and Index Map) mode to compress screen contents. It further improves the coding efficiency for screen content. The improved mode is an alternative method to provide an upper bound for the coded bits, avoiding unexpected large bit number generation which is prohibitively greater than that of raw data. Experimental results of implementing BCIM in HM3.0 for screen content sequences under the high efficiency intra coding configuration are reported in this document. For the typical screen content sequences, the proposed BCIM mode reportedly achieves 38% bit saving on average. For all the tested screen sequences, a 21.6% bit saving on average was reported. Experimental results over the synthesized noise sequence demonstrate that BCIM can provide an upper bund for the output bits.

BD rate gain is high for specific screen content. For natural video, the gain is low (3% or less).

Only intra was tested.

The results reported only show the luma bitrate (except table 1).

Comments included the following: Is PSNR the right measure? May be misleading, as tools like this reproduce flat areas with zero deviation, whereas transform coding may introduce noise which may be acceptable. Edge ringing could be more severe on the other hand. Subjective comparison?

JCTVC-F564 Near Lossless Coding for Screen Content [W. Gao, G. Cook, M. Yang, H. Yu (Huawei)]

This contribution proposes a near lossless coding method that involves modifications to the existing intra coding tools. This method is designed for encoding texts and graphics at high quality and high coding efficiency, and screen sharing is one of potential applications of this method, where computer display signal is treated and processed and delivered as video. Typical screen capture video reportedly consists of a mix of cameral-captured video, computer generated graphics, texts, etc., and fidelity or the quality of the text and graphics are extremely important. The major problems with today's solution reportedly include poor compression quality, low frame rate, and long latency, and poor quality of text and reportedly can cause eye-fatigue. In summary, it was asserted that neither the compression ratio nor compression quality with the existing solutions are satisfactory. To address this asserted problem, a set of modifications to the existing tools were proposed to achieve both near-lossless quality and high compression efficiency in coding of screen compound video. For purpose of evaluation, these modifications and the associated syntax element changes have been integrated into HM3.0-dev-SDIP branch. Two test sequences proposed to the SCC Ad-Hoc group are used in the tests. Compared to baseline HM3.0-dev-SDIP software, the proposed method can reportedly maintain the high coding efficiency of HM while achieving near lossless quality for the text regions.

SDIP is reported to give 13% rate benefit (intra coding) for two screen content sequences, with various tools (ALF, deblocking filter, …) being turned off.

Conclusions from this:

It is interesting to see that tools exist that formally give high gain for this specific content.

Transform bypass could be interesting – this leaves CABAC as plain spatial context-based AE.

Usage of PSNR should be investigated.

6.13 Entropy coding

6.13.1 CAVLC

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

This proposal removed the redundancy in Run-mode coding of CAVLC by replacing unary code with truncated unary code. Experimental results show that the BD-rate saving is 0.1% for Intra only, 0.1% for random access and 0.0% for low delay B under low complexity configuration.

No support for adopting this.

JCTVC-F676 Cross-check for Sony's Proposal (JCTVC-F286) on Redundancy removal for Run-mode in CAVLC [Z. Zhou, S. Liu (MediaTek)] [late reg. 07-07, upload 07-07]

JCTVC-F298 Run-level table reduction for CAVLC [L. Guo, X. Wang, M. Karczewicz (Qualcomm)]

In current HM software, a run-level table of size 434 is used in the coding of Inter block coefficients (as well as Intra Chroma block coefficients). This contribution reduces the run-level related table sizes from 434 to 148. The Luma B-D rate changes for different cases are 0.00% AI, −0.14% RA, 0.03%LD, and 0.06% LDP.

Question: Is the new table available as part of the contribution? Apparently not.

JCTVC-F160, JCTVC-F407, JCTVC-F543 are similar.

JCTVC-F406 Coefficient coding in CAVLC [S. Kim, J. Lee, K. Lim, S. Lee (Yonsei Univ.), J. Chen, J. Park (Samsung)] [late upload 07-12]

JCTVC-F160 CAVLC table-size reduction for Inter/chroma run-level coding [T. Davies (Cisco)]

A modification to the method for computing code numbers for run-level pairs in inter and chroma blocks is proposed. This reduces the size of the table used from 434 bytes to 104 bytes. For I_LC, RA_LC, LDB_LC and LDP_LC the BD-rate performance is reported to be 0.0%, 0.0%, 0.0% and 0.1%. There is no reported significant change to encoder or decoder simulation times.

Very slightly worse than JCTVC-F298, but again a smaller table. Major differences: Lower "switching point", and formula to compute cn is different.

JCTVC-F313 Verification Results of run-level CAVLC table-size reduction (JCTVC-F160) [E. Maani (Sony)] [initial version rejected as placeholder; corrected version late upload 07-06]

JCTVC-F407 Run-mode coding improvement with table reduction in CAVLC [J. Lee, S. Kim, K. Lim, D. Pak, S. Lee (Yonsei Univ.), J. Chen, J. Park (Samsung)]

In this report, a scheme is proposed to determine code number, for inter block, without run-level table. From this approach, the memory size to storage table can reportedly be reduced from 870 bytes to 220 bytes. Simulation results show that coding gains are −0.01%, −0.19% and 0.04% for all intra, low delay and random access configurations respectively.

Yet another approach with larger remaining table size, but slight advantage in terms of compression.

JCTVC-F635 Crosscheck report for JCTVC-F407 on CAVLC run-mode coding from Yonsei Univ. and Samsung [X. Wang (Qualcomm)] [late reg. 07-04, upload 07-14 after opening]

JCTVC-F543 Tableless run-length coding for transform coefficients in CAVLC [A. Hallapuro, J. Kang, J. Lainema, K. Ugur (Nokia)]

The contribution proposes a tableless algorithm for run-length coding of transform coefficients in CAVLC. An equation is used for generating the run-length values with special emphasis on the longest run-length value. It is reported that up to 812 bytes of memory required by the HM3 design can be saved in both encoder and decoder. The contribution reports average BD bitrate impact of −0.1% for intra LC, −0.1% for random access LC and +0.1% for low delay LC configurations.

No cross-check available by the time of presentation (it is said that TI is working on this). Some experts think that this is an even more elegant approach (table size zero); however the additional complexity of formula computation may be a concern (even though the formula could again be replaced by a table).

It was agreed to establish a BoG to get common understanding (coordinated by Thomas Davies), come back with an agreed solution, otherwise establish a CE in CE5.

JCTVC-F750 Cross-check of Nokia's proposal on Tableless run-length coding for transform coefficients in CAVLC (JCTVC-F543) [V. Sze, M. Budagavi (TI)] [late reg. 07-16, upload 07-17]

JCTVC-F395 CAVLC Adaptation using difference counter [T. Yamamoto (Sharp)]

This contribution proposes CAVLC adaptation using a difference counter which does not require the normalization process used in the counter-based CAVLC method adopted in HM-3.0. The proposed method could reportedly also reduce the number of required counters while keeping coding gain achieved by the current counter based adaptation method.

Further study (CE5).

JCTVC-F428 Cross-check of JCTVC-F395 by Sharp [Y. Morigami, K. Sato (Sony)] [upload 07-11]

JCTVC-F458 Improvement of CAVLC run- coding by prediction mode [C. Kim, Y. Park (Samsung)]

In this contribution, a scheme is proposed to run-level coding according to prediction mode of block. The contributor reported that the scheme has −0.2%/−0.1%/0.0% coding impacts with intra, low delay and random access low complexity configuration, respectively. No additional complexity is reported for all tests.

Question: How was the mapping from prediction mode to run-level coding determined? No definite answer.

Contribution noted.

JCTVC-F621 Crosscheck report for Samsung's JCTVC-F458 on CAVLC run coding [X. Wang (Qualcomm)] [upload 07-14 after opening]

JCTVC-F466 Handling for exception cases regarding to code-word larger than 32bit in CAVLC [C. Kim, Y. Park(Samsung)]

In this contribution, a scheme is proposed to handle exception cases for codewords larger than 32 bits in CAVLC, which leads to an error. The modified VLC tables are mixed with fixed-length codes which reportedly eliminates the need for any loop in bitstream writing and errors. It allegedly does not generate any side effect such as performance change but cover the maximum level of quantized coefficients in CAVLC.

Comment: It is agreed that this is an issue. This can also happen for other cases, such as run/level coding. A more general solution would be desirable. Put study on this under mandates of entropy coding AHG

JCTVC-F622 Crosscheck report for Samsung's JCTVC-F466 on CAVLC long codeword handling [X. Wang (Qualcomm)] [upload 07-14 after opening]

JCTVC-F467 Improvement of CAVLC table adaptation for coefficient coding [C. Kim, Y. Park (Samsung)]

In this contribution, a scheme is proposed to switch VLC tables including the last level of run-coding. The contributor said that the scheme has −0.2%/−0.1%/−0.1% coding performance improvements with all-intra, low delay and random access low complexity configurations respectively. No additional complexity was reported for all tests.

Decision: Adopt

JCTVC-F623 Crosscheck report for Samsung's JCTVC-F467 on CAVLC table adaptation [X. Wang (Qualcomm)]

JCTVC-F199 A further improvement of inter prediction direction and reference frame index combined coding in CAVLC [B. Li (USTC), J. Xu (Microsoft), H. Li (USTC)]

This document presents proposed changes of "(a)" the combined coding of inter prediction direction and reference frame index in CAVLC. The contributor said that the BD-Rate difference is negligible under the default test configuration. But when the number of reference frames is reduced, about 0.2% bits saving were reportedly obtained on average. A second proposed aspect was "(b)", to move the adaptive algorithm to decide using combined coding or not, from CU to PU to make the specification simpler. Changing the adaptation algorithm from CU to PU will reportedly not have much impact on the performance.

Decision: Adopt (a) part only.

JCTVC-F615 Cross-verification of Microsoft's JCTVC-F199 by Samsung [T. Lee, J. Chen (Samsung)] [late upload 07-05]

JCTVC-F408 CE5: Run and level mode coding improvement in CAVLC [S. Kim, J. Lee, S. Lee (Yonsei Univ.), J. Chen, J. Park (Samsung)]

In this contribution, some experimental results of CAVLC changes proposed in JCTVC-E446 are reported. Other modifications are also considered. The reported simulation results are −0.7%, 0.0%, −0.4% in all intra, low delay and random access configurations, with reducing 540 bytes.

Further study (CE).

JCTVC-F608 Removing chroma zonal coding in CAVLC [M. Karczewicz, X. Wang, W.-J. Chien, L. Guo (Qualcomm)]

This contribution proposes removing the CAVLC zonal coding as currently applied to chroma blocks with a size of 16x16 or larger. Instead, code those chroma blocks normally with coefficients at every frequency location included.

Several experts expressed the opinion that this is highly desirable and makes the design more consistent.

Decision: Adopt.

JCTVC-F723 Cross-verification of JCTVC-F608 and JCTVC-F296 by Nokia [K. Ugur, O. Bici (Nokia)] [late reg. 07-12, upload 07-15]

See also section on JCTVC-F296.

JCTVC-F612 Modifications to intra blocks coefficient coding with VLC [M. Karczewicz, Y. Zheng, L. Guo, X. Wang (Qualcomm)]

Coding results after modifying the tables used in VLC coding are presented. It is further proposed to extend usage of horizontal and vertical scans to 16x16 and 32x32 blocks. In addition this contribution proposes to modify coefficient coding for 16x16 and 32x32 blocks.

When all these 3 modifications are applied the average gain of 1.4%, 0.6%, and 0.3% was reported for all intra, low delay and random access configurations.

Item 1 (tables) gives 0.5%/0.2% and 0.1% for AI/RA/LD. Several experts support item 1 (new VLC tables) – Decision: Adopt item 1.

(There was however some concern expressed by the contributors of JCTVC-F408.)

Other items are to be investigated in CE5.

JCTVC-F667 Cross-check of JCTVC-F612 on CAVLC Intra coding. [Thomas Davies] [late reg. 07-06, upload 07-11]

JCTVC-F465 Item 3 (Direct coding of Intra DC coefficient in CAVLC mode) of Experiments on tools in Working Daft (WD) and HEVC Test Mode (HM-3.0) [I.-K. Kim, E. Alshina, J. Chen, T. Lee, W.-J. Han, J. H. Park (Samsung), V. Sze, M. Budagavi, M. Zhou (TI)]

Item 3: Direct coding of Intra DC coefficient in CAVLC mode

The text doesn't actually describe the special-case behaviour that's in the software, which seems to provide no benefit as tested (even with many slices).

Decision: Adopt the simplification (with a compile flag to revert). If no evidence of usefulness is provided, we'll consider using the prior behaviour. Text doesn't have the complication anyway.

JCTVC-F465 Item 7 (Adaptive switching on/off combined coding for CAVLC) of Experiments on tools in Working Daft (WD) and HEVC Test Mode (HM-3.0) [I.-K. Kim, E. Alshina, J. Chen, T. Lee, W.-J. Han, J. H. Park (Samsung), V. Sze, M. Budagavi, M. Zhou (TI)]

Item 7: Adaptive switching on/off combined coding for CAVLC.

Was adopted from JCTVC-F470. If some evidence of usefulness is later provided, we can re-enable it.

6.13.2 CABAC

Verbal Report from BoG on context selection (Vivienne Sze): Discussed 6 syntax elements: intra_chroma_pred_mode, merge_flag, ref_idx, mvd, no_residual_data_flag, inter_pred_flag. For the first 5, remove neighbors entirely. Furthermore, alf_flag is referred to depend on neighbors which in fact is not the case.

JCTVC-F059 CABAC with Constrained Outstanding Bits [T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)]

In HM-3.0, there is no constraint on continuous outstanding bits in CABAC. Theoretically, the number of continuous outstanding bits could be infinite. Practically, the number was up to 189 in the contributors' reported analysis. When a lot of continuous outstanding bits are accumulated, a sudden increase of output bits can occur, which was asserted to complicate hardware design significantly because of the unpredictable largest number of continuous outstanding bits. In this contribution, a coding interval adjustment procedure was proposed to constrain the number of continuous outstanding bits. It was reported that the proposed method achieved no differences in coding efficiency and runtime in comparison with the JCTVC-E700 anchor, while at most 18 bits could be output simultaneously.

One expert said that the same thing was discussed already in AVC and SVC standardization, and there would be other ways to solve it. In fact, the suggested approach would add complexity to the decoder (particularly in software).

No other experts expressed the opinion that this is an important issue.

JCTVC-F452 Crosscheck of CABAC with Constrained Outstanding Bits (JCTVC-F059) [T. Nguyen (HHI)]

JCTVC-F061 CABAC with a reduced LPS range table [T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)]

In HM-3.0, the least probable symbol (LPS) range table in CABAC has 4 columns (64*4*8 bits). This contribution used a 3-column table composed of two columns of LPS ranges (64*2*8 bits) and one column of refinement values (64*1*5 bits) to simulate an 8-column LPS range table (64*8*8 bits) on the fly. In comparison with the 4-column table, the simulated table could reportedly reduce quantization errors of LPS ranges without increasing the table size; and reportedly could reduce the table size. It was reported that 0.1% bit rate reduction could be achieved in HE-AI, HE-RA, and HE-LD cases while the overall LPS range table size was reduced by 34%.

Several experts point out that additional operations are needed. Software implementations may suffer.

No other experts expressed the opinion that this is an important issue.

JCTVC-F453 Crosscheck - CABAC with a Reduced LPS Range Table (JCTVC-F061) [T. Nguyen]

JCTVC-F132 Reduction in contexts used for significant_coeff_flag and coefficient level [V. Sze (TI)]

This contribution proposes removal of several contexts used for CABAC entropy coding of syntax elements significant_coeff_flag coding and coefficient level. Specifically, the four contexts used for the first four significant_coeff_flag in a 32x32 transforms were proposed to be removed, and all contexts for significant_coeff_flag in 16x16 and 32x32 were proposed to be shared. The contexts for coeff_abs_level_greater1_flag and coeff_abs_level_greater2_flag were each proposed to be reduced from 60 to 54 and 60 to 48 respectively. A total of 22 contexts were proposed to be removed per slice type. A negligible impact on coding efficiency was asserted in HM-3.2 (0.1% AI-HE, 0.0% RA-HE, −0.1% LD-HE).

JCTVC-F691 Verification of JCTVC-F132: reduction of the number of CABAC contexts [F. Bossen (Docomo USA Labs)] [late reg. 07-08, upload 07-13]

The cross-checker reported that an independent implementation was made.

JCTVC-F133 Simplified MVD context selection (Extension of E324) [V. Sze (TI), A. P. Chandrakasan (MIT)]

Presented in BoG.

JCTVC-F658 Crosscheck for TI's MVD Context in JCTVC-F133 [T.-D. Chuang, Y.-W. Huang (MediaTek)] [late reg. 07-06, upload 07-10]

JCTVC-F148 Context simplification for coefficients entropy coding [X. Che, W. Ding, Y. Shi (Beijing Univ. Tech.)

The proposed technique in this contribution was asserted to simplify contexts using in coefficients entropy coding, including three parts, last_flag, one_flag and abs_flag. All tests about this contribution were based on HM3.0. The reduction of the used contexts was reported as -34.6% (from 104 to 68) for last_flag, and -50.0% (from 60 to 30) for both one_flag and abs_flag. The BD-Rate for the high efficiency intra, random access and low delay configurations was reported as 0.1%, 0.1% and 0.0% with all three parts, and 0.1%, 0.0% and 0.0% for only one_flag and abs_flag, respectively.

It is commented that most loss is observed in class A. Question: Is there a problem with large transforms? From the Excel file, it may also be the case that the loss becomes higher at low QP.

JCTVC-F254 Multi-parameter probability up-date for CABAC [A. Alshin, E. Alshina (Samsung)]

This contribution provides description of multi-parameter probability up-date for HEVC CABAC. Described idea implemented on-top of HM 3.0 and tested using common test conditions. Average performance improvement achieved is reportedly 0.8% with less than 1% encoding time with no increase of decoding time.

Several methods of estimating probability are run in parallel (e.g. taking into account more or less quick changes, i.e. short and long distance probability prediction), and used to derive the actual probability estimate.

Several experts expressed the opinion that this is very interesting – a CE was suggested.

Memory for probability storage is significantly extended – this should also be studied.

JCTVC-F636 Cross-check of JCTVC-F254: Multi-Parameter Probability Update for CABAC [Jinwen Zan, Dake He] [late reg. 07-04, upload 07-14]

JCTVC-F177 Fast bypass mode for CABAC [R. Hattori, K. Sugimoto, S. Sekiguchi (Mitsubishi)]

In this contribution, a bypass mode for CABAC is proposed. Complexity reduction of the bypass mode was reported without bit rate increase. The proposed scheme was reportedly implemented on HM-3.0. The processing time of the pass through mode at decoder was reportedly reduced by 41.74%, 51.79% and 45.68% compared to the bypass mode in HM-3.0 for AI, RA and LD, respectively.

Needs more investigation: Is it still possible to have a throughput of more than one bin per cycle? Memory requirements? Further study in AHG.

JCTVC-F669 Cross-check of Mitsubishi's Fast bypass mode for CABAC (JCTVC-F177) [V. Sze (TI)] [late reg. 07-06, upload 07-07]

JCTVC-F429 Modified Context Derivation for neighboring dependency reduction [H. Sasai, T. Nishi (Panasonic)]

Presented in BoG.

JCTVC-F672 Cross-check of Panasonic’s proposal on modified context derivation for neighboring dependency reduction (JCTVC-F429) [J. Sole (Qualcomm)] [late reg. 07-06, upload 07-10]

JCTVC-F455 Modified binarization and coding of MVD for PIPE/CABAC [T. Nguyen, D. Marpe, H. Schwarz, T. Wiegand]

Discussed in BoG.

JCTVC-F761 Cross verification for HHI's proposal JCTVC-F455 (part3) [H. Sasai, T. Nishi (Panasonic)] [late reg. 07-19, upload 07-19]

JCTVC-F497 Simplified context model selection for block level syntax coding [J. Chen, T. Lee (Samsung)]

This contribution targets to reduce line buffers of CABAC engine by removing interdependency of neighboring block in current context model selection method. In the proposed method, context of merge_flag, inter_pred_flag, bin0 of ref_idx, bin0 of mvd and bin0 of intra_chroma_pred_mode is fixed without considering neighboring value. Context of split_coding_unit_flag is selected jointly based on value of left block and coding unit depth. The modification was tested in HM-3.0 with high efficiency configuration and almost no performance degradation was reported.

Discussed in breakout meeting.

JCTVC-F650 Crosscheck for Samsung's Context Model Selection in JCTVC-F497 [T.-D. Chuang, Y.-W. Huang (MediaTek)] [late reg. 07-05, upload 07-10]

JCTVC-F593 Improved CABAC Context Initialization [Kiran Misra, Andrew Segall (Sharp)]

This contribution proposes that CABAC initialization for forward predicted B slices be carried out with P-slice tables instead of B-slice tables. The performance of this change is reported using HM-3.1 with 1500 byte slices. The average BD bitrate change was reported to be: LD-HE: Y: −0.2%, U: −1.8%, V: −1.7%; RA-HE: Y: −0.1%, U: −0.8%, V: −0.9%.

Question: How does it relate to high-level syntax cabac_init_idc? Concepts for context initialization should be consistent.

With one slice per picture, the gain would be negligible.

Further study.

JCTVC-F739 Cross Check of Sharp's JCTVC-F593 on CABAC Context Initialization [G. Van der Auwera (Qualcomm)] [late reg. 07-15, upload 07-15]

JCTVC-F606 Memory and Parsing Friendly CABAC Context [W.-J. Chien, M. Karczewicz, X. Wang, (Qualcomm)]

This contribution proposes some changes to the CABAC context used in coding of various syntax elements. The changes aim at reducing the memory requirements in implementation, as well as removal of parsing related complications associated with the current context for these syntax elements. Simulation results reportedly show that the proposed context modifications do not incur coding performance loss.

Presented in BoG and partially in track B: Replace two chroma_cbp flags (different for intra and inter) by a unique method (inter version also applied for intra) saves two checks in parsing process and removes 50 lines of code.

It is pointed out that there may be more issues which would be desirable to resolve for chroma cbf (aliasing, contexts may be interpreted differently depending on neighboring CUs in intra or inter residual). With the suggested solution, RQT may still not be identical for intra and inter as far as chroma cbf is concerned.

In spirit, it was agreed to adopt the simplification of chroma cbf as suggested in JCTVC-F606; this was revisited with the BoG report JCTVC-F746: Decision: Adopt.

JCTVC-F698 Cross verification for Qualcomm's proposal JCTVC-F606 [H. Sasai, T. Nishi (Panasonic)] [late reg. 07-11, upload 07-12]

JCTVC-F423 Modified MVD coding for CABAC [H. Sasai, T. Nishi (Panasonic)]

This proposal presents a technique for complexity reduction on the motion vector difference (MVD) parameter parsing process. In this contribution, it is proposed that the data structure change to increase parallel processing capabilities and modified context selection to reduce the dependency on neighboring blocks to reduce the line buffer are used for MVD coding. Moreover, bypass processing concatenation is asserted to make parallel processing capability further improved. The proposal was implemented in HMv3. The average gain for the proposal for random access and low-delay configurations were reportedly 0.02% and 0.02%, respectively.

Similar to JCTVC-F133, JCTVC-F429, JCTVC-F497.

With this approach, bypass mode could be faster.

JCTVC-F137 Cross-check results of Panasonic's Modified MVD coding for CABAC (JCTVC-F423) [V. Sze (TI)] [late upload 07-07]

Note from Plenary: Vivienne Sze was asked to lead a breakout activity on CABAC context selection.

JCTVC-F130 Parallel Context Processing of Coefficient Level [V. Sze, M. Budagavi (TI)]

Bypass bins do not require contexts, and thus multiple bypass bins can be coded in a single cycle for increased throughput. Grouping the bypass bins together maximized the throughput impact. In HM-3.0, only the first two bins of the coefficient level are context coded. This contribution proposes grouping the bypass bins together in the coefficient level syntax elements in order to increase the throughput of the CABAC. This modification was tested for the high efficiency configuration in HM-3.0 and no coding loss was reported (0.0% for AI-HE, RA-HE and LD-HE).

Current implementation is in HM 3.0; however this part was significantly changed / cleaned up in HM 3.2.

Decision: Adopt concatenation of bypass bins as suggested in JCTVC-F130 and JCTVC-F423. Unlike the suggested method of JCTVC-F130, it would be better to concatenate the sign bits together. F. Bossen will implement this accordingly, and V. Sze provides the necessary WD changes; for WD changes for MVD coding - see BoG on context reduction.

JCTVC-F370 Cross-check report for TI's proposal JCTVC-F130 on Parallel Context Processing [H. Sasai, T. Nishi (Panasonic)]

6.13.3 Other

JCTVC-F162 Entropy coding performance simulations [T. Davies, A. Fuldseth (Cisco)]

(Information document)

Various coding conditions were simulated with both CAVLC and CABAC. Under common conditions it is reported that CABAC provides gain between 6.1% and 7.6%. The performance of the entropy coders is also investigated with various encoder restrictions: no RDOQ, no adaption during RDO mode search, and tile-based coding. These assumptions individually reduce the average gap between CABAC and CAVLC by 0.9%, 1.75% and 0.75%, respectively, in LC settings. When RDOQ is off, RDO adaption is off and tiles are also enabled the gap is reported to be between 2.0% and 3.8% on average in LC settings.

JCTVC-F176 Improved PIPE/V2F for low complexity entropy coding [K. Sugimoto, R. Hattori, S. Sekiguchi, K. Asai (Mitsubishi)]

In this contribution, PIPE/V2F using 8 bit fixed length code for low complexity condition is proposed. In the proposed scheme, V2F(Variable Length to Fixed Length) coders are used instead of V2V(Variable Length to Variable Length) coder for PIPE, and all V2F coders except the coders for the highest and the lowest MPS probabilities are designed to generate 4 bit fixed length code. For the lowest MPS probability V2F coder, input 8 bins are directly output as 8bit fixed length code to realize memory-less 8bit V2F conversion. For the highest MPS probability V2F coder, truncated unary bins are converted to 8 bit fixed length code. Number of preceding "0"s are the 8 bit fixed length code for each entry to realize memory-less. The proposed scheme is implemented on HM3.0, and simulations are conducted using common test configurations of low complexity settings. It is reported that the proposed scheme achieves BD-rate reduction 3.9%, 4.3% and 3.2% on average for AI, RA and LD respectively. It is also reported that the increase of decoding time compared to the anchor is around 10%, 1% and 0% for AI, RA and LD respectively.

The proposal is using the context modelling of CABAC but replaces the arithmetic coding engine by a fixed length code.

It was noted that a loss in chroma occurs compared to CAVLC.

JCTVC-F284 Cross-check of Mitsubishi Electric's improved PIPE/V2F for low complexity entropy coding proposal JCTVC-F176 [J. Stegemann (Fraunhofer HHI)]

JCTVC-F268 Unified PIPE-Based Entropy Coding for HEVC [D. Marpe, H. Kirchhoffer, B. Bross, V. George, T. Nguyen, M. Preiß, M. Siekmann, J. Stegemann, T. Wiegand (Fraunhofer HHI)]

This contribution presents a unified entropy coding architecture for HEVC. The proposed method is based on probability interval partitioning entropy (PIPE) coding and supports two operation modes: a low-complexity (LC) mode as a substitute for CAVLC and a high-efficiency (HE) mode as a substitute for CABAC. Both entropy coding modes of this unified architecture share the same syntax and semantics, the same binarization schemes as well as the usage of the same set of PIPE/V2V codes. In addition, a common process for initialization of probability models based on 8-bit initialization values is included. The HE operation mode is conceptually similar to CABAC in the sense that it provides the same degree of adaptivity, both by exploiting higher order statistical dependencies through the use of the same set of conditional probabilities and by adapting the model probabilities to the actual source statistics using the same probability estimation process. In the LC operation mode, all conditional probabilities based on prior encoded/decoded symbols as well as all adaptive probability models are replaced by appropriately initialized, fixed model probabilities. In terms of coding efficiency, both operation modes of the proposed unified entropy coding method provide approximately the same R-D performance as their currently specified counterparts. The reported decoder run times in HE and LC configuration allegedly indicate some advantages in terms of decoding complexity relative to CABAC and CAVLC, respectively.

Could the same not be done using CABAC (i.e. scaling it down in complexity)?

Several experts opined that in general, the idea of having a complexity-scalable entropy coder is interesting.

Is PIPE better parallelizable? (As before, there was no initial consensus on this.)

Question: How was the multiplexing problem of PIPE solved? (The contribution does not really seem to be answering this.)

May investigate in an AHG or CE? Discussed further in Tuesday JCT-VC plenary. We may define a CE if there is a specific experiment to be performed. However, the buffering aspect is critical to address. An AHG can more broadly study the subject area.

Suggestion made (by T. Wiegand) to study the possibility of complexity-scalable entropy coder in AHG, and the performance of JCTVC-F176 and JCTVC-F268 compared to CAVLC in CE

Also relates to the question: Do we need two different entropy coders after all?

JCTVC-F762 Entropy Coders: How many do we need in HEVC? [K. McCann (Samsung/ZetaCast)] [late reg. 07-19, upload 07-19]

A new input JCTVC-F762 (Samsung) was presented: It was advocated that the best option would be to have only one entropy coder, second best would be one complexity-scalable coder, and third best would be two different coders. The two entropy coders have more converged since the days of TMuC (more approached each other in terms of complexity and performance). Could be investigated in AHG coordinated with CE.

One expert mentions that the question of one or two entropy coders and the specific technology proposed here are two different issues.

CE would have the main purpose to collect data for such an assessment, not necessarily target adoption or removal of technology by the next meeting.

The question how to assess complexity/throughput (incl. multiplexing in PIPE) is not really resolved.

JCTVC-F180 cross-check of (JCTVC-F268) [K. Sugimoto, S. Sekiguchi (Mitsubishi)] [late upload 07-12]

6.14 Transform coefficient coding

JCTVC-F077 Transform skip mode [M. Mrak, A. Gabriellini, N. Sprljan, D. Flynn (BBC)]

This contribution addresses transformation of residuals, where row and/or column transforms can be skipped. Encoder determines a selection of transforms / skipped transforms, i.e. so-called Transform Skip Mode (TSM), for each block based on RDO search. The transform skip mode choice is signalled to the decoder where inverse transforms of rows/ columns are performed or skipped.

This method was implemented in HM3.2, for motion compensated blocks. Skipped transforms are replaced with scaling of input coefficients. The presented design relies on the block transform with 16-bit intermediate data representation [JCTVC-E243]. Underlying transform properties are asserted to allow for a simple design of the transform skip - HM3.2 quantization reportedly does not require any changes and the choice of scaling factor for a row/column where transform is skipped depend only on the block size.

Tests were performed without RQT for targeted blocks (inter coded). Compared to HM3.2 anchors the presented approach reportedly shows gains of 0.2% BD-rate averaged over all inter coded configurations. Since the proposed approach has been implemented without RQT, its performance has also been compared to HM3.2 with disabled RQT for inter coded blocks. In that case, the gain is reported as 1.0% BD-rate averaged over all inter coded configurations.

The performance of the new method reportedly introduces gains comparable to the RQT gains on inter coded blocks, while preserving non-recursive design.

How often is it used? For 4x4, almost 50% are coded with 1D or no transform, and the ratio goes down for larger transform block sizes.

The method mainly has gain in LD cases. For RA, there is no gain (for HE) or even loss (for LC) when RQT is on. Gains with RQT off look more interesting.

Several experts expressed the view that this is interesting.

Further study was recommended (AHG?); the encoding method is said to not yet be fully optimized.

JCTVC-F152 Cross-check of JCTVC-F077 Transform Skip Mode [T. Davies (Cisco)]

JCTVC-F581 Cross-check report for BBC's proposal on Transform skip mode (JCTVC-F077) by Motorola Mobility [K. Panusopone, X. Fang, V. Kung, L. Wang (Motorola Mobility)] [upload 07-14 after opening]

JCTVC-F287 Improvements on last nonzero position coding of 4x4 TU in CAVLC [J. Xu, A. Tabatabai (Sony)]

In this proposal, the coding of last nonzero coefficient for 4x4 TU in CAVLC is changed. In HM3.0, Chroma and Luma from Intra TU are mixed together as one of contexts for last nonzero coefficient of 4x4 in CAVLC. This proposal redefines the contexts to separate Luma and Chroma and then different VLC tables are used for Luma and Chroma. Experimental results reportedly show that the BD-rate savings for LC conditions were 0.1% for Y, 1.7% for U and 1.6% for V under Intra only configuration, 0.0% for Y, 1.4% for U and 1.3% for V under random access configuration, and 0.0% for Y, 0.8% for U and 0.9% for V under low delay configuration.

No interest expressed - no action.

JCTVC-F677 Cross-check for Sony's Proposal (JCTVC-F287) on Improvements on last nonzero position coding of 4x4 TU in CAVLC [Z. Zhou, S. Liu (MediaTek)] [late reg. 07-07, upload 07-07]

JCTVC-F124 Extended Mode-Dependent Coefficient Scanning [X. Zhao, X. Guo, M. Guo, S. Lei (MediaTek), S. Ma, W. Gao (PKU)]

In this contribution, an extended mode-dependent coefficient scanning (MDCS) method is proposed. Based on the MDCS in HM 3.0, this proposal makes two extensions. First, a modified MDCS is applied to larger block sizes including 16×16 and 32×32, in which the horizontal scanning order and vertical scanning order are different from the current ones. Second, MDCS is also applied for scanning of the absolute values in CABAC, which only uses zigzag scanning now. It is reported that, with both modifications, average 0.3% and 0.7% BD-rate reductions are reported for AI-HE and AI-LC configurations, respectively. It is also reported that the running time of the proposed method is almost the same with that of anchor.

Is the more random scan sequence a problem for software and hardware?

Seems to give some gain -> CE?

JCTVC-F646 Cross-verification of MediaTek's JCTVC-F124 on Extended Mode-Dependent Coefficient Scanning [J. Chen, V. Seregin (Samsung)] [late reg. 07-05, upload 07-07]

JCTVC-F186 Predicted neighbour for context selection of significant_coeff_flag for parallel processing [C. Rosewarne, M. Maeda (Canon)]

This contribution proposes a method for context selection, modified from the approach presented in contribution JCTVC-E330 by TI and studied in CE11. Similarly to JCTVC-E330, the context selection is modified along the top edge and the left edge of the Transform Unit, where the zigzag scan changes direction. In these locations, a value for a neighbouring significant coefficient flag, immediately preceding a current significant coefficient flag along the scan pattern, is predicted. This modification was implemented in HM-3.0 and reportedly resulted in degradations of 0.1% for IA_HE, 0.0% for RA_HE and 0.0% for LD_HE configurations in the Luma channel. Use of the predicted value instead of the neighbouring value reportedly enables context index determination to occur earlier in the bitstream parsing process.

The contributor confirmed that there was no need to present this contribution, as it became obsolete due to adoption of diagonal scan.

JCTVC-F668 Cross-check results of Canon's Predicted neighbour for context selection of significant_coeff_flag for parallel processing (JCTVC-F186) [V. Sze (TI)] [late reg. 07-06, upload 07-06]

JCTVC-F134 CE11.A: Cross checking of JCTVC-C227 and proposal on semantic, syntax, and implementation [C. Auyeung (Sony)]

This proposal clarifies the text and software implementation of JCTVC-F129 in that the zigzag scan is not removed entirely in the CAVLC case, as it will still be needed for CAVLC.

Suggested action: JCTVC-F129 needs to be clarified/corrected to avoid removing the zigzag, which would be a breaking bug for CAVLC. Agreed.

JCTVC-F671 Cross-check of Sony's proposal on semantic, syntax, and implementation (JCTVC-F134) [V. Sze (TI)] [late reg. 07-06, upload 07-06]

JCTVC-F236 IDCT pruning and scan dependent transform order [M. Budagavi, V. Sze (TI)]

High frequency region of large transforms is typically zero due to quantization and energy compaction properties of transform. This contribution presents non-zero low frequency sub-block statistics of large transform blocks in anchor bitstreams of HM-3.0. It is reported that 88%-91% of the large transform blocks do not need to undergo a full 2D inverse transform in HM-3.0 bitstreams. The non-zero sub-block information can be used to carry out IDCT pruning where in the IDCT computations that have zero input and zero output can be eliminated. This contribution asserts that IDCT pruning is a useful technique that can be used to reduce SIMD computational complexity based on source statistics in decoder. It is also asserted to result in corresponding power savings in hardware transform engines. Note that IDCT pruning as defined in this contribution is a lossless process (i.e. non-normative). This contribution also presents a normative tool: scan dependent transform order that defines row-column transform order depending on scan type. This tool is asserted to reduce transform complexity and increase amount of pruning that can be used. This contribution recommends that the pruning behavior of large transforms and scan dependent transform tool be considered in design of HEVC transforms.

The transform order would need to be normative.

Would only be relevant for intra blocks with hor/vert scan, which seems to be a very specific case. What would be the actual saving in terms of operations, e.g. for case of butterfly implementation?

A. Fuldseth reports that in software row/column order was found to perform better, but not interpreted so far (HM uses reverse sequence).

Further study.

JCTVC-F501 Mode dependent coefficient scan for inter blocks [J. Song, M. Yang, H. Yang, H. Yu, X. Zheng (Huawei)]

In this contribution, a mode dependent coefficient scan method is proposed for inter-coded blocks. A scan pattern out of the three scans in HM3.0, i.e., zigzag, horizontal, and vertical scans, is selected based on the PU partition mode. The averaged RD performances of the proposed method under RA_HE, RA_LC, LB_HE, LB_LC, LP_HE, and LP_LC conditions are reportedly 0.0%, 0.0%, −0.1%, −0.5%, −0.2% and −0.4%, respectively.

Gives gain mainly for LD, and particularly CAVLC

In HE it may be conflicting with context modelling?

There may be relation with the Nx2N transforms proposed elsewhere (CE2)

Further study for LC only (CE5 on CAVLC)

JCTVC-F227 Cross-check report for Huawei's proposal JCTVC-F501 [Y. Shibahara, T. Nishi (Panasonic)]

JCTVC-F375 Binarization modification for last position coding [V. Seregin, I.-K Kim (Samsung)]

In this document modification of binarization, consisting in coupling unary and fixed binary codes, for last position coding is investigated and tested. And for fixed binary part CABAC compression with equal probabilities (bypass) mode is suggested for complexity reduction. Also, number of context models of last position is reduced from 52 to 38. Experimental results reportedly show 7% bins bypass coded with 0.1%, 0.0% and 0.0% BD-rate gain in high efficiency intra-only, random access and low-delay test conditions respectively.

In total, the throughput is estimated to be increased by approx. 2.5%, number of bypass bins by approx. 0.5-1% (assuming 10% last coeff. rate). This mainly applies at high QP.

Further discussion in BoG on CABAC - must be seen in combination with other simplification proposals.

JCTVC-F538 Cross-check of Samsung’s binarization modification for last position coding (JCTVC-F375) [J. Sole (Qualcomm)]

Cross-checkers in principle support this, confirming that the implementation is correct and straightforward; however it was suggested to study the relationship with other CABAC simplifications, and BoG activity was requested for this.

JCTVC-F552 Parallel processing of residual data in HE [J. Sole, R. Joshi, M. Karczewicz (Qualcomm)]

This document presents two techniques to facilitate the parallelization of the residual coding in HE. The first one extends the concept of parallel context processing of coefficient level to include the significance map coding pass. This provides localized data access for all the coding passes of the residual. The BD-rate of this technique for AI-HE, RA-HE and LB-HE configuration is reported as -0.25%, -0.21%, and -0.05%, respectively. A delayed state update in CABAC is also proposed to help parallelism. The BD-rate of both techniques combined for AI-HE, RA-HE and LB-HE configuration is reported as -0.15%, -0.13%, and 0.00%, respectively.

Context model is updated with a delay of one bin.

The gain in compression is due to usage of backward scanning.

The real amount of benefit for hardware implementation needs more thorough investigation.

The current approach would support better pipelining or at most 2x parallelism; for more parallelization, it would be necessary to introduce larger delay.

For interleaving: Tradeoff with additional memory.

In general, interest is expressed; further study – second part (delayed update) in CE.

JCTVC-F654 Cross verification for Qualcomm's proposal JCTVC-F552 on Parallel Processing of Residual Data in HE [Hisao Sasai, Takahiro Nishi (Panasonic)] [late reg. 07-05, upload 07-12]

JCTVC-F569 Adaptive Scan for Large Blocks for HEVC [Y. Yu, K. Panusopone, J. Lou, L. Wang (Motorola Mobility)]

This contribution proposes an adaptive scan for big block size for intra coding to the new video coding standard, HEVC (High Efficiency Video Coding). Reportedly without increasing complexity at both encoder and decoder, average coding gains of 0.3% and 0.2% are asserted for low complexity and high efficiency intra coding cases, respectively.

Horizontal and vertical scans applied for quarters of large transform blocks.

2 additional scan patterns for 16 and 32 cases each

Most gain comes in class E for both HE and LC, plus A for LC

Scan direction derived from prediction direction

Further study.

JCTVC-F614 Cross-check report for Motorola Mobility's JCTVC-F569 by HKUST [F. Zou, O. C. Au (HKUST)]

JCTVC-F598 Adaptive significance map coding for large transform [J. Min, Y. Piao, J. Chen (Samsung)] [first version rejected, second version also unacceptable, third version late upload 07-16]

This contribution proposes an adaptive context type selection method for significance map coding. The proposed method selects the best context model type according to coefficient distributions. The selected context model type is signaled to decoder for each transform unit when the coefficient distribution satisfied a given condition. The method reportedly provides 0.3% gain overall and 0.6% for class A in HE, All Intra configuration.

Would need much more improvement (less encoder complexity, more gain particularly for inter) to become interesting.

JCTVC-F709 Crosscheck of Samsung's proposal JCTVC-F598 by Huawei [Q. Shen, H. Yang, H. Yu (Huawei)] [late reg. 07-11, upload 07-13]

6.15 Intra prediction and mode coding

6.15.1 Intra prediction

JCTVC-F104 On Intra Smoothing [Y. Jeon, B. Jeon (LGE)]

The intra smoothing of the HM filters the 4N-1 neighbouring samples to increase prediction accuracy where N is the size of PU. It is observed that at most half (2N-1 or 2N+1) of samples out of the filtered 4N-1 neighbouring samples are used for prediction. Therefore the other half (2N or 2N-2) of the samples are filtered and never used for prediction. The filtering for the unused samples is obviously a useless waste of complexity and this waste always happens in the current MDIS (Mode Dependent Intra Smoothing). In this contribution, a look-up table is introduced to filter only the samples which could be actually used for prediction. By the proposed look-up table, the waste can be minimized and the number of filtering operation for intra smoothing is reduced by half compared to the current MDIS of HM.

This is just a matter of implementation. There is no need to reflect this in the text. Speedup of software is not observed from the reported results.

JCTVC-F087 Cross verification of LGE's proposal JCTVC-F104 on intra smoothing [M. Zhou (TI)]

JCTVC-F095 Chroma intra prediction based on residual luma samples [K. Kawamura, T. Yoshino, H. Kato, S. Naito (KDDI)]

HM3.0 employs LM mode which is reported in JCTVC-E266 as chroma intra prediction. The LM mode predicts chroma samples based on reconstructed luma with a linear model. The parameter of the linear model is derived from adjacent blocks with a linear least square solution. However, only LM mode is allegedly insufficient to predict texture where the correlation among adjacent blocks is low. Inter-channel prediction of chroma intra residuals is proposed. Chroma intra direction is derived from luma intra direction. The parameter of the inter-channel correlation model is derived and coded on the encoder side. Compared to the HM3.0, the average BD-bitrate gain is 0.1%, 3.4%, 3.9% for intra configuration and the average BD-bitrate gain is 0.0%, 4.6%, 4.6% for random access configuration, respectively for Y, U and V components.

Nebuta and Steam Locomotive have significantly higher gain – explanation could be that these sequences are actually interpolated from sub-sampled RGBG Bayer pattern?

Significant complexity increase (6-7%) at encoder – is this justified by the effective overall approx. 0.1-0.2% rate reduction?

Could parameters be derived at decoder? In principle yes, but this would shift the complexity to decoder.

Further study – significant reduction of complexity would be necessary to consider this.

JCTVC-F097 Cross-check for KDDI's proposal on intra coding (JCTVC-F095) [M. Matsumura, S. Matsuo, Y. Bandoh, S. Takamura, H. Jozawa (NTT)]

JCTVC-F121 Intra Chroma LM Mode with Reduced Line Buffer [M. Guo, X. Guo, Y.-W. Huang, S. Lei (MediaTek)]

In HM3.0, when a chroma prediction unit (PU) is coded with intra LM mode, two lines of reconstructed pixels above the corresponding luma PU are used to derive the correlation parameters between the luma component and chroma component. When the current luma PU is located beneath the upper boundary of the largest coding unit (LCU), two bottom lines of reconstructed luma pixels in the upper LCU are required. Therefore, two line buffers are needed in hardware implementation. This contribution proposes to use only one line from the upper LCU in LM mode for PUs located beneath the upper LCU boundary, and keep the current method for PUs in other positions. Using this method, no additional line buffer is needed for intra LM mode since one line buffer is also needed for luma intra prediction. It is reported that there is almost no change of BD-rate and running time with this method.

What would be the chip size decrease? Estimated at 3-4%

Would it be possible to share the line buffer with the de-blocking filter? Probably not, HW implementations often use different processing elements.

JCTVC-F641 Cross-verification of MediaTek's JCTVC-F121 on Intra Chroma LM Mode with Reduced Line Buffer [J. Chen, V. Seregin] [late reg. 07-05, upload 07-05]

JCTVC-F233 Luma-based chroma intra prediction simplification [M. Budagavi, A. Osamoto (TI)]

This contribution proposes three modifications to luma-based chroma intra prediction: (1) reduction in number of operations for calculation of alpha and beta parameters, (2) reduction in number of bits used for alpha, and (3) reduction of number of luma line buffers. In the first modification, reference luma and chroma samples are subsampled before being used in calculation of alpha and beta. As a result, it is reported that the number of multiplications for 16x16 blocks goes down from 64 to 16, and the number of multiplications for 8x8 blocks goes down from 32 to 16. The number of multiplications for 4x4 blocks remains the same. BD-Rate results for this simplification are reported to be: AI-HE: Y: 0.0, U: 0.1, V: −0.1, and AI-LC: Y: 0.0, U: 0.0, V: −0.1. The second modification reduces the number of bits used for alpha from 16 to 7 bits. BD-Rate results for this simplification are reported to be: AI-HE: Y: 0.0, U: 0.0, V: 0.0, and AI-LC: Y: 0.0, U: 0.0, V: 0.0. The third modification reduces the number of luma line buffers at LCU boundary from 2 lines to 1 line. BD-Rate results for this simplification are reported to be: AI-HE: Y: 0.0, U: 0.2, V: 0.1, and AI-LC: Y: 0.0, U: 0.2, V: 0.1.

Line buffer reduction same as JCTVC-F121, same loss of 0.2% in U and 0.1% in V.

Reduction of complexity by subsampling with marginal change.

Alpha reduction to 7 bits (from 16) without loss.

JCTVC-F639 Cross-verification of TI's JCTVC-F233 on Luma-based chroma intra prediction simplification [J. Chen, V. Seregin] [late reg. 07-05, upload 07-07]

JCTVC-F494 Complexity reduction of chroma intra LM prediction mode [J. Chen, V. Seregin, T. Lee, E. Alshina (Samsung)]

Chroma predicted by reconstructed luma signal with Linear Model (named as LM mode) is used as one chroma intra prediction method in HEVC test model. In this contribution, three improvements were done to reduce the complexity of LM mode.

- Use one line of above neighboring luma reference pixels to calculate linear model parameter
- Remove 1 bit right shift operation when downsampling luma signal to match size of chroma signal
- Remove clip operation upon final prediction signal

Item 1 (Using one line of above neighboring pixels) shows 0.0%, 0.4%, 0.3% BD-rate loss, respectively in Y, Cb and Cr components while it reduces the above reference pixels from 2 to 1 line. Item 2 (removing one bit right shift) shows 0.0%, −0.4%, −0.3% BD-rate gain in HE AI and no performance change in LC AI. Item 3 (clip operation removal) does not cause any performance change. One bug of table access was also fixed with 0.0%, −0.1%, −0.1% bit rate gain. The whole package shows 0.0%, 0.0%, −0.1% BD-rate loss at HE AI, 0.0%, 0.3%, 0.2% BD-rate loss at LC AI.

Loss of using one line is higher than in other two proposals, as the subsampling is applied here is not only applied at LCU boundary, but at each CU boundary.

JCTVC-F250 Crosscheck results for Samsung JCTVC-F494 (Complexity reduction of chroma intra LM prediction mode) [M. Budagavi (TI)] [late upload 07-10]

JCTVC-F431 Complexity Reduction of Chroma Intra Prediction by Reconstructed Luma Samples [K. Sato (Sony)]

At the 5th JCT-VC meeting, chroma intra prediction by reconstructed luma samples has been adopted. It contributes to gain in chroma by as much as much as −7.8% for U and −6.1% for V in AI_HE and AI_LC cases. However there are two concerns on implementation of this tool: calculation of α&β and storage for reconstructed luma pixels.

In this document complexity reduction of chroma intra prediction by reconstructed luma samples on these 2 aspects is studied.

Downsampling: Similar to TI

Use 8 bit luma samples in alpha and beta calc.

Still use 2 line buffers, but reduce to 8 bit

Breakout group (J. Chen) to find out commonalities and if possible suggest a combined solution. See notes for JCTVC-F760.

JCTVC-F717 Cross-verification of Sony's proposal JCTVC-F431 by Panasonic [Chong Soon Lim, Sue Mon Thet Naing (Panasonic)] [late reg. 07-11, upload 07-12]

JCTVC-F122 Direction based Angular Intra Prediction [M. Guo, X. Zhao, X. Guo, S. Lei (MediaTek)]

In HM3.0, the intra prediction generates the predictor by directly using the neighbouring reference samples in one end of a certain angle. This contribution proposes a direction based angular intra prediction, which includes two techniques: the gradient based prediction and bi-directional prediction. In the first one, the predictor is compensated with the gradient along the direction, which is calculated with the neighboring reference samples. In the second one, the proposed method generates the predictor with a weighted sum of two reference samples at both ends of the direction. It is reported that the proposed method can achieve an average bit-rate reduction of 0.7% for both high efficiency all-intra (HE-AI) and low complexity all-intra (LC-AI). The running time is reported to be similar to HM3.0.

Two elements: gradient of boundary used to align the prediction; weighted bi-prediction (weight based on distance from boundary).

JCTVC-F517 Cross verification of MediaTek's direction based angular intra prediction (JCTVC-F122) by Intel [Yi-jen Chiu, Lidong Xu, Wenhao Zhang, Yu Han]

JCTVC-F172 An improved intra vertical and horizontal prediction [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)]

In this contribution, a modification to intra vertical and horizontal prediction is proposed. In the proposed scheme, the difference between two reference samples in left or above prediction direction is scaled and added to corresponding prediction sample in intra vertical and horizontal prediction modes. The proposed scheme is implemented onto HM-3.0 software, and simulations are conducted using common test configurations to evaluate the performance of the proposed scheme. It is reportedly confirmed that the proposed scheme achieves 0.3% BD-rate reduction on average for high efficiency and low complexity intra configuration respectively.

The idea is similar to JCTVC-F122: Using the gradient parallel to the boundary to adjust the prediction, but here it is used only for horizontal and vertical prediction modes.

JCTVC-F146 Cross-verification result of JCTVC-F172 proposed by Mitsubishi [K. Kazui, S. Shimada, J. Koyama, A. Nakagawa (Fujitsu)]

JCTVC-F252 Block-size and pixel position independent boundary smoothing for non-directional Intra prediction [E. Alshina, A. Alshin (Samsung)]

This proposal introduces test results if boundary smoothing which is applied in HM3.0 for non-directional Intra prediction was changed to use the same smoothing algorithm for all PU sizes and all pixels regardless of the position in a block. No performance drop was reported in all-intra testing for both Luma and Chroma components. Additionally, extension of boundary smoothing for 32x32 Intra non-directional predictions was tested. No performance change was reported for the Luma component and 0.1% gain for Chroma component was reportedly observed in this test.

Was subjective quality tested? No, but it is believed that it would not change.

The gain comes mainly due to extension to 32x32 and from class A and B.

Decision: Adopt (including 32x32)

JCTVC-F740 Crosscheck results for Samsung's JCTVC-F252 (Block-size and pixel position independent boundary smoothing for non-directional Intra prediction) [J. Lainema, K. Ugur (Nokia)] [late reg. 07-15, upload 07-15]

JCTVC-F249 Crosscheck results for Samsung JCTVC-F252 (Block-size and pixel position independent boundary smoothing for non-directional Intra prediction) [M. Budagavi (TI)] [late upload 07-10]

JCTVC-F358 Mode dependent filtering for intra predicted samples [J. Lee, S.-C. Lim, H. Y. Kim, J. S. Choi (ETRI)]

This contribution presents Mode-Dependent Filtering (MDF) for intra predicted samples. The proposed method applies mode-dependent filters on DC, planar, and angular predicted samples to improve the prediction continuity in the block boundary region. It is reported that the average BD-rate gain of the proposed method is 0.4% and 0.3% in Intra, High-Efficiency (HE) and Low-Complexity (LC), respectively.

In terms of how it is used in DC prediction, this is identical as JCTVC-F252 up to 16x16. The mode-dependent approach is new and gives some interesting additional gain. This however may not be orthogonal with the gains by the gradient-based approaches. It was asked whether there was a relationship with MDIS for which new better-performing LUT was decided.

JCTVC-F649 cross-check of (JCTVC-F358) [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)] [late reg. 07-05, upload 07-11]

JCTVC-F456 Directional intra prediction smoothing [J. Lainema, K. Ugur (Nokia)]

HM3 currently smooths the DC prediction signal by applying 2-tap and 3-tap filters to the border samples of the intra prediction block. This contribution presents a Directional Intra Prediction Smoothing (DIPS) technique with similar intent to be applied to the directionally predicted intra blocks. A directional 2-tap filter is applied to either top row or left column of the intra prediction block depending on the directionality of the intra sample prediction. The coding results reported in this contribution indicate −0.4% and −0.4% BD bitrate impact in Intra HE and Intra LC configurations, respectively. The contribution also reports performance of DIPS when combined with JCTVC-F172 (Improved intra horizontal and vertical prediction by Mitsubishi). In that case BD bitrate impact of −0.6% and −0.6% for Intra HE and Intra LC configurations are reported, respectively.

Similar to JCTVC-F358 in terms of diagonal MD filters.

Gains were consistent over all classes.

Conclusion: CE on 122, 172,358,456

JCTVC-F711 Cross-check of Nokia's proposal (JCTVC-F456) on directional intra prediction smoothing [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi) [late reg. 07-11, upload 07-12]

JCTVC-F173 An improvement to chroma intra prediction from luma [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)]

In this contribution, a modified downsampling method for chroma intra prediction from reconstructed luma samples (JCTVC-E266) is proposed. In this proposal, the down-sampling filter for luma samples used for chroma intra prediction is modified to constrain aliasing effect for horizontal direction. The proposed filter was tested on top of HM-3.0 under common test configurations [2]. It is reportedly confirmed that the average BD-rate gain with the proposed filter is 0.1%, 0.5% and 0.3% for intra high efficiency configuration, 0.1%, 0.8% and 0.6% for intra low complexity configuration, respectively for Y, U and V components. It is also reported that the increase of encoding/decoding time was negligible.

A simplified method is also proposed, and the simulation results show that the average BD-rate gain with the simplified method is 0.1%, 0.6% and 0.4% for intra high efficiency configuration, 0.1%, 0.9% and 0.7% for intra low complexity configuration, respectively for Y, U and V components without any encoding/decoding time increase.

Complexity is increased, versus relatively small gain.

JCTVC-F647 Cross-verification of Mitsubishi's JCTVC-F173 on chroma intra prediction from luma improvement [J. Chen, V. Seregin (Samsung)] [late reg. 07-05, upload 07-05]

JCTVC-F502 Cross-channel techniques to improve intra chroma prediction [Y.-J. Chiu, Y. Han, L. Xu, W. Zhang, H. Jiang (Intel)]

This contribution reports two techniques to improve intra chroma prediction: a 2-dimensional 3x2 filter for LM intra chroma prediction mode, and a new intra chroma prediction mode based on the technique of local adaptive prediction selection (LAPS) process to produce the intra chroma prediction sample from the comparison of the reconstructed luma sample of target location to the local reconstructed luma samples in the neighborhood. The tests of the 2-D filter for LM intra chroma prediction have reported that an BD-bit rate reduction of U & V components by 0.5% & 0.3% for AI_HE case (up to 2.0% & 1.7% for clip PartyScene) with almost no change in encoding time and decoding time. The tests of LAPS mode have reported that an BD-bit rate reduction of U & V components by 0.3% & 0.3% for AI_HE case (up to 0.9% & 0.9% for clip BasketballPass) with 3% increase in encoding time and almost no change in decoding time. The tests of the combined two techniques have reported that an BD-bit rate reduction of U & V components by 0.7% & 0.6% for AI_HE case (up to 4.0% & 2.9% for clip BasketballDrill) with 3% increase in encoding time and almost no change in decoding time.

Downsampling filter approach same as JCTVC-F173.

LAPS is a kind of template prediction. A local search on 5 positions is performed

Complexity is increased, versus relatively small gain.

Conclusion on JCTVC-F173 and JCTVC-F502: Currently, we try to reduce complexity of LM mode, these proposals would increase it again, and it is questionable whether this is desirable versus the relatively small gain.

One expert commented that this could be more relevant in the context of 4:4:4 coding

JCTVC-F706 Crosscheck for Intel's Proposal JCTVC-F502 [M. Guo, X. Guo (MediaTek)] [late reg. 07-11, upload 07-14 after opening]

JCTVC-F505 A chroma coding scheme for SDIP mode [J. Song, H. Yang, M. Yang, H. Yu (Huawei), C. Lai (Hisilicon), J. Xu (Microsoft)]

In this contribution, a chroma coding scheme for SDIP (Short Distance Intra Prediction) mode is proposed. In the proposed scheme a new chroma prediction mode called SDIP direct mode is introduced. When the SDIP direct mode is selected, chroma component shares the same PU partition and prediction modes of luma component. Therefore no overhead is transmitted to signal the chroma PU mode and the prediction mode of each PU. The proposed scheme is reported to provide U/V component BD-rate of −0.9%/−0.9% and −1.5%/−1.3% under AI_HE and AI_LC conditions, while the performance of Y component is not affected.

To be further investigated in SDIP CE (CE5).

JCTVC-F629 Cross-verification of Huawei's JCTVC-F505 on chroma coding scheme for SDIP mode [J. Chen (Samsung)] [late reg. 07-04, upload 07-04]

JCTVC-F479 Chroma DC offset for intra coding [T. Matsunobu, H. Sasai, T. Nishi (Panasonic)]

In this contribution, a chroma compensation scheme using DC offset signalling for intra coding units is proposed. The offset value is determined based on the difference between original samples and reconstructed samples of chroma component, and then signaled at the LCU or CU level to compensate the reconstructed chroma samples. It is reported that less color bleeding artifact was observed by the proposed scheme comparing with the HM3.0 anchors. Average BD-rate difference by the proposed scheme relative to HM3.0 Intra HE anchors was reported as −0.1% for Y, 2.4% for U and 2.8% for V component by the LCU level signalling, and −4.1% for Y, 11.0% for U and 12.4% for V component by the CU level signalling.

CU level signalling apparently increases the rate a lot and gives the desirable improvement.

LCU level signalling would only be marginal rate increase (0.1%) but does not yet give desirable improvement.

Question: Should this be seen in the context of quantization matrix?

One expert suggests that this could potentially be done as post processing (SEI message)?

Further study.

JCTVC-F686 Cross-check report on JCTVC-F479: Chroma DC offset for intra coding [K. Chono, H. Aoki (NEC)] [late reg. 07-08, upload 07-11]

JCTVC-F178 Removing availability checking for Intra DC prediction filtering [A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)]

In this contribution, it is proposed to remove availability checking of top and left neighbouring samples for the intra DC prediction filtering adopted into HM3 at the last JCT-VC meeting. The proposed modification has been tested on top of HM-3.0 under common test configurations. It is reportedly confirmed that the proposed modification does not increase the bitrate as well as the encoding and decoding time.

Decision: Adopt this simplification provided that F. Bossen does not see any software complication due to this – later confirmed OK.

JCTVC-F184 Evaluation of PU-level vs. TU-level intra prediction [A. Gabriellini, M. Mrak (BBC)]

This contribution reports on the evaluation of intra prediction carried out at the prediction unit (PU) vs. default HM setting where it is carried out at the transform unit (TU) level. In order to show what performance penalty, if any, is associated with restricting intra prediction to the PU-level, support for PU-level intra prediction has been added to the HM for all intra coding modes (directional prediction, planar, chroma from luma prediction). PU level intra prediction allows a decoder to compute a prediction signals for all TUs belonging to a PU at once. On the encoder side, all TU configurations can be evaluated at once, in parallel. The tests have been performed for intra configurations only. It is shown that on average there is a compression performance loss of 0.2% and 0.4% BD-rate for the luma component for intra high efficiency and low complexity test configurations, respectively. For chrominance components, there is no difference for the high efficiency configuration, while for the low-complexity configuration the gain is 0.4%. The running times are close to standard HM times, with the only noticeable difference a reduction of average decoding times for intra low complexity (92% of reference).

Prediction is becoming worse for the bottom-right part of a PU that is split into several PUs.

Was visual quality checked? No, but the proponent thinks that in case where this would be a problem a different mode would be selected.

For the bottom-right TUs, the statistical properties of the residual signal could be different now; in combination with the mode-dependent transform this may also have implications.

It would be interesting to see whether quality is the same at the same QP.

Why is the software decoding time decreased, whereas the approach is only beneficial for parallel processing? May depend on caching/sequence of function calls.

Some experts expressed the opinion that this is interesting and would simplify the design (however at cost of increased rate) – decoupling prediction and transform.

Further study recommended.

JCTVC-F659 Cross Check of BBC's proposal JCTVC-F184 on PU-level Intra Prediction Jane Zhao, Andrew Segall [late reg. 07-06, upload 07-06]

JCTVC-F330 Cross check report of BBC's proposal of JCTVC-F184 from Toshiba [A. Tanizawa (Toshiba)]

JCTVC-F253 Simplified Bidirectional Intra Prediction [T. Shiodera, A. Tanizawa, T. Chujoh, T. Yamakage (Toshiba)]

This contribution presents the experimental results of simplified Bidirectional Intra Prediction (BIP) on intra prediction improvement. BIP was firstly included in the CfP submission of JCTVC-A117 and the improved BIP was proposed in the contribution of JCTVC-D108 at the JCT-VC Daegu meeting.

In this document, two simplifications of BIP to reduce the computational complexity are presented and the experimental results in HM software version 3.0 under HM common test conditions defined in JCTVC-E700 are reported. For I slice only coding structure, the average BD-rate gain of simplified BIP is 0.3% on low complexity condition and 0.1% on high efficiency condition without significant increase of the encoding time and the decoding time.

Small gain with increased complexity – no action.

JCTVC-F438 Cross-check of Toshiba's Intra bi-prediction (JCTVC-F253) by Institute for Infocomm Research [Y. H. Tan, C. Yeo (I2R)]

JCTVC-F414 Reference sample padding harmonization for intra DC mode [V. Wahadaniah, C. S. Lim (Panasonic), K. Chono, H. Aoki (NEC)]

This joint contribution describes a possible issue when intra DC prediction is performed using padded reference samples. Non-uniform averaging is performed when unavailable reference samples are padded using available reference samples. A revised reference sample padding scheme for intra DC mode is subsequently presented. The revised scheme is reported to give average luma 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 times are not affected by the revised scheme. It is suggested by the authors that JCT-VC consider the trade-off between design simplicity and conceptual accuracy of intra DC prediction and subsequently decide whether it is desired to use a revised padding scheme for intra DC prediction.

F. Bossen commented that (at least in terms of software) the padding process could be highly improved. The problem should be tackled more generally rather than just for the case of DC prediction.

It was suggested to study this problem more generally, and agreed to create an AHG on study of padding process (chaired by V. Wahadaniah).

JCTVC-F477 Unification of the Availability Checking method for Intra prediction [C. Kim, H. Yang (Samsung)]

In this contribution, the unification of the availability checking methods is presented. The different available checking methods are used whether the CIP (Constrained Intra Prediction) on or not in the current HM. This contribution unifies these different checking methods. The result is shown that this contribution keeps the same checking method without performance degradation.

Problems:

(1) Even though there are available sample in the near of boundary which is less than the current PU size, these samples are marked as unavailable them in the current HM.

(2) Different availability checking method gives different result of intra prediction, even if the same intra-coding conditions.

Discussion:

(1) is a known bug. Currently, there is mismatch between software and text. The solution suggested here is believed to be aligned the text and fix the bug. Decision: Adopt software fix of JCTVC-F477.

F. Bossen commented that fine-granularity slices may cause conflicts with other tools that have so far only been tested with HM3.0. Therefore, adopted tools should first be checked again with HM3.3.

JCTVC-F653 Cross-check report on Unification of Availability Checking Method for Intra Prediction (JCTVC-F477) [K. Chono, H. Aoki (NEC)] [late reg. 07-05, upload 07-06]

JCTVC-F483 Planar intra prediction improvement [J. Chen, T. Lee (Samsung)]

In this contribution, it is proposed to apply the existing intra smoothing filter to planar reference signal in case of 16x16 or 32x32 prediction units. And when the prediction signal is derived, the right-column is generated by replication of the right-top pixel and the bottom-row is generated by replication of the left-bottom pixel outside the current unit. For intra-only coding structure, the experimental results reportedly show −0.1% gain in high efficiency profile and −0.2% gain in low complexity profile with both modifications.

Usage of MDIS for planar mode already adopted per CE6.

Decision: Adopt the right-top pixel and the left-bottom pixel to be used for the planar mode.

JCTVC-F211 Cross-check of planar intra prediction improvement (JCTVC-F483) [J. Xu (Microsoft)] [late upload 07-12]

JCTVC-F465 Item 6 (Planar prediction for chroma) of Experiments on tools in Working Daft (WD) and HEVC Test Mode (HM-3.0) [I.-K. Kim, E. Alshina, J. Chen, T. Lee, W.-J. Han, J. H. Park (Samsung), V. Sze, M. Budagavi, M. Zhou (TI)]

Item 6: Planar prediction for chroma.

Solved by other actions (JCTVC-F765).

JCTVC-F528 Simplified Bilateral Intra Smoothing Filter [G. Li, N. Ling (Santa Clara University), L. Liu, J. Zheng, P. Zhang (Hisilicon)]

This proposal provides a method to improve the performance of Intra smoothing filtering in High Efficiency Video Coding (HEVC). The proposed technology employs a simplified bilateral filter to adaptively adjust filter coefficients to preserve edges while smoothing.

Gain is 0.2% when MDIS off, with runtime increase 3-5%.

When MDIS on, the gain is practically zero.

No action.

JCTVC-F708 Crosscheck of JCTVC-F528 Simplified Bilateral Intra Smoothing Filter [D. Hoang (Zenverge)] [late reg. 07-11, upload 07-14 after opening]

JCTVC-F343 Evaluation of SDIP [J. Xu, A. Tabatabai, T. Suzuki (Sony)]

This document provides an investigation summary, both in terms of coding performance and the HW complexity, for support of 1x16 (16x1) and 8x2 (2x8) partitions in SDIP. It is reported that removing 1x16 and 16x1 TU partitions results in significant HW complexity reduction with negligible coding performance loss, i.e., 0.1% for AI_HE and 0.0% for AI_LC. Partial results for coding performance as well as HW complexity are also provided for 8x2 (2x8) partitions.

The presentation deck also includes results of disabling 2x8 block size: Enc. Time decreased 10%, but loss around 0.7%.

JCTVC-F555 Cross-Check Report of Evaluation of SDIP (JCTVC-E343) [A. Saxena, F. Fernandes (Samsung)] [late upload 07-12]

JCTVC-F584 Modification to DC prediction in SDIP [Y. Lin, C. Lai (HiSilicon)]

A change on DC prediction of SDIP PU is proposed with only shifting to avoid division operation. A minor coding loss can be found according to the reported test results.

No significant change relative to SDIP branch.

It was recommended to use this in further investigations on SDIP.

Note: JCTVC-F556 is also about SDIP de-blocking. This was also presented here:

This contribution contains proposals on the harmonization of SDIP, in the context of CE6.b, with deblocking, mode-dependent intra smoothing (MDIS) and high efficiency residual coding. In addition, results are included for mode-dependent coefficient scanning (MDCS) and DC prediction filtering.

Two new filters are introduced, additional rules e.g. for the 16x4 partitions.

JCTVC-F632 Cross-check of Huawei's proposal (JCTVC-F584): Modification to DC prediction in SDIP [J. Jung, J. Le Tanou (Orange Labs)] [late reg. 07-04, upload 07-04]

JCTVC-F586 Adaptive sampling for Intra coding [J.H. Kim, J. Lou, X. Fang, L. Wang (Motorola Mobility Inc.)]

This contribution presents an adaptive sampling technique exploiting spatial correlation in CUs at a specified depth. Different sampling directions are defined and tested to select a sampling mode in CU at the specified depth. Multiple sampling modes are proposed to reflect different spatial correlation in a picture. Experimental results based on HM2.0 for Intra prediction reportedly show average 1.4% and 2.5% of bit rate savings in Luma for class B and class E test sequences.

The contribution doc seems rather vague about the technique actually used.

Question: What is the complexity? No definite answer.

DCT used for down/up-sampling.

It was remarked by another participant that JCTVC-F618 is similar.

Further study recommended.

JCTVC-F743 A Cross-check report for JCTVC-F586 proposal on adaptive sampling for intra coding [Kiran Misra, Andrew Segall] [late reg. 07-16, upload 07-17]

JCTVC-F617 Intra prediction based on repetitive pixel replenishment [S. Mochizuki, R. Hashimoto, K. Iwata (Renesas)]

This contribution presents evaluation results of intra prediction by template matching based on repetitive pixel replenishment (Intra-RPR). The simulation results reportedly show that this proposed technique has an average of −0.3% (Y), 0.1% (U), and 0.1% (V) BD-rate improvement on Intra high efficiency condition and an average of −0.5% (Y), 0.1% (U), and 0.0% (V) BD-rate improvement on Intra low complexity condition against HM3.0. It is also reported that the encoding time increases at 118% and 133%, respectively on Intra high efficiency and Intra low complexity, and there is no significant increase as to the decoding time.

Displacement parameters for replenishment are determined at the encoder, therefore encoder complexity increased. 16x16 search range.

Observation: Relatively high gain observed for Basketball drill (2%), other sequences much lower.

No action

JCTVC-F736 On Performance Drawbacks of Intra Luma Prediction [Shevach Riabtsev] [late reg. 07-14 after opening, upload 07-14]

6.15.2 Intra mode coding

JCTVC-F062 Luma Intra Prediction Mode Coding [T.-D. Chuang, C.-Y. Chen, M. Guo, X. Guo, Y.-W. Huang, S. Lei (MediaTek)]

In this contribution, a luma intra prediction mode coding method was proposed. As in HM-3.0, a current intra prediction mode was first checked to see if it is equal to a most probable mode (MPM) derived from its left block or upper block. When the current intra prediction mode was not equal to any MPM, at most three most probable remaining modes (MPRMs) according to the intra modes of neighboring blocks could be used. When the current intra prediction mode is not equal to any MPM or MPRM, one of the remaining modes was signaled to indicate the current intra prediction mode. Simulation results reportedly showed 0.4% bit rate reduction in the high efficiency all intra condition with 1% encoding time increase.

Due to additional table mapping, complexity is increased

Tables were trained with the test data.

JCTVC-F108 Cross-verification results of MediaTek's improved Intra Mode Coding (JCTVC-F062) by LG [J. Park, B. Jeon (LGE)]

JCTVC-F416 Intra Mode Coding considering MPM [C.-W. Seo, J.-K. Han, H.-K. Kim (Sejong Univ.), J. Lim (SK telecom)]

This contribution proposes and intra mode coding method considering "Most Probable Mode" (MPM). At the last meeting held in Geneva, use of multiple MPMs was adopted in HM. So, it is suggested to study encoding method for remaining intra modes which depend on MPMs. The encoding method for remaining intra modes is proposed in this contribution. When multiple MPMs are used and prev_intra_luma_pred_flag is equal to '0', rem_intra_luma_pred_mode may be determined without signalling the intra mode, since the number of remaining modes is only one and the mode can be expected. In this case, this contribution reduces the redundant bits for intra mode coding in HM with simple modification.

However, this does not give a benefit in terms of bit rate reduction, and the determination at the decoder side is more complicated and also means that the derivation needs to be described in the text.

JCTVC-F360 Cross-check result of Sejong Univ.'s proposal (JCTVC-F416) on Intra Mode Coding considering MPM by ETRI [J. Lee, S.-C. Lim, H. Y. Kim (ETRI)] [late upload 07-11]

JCTVC-F109 Remaining mode redundancy removal [J. Lim, B. Jeon (LGE)]

When parsing the syntax rem_intra_luma_pred_mode, if the syntax prev_intra_luma_pred_flag (mpm_flag) is equal to 0, the possible number of intra prediction modes is 3 (64x64), and the two MPM candidates have different intra prediction mode, the value of rem_intra_luma_pred_mode can be inferred without signalling since the possible number of intra prediction mode is three and the two MPM candidates have the two modes out of the three. However, the current HM always signals rem_intra_luma_pred_mode even though it can be inferred in that case. Therefore the current HM has a redundancy in signalling of the syntax rem_intra_luma_pred_mode. This contribution proposes to add a condition when parsing rem_intra_luma_pred_mode not to waste bits for the syntax element.

Is similar to JCTVC-F416; no need to present according to contributor.

JCTVC-F675 Cross Check of LGE's proposal (JCTVC-F109) on Remaining mode redundancy removal [J. Zhao, A. Segall (Sharp)] [late reg. 07-07, upload 07-07]

JCTVC-F378 Intra mode parsing without access neighbouring information [V. Seregin, T. Lee, J. Chen (Samsung)]

In this document, making luma intra mode parsing independent from neighbours is investigated and tested. In the proposed method always two probable intra modes are used for coding luma intra directions. In order to do this, the following modifications were done on top of HM3.0: Planar mode was coded as one of angular intra directions and default most probable mode was added in case two most probable intra modes are same. Experimental results reportedly show 0.0%, −0.1%, −0.1% and 0.0%, 0.1%, 0.1% BD-rate differences for luma and chroma in high efficiency and low complexity intra-only test conditions respectively.

The main intention is to decouple parsing and decoding and increase throughput.

JCTVC-F212 Cross-check of intra mode parsing (JCTVC-F378) [J. Xu (Microsoft)] [late upload 07-12]

JCTVC-F459 Parsing friendly intra mode coding [W.-J. Chien, X. Wang, M. Karczewicz (Qualcomm)]

This contribution presents a coding method for intra prediction mode. In the current HEVC Test Model, different codeword binarizations are defined based on the intra prediction modes of neighboring partitions for the luma intra prediction mode coding. It also uses different codeword binarization for chroma intra prediction mode based on the luma intra prediction mode of the current partition. This method reportedly unifies different binarizations by utilizing constant number of candidate modes. The simulation results reportedly show average performance gain of 0.3% and 0.2% in Intra only configurations.

It is suggested to use a fixed number of most probable modes, but additional MPMs are suggested which are systematically derived. This is where the gain comes from.

JCTVC-F721 Cross-verification of Qualcomm's JCTVC-F459 on parsing friendly intra mode coding [V. Seregin, J. Chen (Samsung)] [late reg. 07-12, upload 07-12]

JCTVC-F340 Fixing the number of MPM candidates [T. Kumakura, S. Fukushima, M. Ueda (JVC Kenwood)]

In the 5th JCT-VC meeting, a most probable mode (MPM) signalling was adopted. However, the parsing process for deriving intra prediction mode becomes more complex since the number of MPM is variable with the combination of decoded intra prediction modes.

In this contribution, it is proposed to change the parsing process by fixing the number or MPM candidates to two for all prediction units. This is done by adding the predetermined mode as MPM candidates in case that the intra prediction mode of left prediction unit and the intra prediction mode of above prediction unit are identical.

The simulation results reportedly show that the proposed technique provides no BD-rate loss for intra high efficiency settings and average 0.1% loss for intra low complexity settings.

Fixing to number of 2 is suggested (like JCTVC-F378)

Furthermore, it is suggested to add a mode 17 for 4x4 and mode 3 for 64x64 (not related to MPM). However, this increases encoder runtime, with no gain.

JCTVC-F350 Cross-check report on JCTVC-F340 [K. Chono, H. Aoki (NEC)]

a) Targets of (JCTVC-F378, JCTVC-F459, JCTVC-F340): Simplification of HM/WD parsing by using a fixed number of MPMs (should be 2).

b) Targets of (JCTVC-F062, JCTVC-F459): Increasing compression by adding more MPMs

A breakout group was asked to work on a harmonized solution on a) and b) if possible, and this was done.

See conclusions from BoG discussion and planned CE6.

JCTVC-F190 Planar Mode Binarization for Intra Mode Coding [F. Zou, O. C. Au, C. Pang, J. Dai, X. Wen (HKUST)]

This contribution proposes a codeword mapping scheme for the planar mode with CABAC. In HM3.0, when the syntax prev_intra_luma_pred_flag (MPM_flag) is 0 and the two MPM candidates are different, there is always one redundant codeword in the remaining mode coding. The proposed scheme removes the codeword redundancy by mapping the planar mode to the mode that corresponds to the redundant codeword. In this case, the DCPlanar flag is also saved.

In particular, the proposed scheme allows the planar mode to be mapped to Mode 2 first, and then decides whether the most probable modes can predict it correctly. If most probable modes cannot predict the current mode correctly (prev_intra_luma_pred_flag=0), and the two most probable modes are different, the Planar mode is remapped to the mode who corresponds to the max allowable codeword used in remaining mode coding. Therefore there is no need to transmit the DCPlanar flag in this case. Otherwise, the original HM3.0 scheme is applied. Doing so saves DCPlanar flag and is asserted to remove codeword design redundancy in HM3.0. The proposed scheme is implemented in HM3.0, achieving a reported average 0.1% bit rate reduction for intra HE with no effect on encoding and decoding time. The results are verified by Motorola Mobility in JCTVC-F572.

Note: Redundant bin removal is also suggested in JCTVC-F378.

JCTVC-F572 Cross-check report for HKUST's test JCTVC-F190 by Motorola Mobility [J. Lou, L. Wang (Motorola Mobility)]

JCTVC-F426 Fixed probability coding for Intra mode [H. Sasai, T. Nishi (Panasonic)]

This proposal presents a technique for complexity reduction for intra-mode parameter parsing process. In this contribution, it is proposed that 1) redundant bit saving for binarization for CABAC, 2) bypass coding and 3) no context updates are used for intra mode coding. In current HM3.0, the additional bin to indicate whether 32 or 33 is specified even it is always less than 33 in case that number of MPM equal to 2 and one context index is used and updated for all bins of intra mode coding. The proposed solution was implemented in HMv3 and their coding efficiencies were evaluated. The result reportedly shows 0.1% performance gain with fixed probability and less than 0.1% performance change with redundant bit reduction and bypass coding for All-Intra high efficiency configuration.

Redundant bin removal (as JCTVC-F190).

Bypass mode frequently used (equal probabilities).

An interpretation for no performance loss in case of fixed probability coding of intra modes may be the local variation of statistics.

Also related to the delayed context update – further study.

JCTVC-F678 Cross-verification results of Panasonic's intra mode coding (JCTVC-F426) [LG J. Park, B. Jeon (LGE)] [late reg. 07-07, upload 07-11]

JCTVC-F376 Utilization of CABAC equal probability mode for intra mode coding [V. Seregin, I.-K Kim (Samsung)]

In this document CABAC equal probability coding (bypass) mode utilization in addition to current context modelling for luma and chroma intra modes coding is studied and tested. In the proposed method a majority bins of intra mode are coded with bypass mode without context modelling with the exception of the first bin of chroma intra mode, and luma intra mode for 8x8, 16x16 and 32x32 prediction units. Experimental results reportedly show 70% bins bypass coded with 0.0%, 0.0% and 0.0% BD-rate gain in high efficiency intra-only, random access and low-delay test conditions respectively.

Question: Why code first bin context-based in chroma, and bypass in luma? It could potentially be done more consistently, including first bin of the remaining mode.

(Does not apply to MPM.)

Further study – may have implications that are not fully understood yet, and it can easily be done later.

In general, it is agreed that this is a reasonable thing to do.

JCTVC-F514 Crosscheck of Samsung's proposal JCTVC-F376 by Huawei [Q. Shen, H. Yang, H. Yu (Huawei)]

JCTVC-F091 Unifying binarizations of Intra modes in HE and LC [E. Maani, A. Tabatabai (Sony)]

This document proposes a method for binarization and coding of Intra prediction modes. Unlike the current Intra mode coding technique, the proposed approach uses the same binarization and adaptation in Low Complexity (LC) and High Efficiency (HE) and does not use a VLC or initialization tables. Using this approach 400 bytes of VLC tables are removed and, on average, a compression gain of 0.3% and 0.1% were reported in the HE and LC settings, respectively.

Gain in HE most probably comes mainly due to the fact that similar swapping is used as in LC, and number of contexts is increased.

JCTVC-F603 Cross-check of Sony proposed JCTVC-F091 on Unifying binarizations of Intra modes in HE and LC [W.-J. Chien, M. Karczewicz (Qualcomm)]

JCTVC-F154 Cross-check of JCTVC-F091 on Intra prediction mode coding [T. Davies (Cisco)] [late upload 07-07]

JCTVC-F269 Modified Intra Mode Coding [E. François, S. Pautet, C. Gisquet (Canon)]

This contribution proposes a modification of the Intra Mode Coding process. The current HM design does not take (in CABAC configuration) or partially takes (in CAVLC configuration) into account the intra mode statistics. In this proposal, intra mode statistics are updated on the fly and further used to decode the intra mode when the mode is not equal to one of the neighboring Most Probable Modes (MPMs).

In the CABAC case, counters and related mode ranking tables are used and updated each time an intra mode is decoded. This updating is done when the intra mode is signaled as an MPM or not. Ranking tables are further used to adaptively binarize the mode value before arithmetic coding.

In the CAVLC case, the number of modes-codewords mapping tables is reduced from 4 (2 for 4x4 CUs, 2 for 8x8 to 32x32 CUs) to 2 (1 for 4x4 CUs, 1 for 8x8 to 32x32 CUs). The swapping process is done based on the real mode value (not the decoded codeword value) when the intra mode is signaled as an MPM or not.

The tool was tested in HM3.1. The overall average luma BD-rate improvement is reportedly 0.3% for the High Efficiency All Intra configuration, 0.1% for the Low Complexity All Intra and High Efficiency Random Access configurations. No impact is reported for the other configurations. Higher gains are reported on high resolution than on low resolution sequences. The proposal has also reportedly been evaluated on the HM3.0_SDIP branch. Consistent results are reportedly obtained, showing that SDIP and the proposal give additive gains.

Very similar to JCTVC-F091, but exactly same swapping (counter based) is used for CABAC as in CAVLC.

JCTVC-F540 Crosscheck report for Canon's Modified Intra Mode Coding (JCTVC-F269) [C. Lai, L. Liu, J. Zheng (HiSilicon), H. Yu (Huawei)] [late upload 07-07]

JCTVC-F430 Crosscheck for Canon's proposal JCTVC-F269 [M. Guo, X. Guo (MediaTek)] [late upload 07-09]

JCTVC-F094 Coding order of luma and chroma intra prediction modes [H. Nakamura, S. Fukushima (JVC Kenwood)]

This contribution recommends that next WD description corresponds to HM implementation in terms of coding of intra prediction mode because WD3 description is different from HM3.0 implementation.

In addition, this contribution recommends that the chroma intra prediction mode is coded after the luma intra prediction mode located at the same position in the same prediction unit, so coding order of luma and chroma intra prediction modes is changed.

Alignment between WD text and SW implementation – Apparently the text must be corrected.

AVC does it the same way as the software currently does it.

Regarding other chroma formats than 4:2:0 – needs further discussion.

JCTVC-F465 Item 2 (Chroma codeword switch) of Experiments on tools in Working Daft (WD) and HEVC Test Mode (HM-3.0) [I.-K. Kim, E. Alshina, J. Chen, T. Lee, W.-J. Han, J. H. Park (Samsung), V. Sze, M. Budagavi, M. Zhou (TI)]

Item 2: Chroma codeword switch

Not clean design. Not in the text. Decision: Remove the switch from the software. (If evidence of usefulness arrives later, …)

JCTVC-F098 Cross-check for JVC Kenwood's proposal on intra coding (JCTVC-F094) [M. Matsumura, S. Matsuo, Y. Bandoh, S. Takamura, H. Jozawa (NTT)]

JCTVC-F106 CAVLC coding for intra prediction mode [J. Park, B. Jeon (LGE)]

This contribution proposes a mode coding with CAVLC for luma intra prediction. In HM 3.0, the index mapping tables for intra remaining modes represent the accumulated distribution of intra remaining modes. However, those tables do not consider the dependency of remaining modes on the values of MPM candidates. In the proposed method, the orders of index mapping process and remaining mode calculation process are switched. By switching them, the tables can allegedly represent the distribution of prediction modes instead of the distribution of remaining modes. The proposed change reportedly brings 0.2% BD-rate reduction for intra low complexity configurations.

Concept same as JCTVC-F269, other VLC table – does not need to be presented.

JCTVC-F066 Crosscheck for LGE's Luma Intra Prediction Mode Coding in JCTVC-F106 [T.-D Chuang, Y.-W. Huang (MediaTek)]

JCTVC-F111 Intra prediction mode coding with LCEC on SDIP [J. Lim, B. Jeon (LGE)]

This contribution proposes a CAVLC joint coding scheme for intra prediction mode on SDIP. When SDIP is enabled, split mode and four kinds of partitioning type exist for intra prediction. Similar CAVLC joint coding scheme and counters as used for inter mode coding was also applied to intra mode coding. The simulation result reportedly shows that the proposed method achieves 0.1% bit rate reduction for INLC configuration without any encoder and decoder complexity changes.

Applies to split flag used in SDIP partitioning.

Results are relative to 3.0 SDIP branch, not harmonized version.

JCTVC-F660 Cross Check of LGE's proposal (JCTVC-F111) on Intra prediction mode coding with LCEC on SDIP [Jane Zhao, Andrew Segall] [late reg. 07-06, upload 07-06]

JCTVC-F123 Updated CAVLC Tables of Intra Mode Coding with Separated DC and Planar [M. Guo, X. Guo, S. Lei (MediaTek)]

In HM3.0, DC and Planar modes are coded using a dependent manner, which shares the same codeword in the codeword tables of CAVLC. After the codeword, one flag is then transmitted to signal whether DC or Planar is used. This contribution proposes to update the CAVLC codeword tables in HM3.0 with separate codewords for DC and Planar modes. It is reported that an average BD-Rate reduction of 0.2% is achieved for low complexity all intra (LC-AI) configuration using the proposed method. It is also reported that the running time is almost the same with that of anchor.

Conclusion: Establish CE on Intra Mode coding to establish a unified and (hopefully) simplified solution for the whole package (expected gain: 0.5%?)

- Increased number of MPM
- Unified binarization
- DC & planar
- Amount of bins that could be bypassed

JCTVC-F490 Cross-checking of results of JCTVC-F123 from MediaTek [E. François (Canon)]

JCTVC-F339 Intra prediction mode coding based on direction difference [T. Kumakura, S. Fukushima (JVC Kenwood)]

MPM for Intra prediction mode is applied in the HM3.0 and is asserted to reduce the entropy of intra prediction mode. The technique is based on a uniform probabilistic model.

It is estimated that the current intra prediction mode correlates with the combination of intra prediction modes of the decoded prediction units. And it is estimated that the suitable probabilistic model is switched by each prediction unit.

In this proposed method, MPM sets are switched by using direction difference of two intra prediction modes in adjacent blocks.

The contribution reports that the proposed technique provides average 0.2% BD-rate gain for intra high efficiency settings and average 0.1% gain for intra low complexity settings.

Comment: A fixed number of MPM would be desirable.

JCTVC-F432 Crosscheck for JVC's proposal JCTVC-F339 [M. Guo, X. Guo (MediaTek)] [late upload 07-09]

6.16 Transforms

6.16.1 Core transform implementation

JCTVC-F193 Accuracy improvement of Cisco and TI's transform (JCTVC-E243) [Y. Sugito, A. Ichigaya, S. Sakaida (NHK)]

This contribution proposes "high accuracy" 16x16 and 32x32 transform bases based on HM 3.0's transform proposed by Cisco and TI. The word "accuracy" was asserted to mean orthogonality and isometry (normality of transform) of basis vectors. Proposed bases were reportedly verified according to CE10's coding efficiency. The results for the normal QP range (QP=22, 27, 32, 37) and the high QP range (QP=36, 42, 47, 51) reportedly show around 0% average gains for luma. Almost all of the results of sequences for the low QP range (QP=1, 5, 9, 13) show gains for luma; the peak gain is 1.2% without any increase in process time.

Gain at low QP seems most probably due to having a higher degree of orthonormality. The question was asked whether this was penalized by slightly higher ripple that can be observed in some of the basis functions? (In general, basis functions were designed from the HM version by using deviations of +/-1.)

Remark (JO) about CE (not related to this contribution): Would it be useful to perform a visual comparison, e.g. evaluating different transforms when encoding test charts at high QP?

JCTVC-F448 Cross-check of NHK's contribution on accuracy improvement of the JCTVC-E243 core transforms (JCTVC-F193) [A. Fuldseth (Cisco)]

JCTVC-F563 Non-Square Transform for 2NxN and Nx2N Motion Partitions [L. Guo, J. Sole, R. Joshi, P. Chen, X. Wang, M. Karczewicz (Qualcomm)]

The current HM software only employs square-shaped transforms. In this contribution, for inter non-square PUs, i.e., 2NxN PU and Nx2N PU, additional non-square transforms 2NxN and Nx2N are integrated in the RQT structure. Non-square transforms achieve an average BD-rate reduction of 0.2% for the RA HE case, 0.6% for LB HE, and 0.7% for LP HE. For the low complexity, the average BD-rate reductions are 0.1% for RA LC, 0.6% for LB LC and 0.6% for LP LC.

Further study encouraged in new CE2.

JCTVC-F624 Crosscheck for Qualcomm's Transform in JCTVC-F563 [Y.-W. Chen, Y.-W. Huang (MediaTek)] [late upload 07-09]

JCTVC-F592 Recursive factorization for 16 and 32-point transforms using 4 and 8-point HM 3.0 core transforms [R. Joshi, Y. Reznik, J. Sole, M. Karczewicz (Qualcomm)]

In this contribution, 16 and 32-point transforms are proposed based on the recursive factorization proposed in JCTVC-F352. However the 4 and 8-point transforms in the factorization are replaced by the 4 and 8-point core transforms from HM3.0. This represents a trade-off between the number of multiplications and the number of sequential operations in the transform. As an added benefit, the amount of memory required for storing the quantization and dequantization matrices decreases compared with the full butterfly factorization in JCTVC-F352.

Supplements the proposal in CE10 which is based on full factorization. Compromise sought to reduce the sequential operations.

If used in CE10, only one design should be brought and decided early

JCTVC-F595 New results for guaranteeing 16-bit transform dynamic range [K. Misra, A. Segall, L. Kerofsky (Sharp)]

This document reports new results for limiting the dynamic range within an inverse transform. It is asserted that the method guarantees a 16-bit dynamic range limit within the transpose buffer. Additionally, it is asserted that the current HM3.0 design does not guarantee this 16-bit limit. The proposed technique was previously proposed in JCTVC-D071/JCTVC-E411. Here, the technique is adapted to HM3.1 which includes as default the transform proposed in JCTVC-E243. The proposed approach shows a BD-rate impact of 0.0% on coding efficiency for common test conditions. Further evaluation for CE10 configuration settings on HM3.0 demonstrates BD bit rate increase of 0.0%.

With a normally operating the quantizer (and usual input data) this cannot happen, and it actually does not happen in the current test set.

Another possibility would be to enforce by specification that an encoder shall not produce such overruns. This was done in AVC, but it may not be the best solution.

The possibility of overflow is also reduced due to the fact that a right shift was introduced in the quantizer.

Must this be normative? Any decoder implementer could include such clipping e.g. to combat against transmission errors.

Anyway, the problem must be solved either by imposing constraints on the encoder or clipping.

Study in AHG (A. Segall, E. Alshina were suggested as chairs for this) with mandate to work out a solution.

JCTVC-F561 Crosscheck of Sharp's proposal on 16 bit dynamic range restriction in inverse transforms [R. Joshi (Qualcomm)] [late upload 07-07]

6.16.2 Alternative transforms

JCTVC-F153 On fast implementation of 4-point ODST-3 in HM3 [C. Yeo, Y. H. Tan, Z. Li (I2R)]

In this contribution, possible fast implementations of the 4-point ODST-3 that are asserted to be mathematically equivalent to that in HM3 but have lower operations count than that found in the current HM3 software were presented. The (29, 55) approximation of ODST-3 required 11 additions and 8 multiplications as implemented in HM3, while two other implementations require either 10 additions and 6 multiplications or 13 additions, 4 multiplications and 2 bit-shifts. A previously mentioned (28, 56) approximation of ODST-3 required 11 additions, 5 multiplications and 3 bit-shifts, while two other implementations require either 10 additions, 5 multiplications and 1 bit-shift or 11 additions, 4 multiplications and 2 bit-shifts.

This contribution shows that in principle any of the two versions can be implemented in similar fast algorithms. Some argumentation is made that the 56 version saves some gates in adders, but this seems to be minimum. The group decided to leave DST as it is currently.

JCTVC-F225 Consideration of reference pixel availability for adaptive DCT/DST decision [Y. Shibahara, T. Nishi (Panasonic)],

In the Working Draft 3 (WD3) of HEVC, 4x4 DST is used for intra prediction unit depending on its intra prediction mode. The DST shows better coding gain than DCT when it is used together with the coupled intra prediction modes. In the latest design of HEVC, however, availability of reference pixels is not considered for the choice of DST, although it may affect the coding gain of the transform. In this contribution, it is proposed to check the availability of the reference pixels before deciding to use DST. An experimental result reportedly shows that the proposed method provides 0.01%, 0.01%, 0.02% and 0.00% gain for AI HE, AI LC, RA HE and RA LC, respectively on the common condition. As for the condition using slice (1500 byte / slice), an experimental result reportedly shows that the proposed method provides 0.01%, 0.10%, 0.10%, 0.03% and 0.05% gain for AI HE, AI LC, RA HE and RA LC, respectively. And as for the condition of CIP enabled (constrained intra prediction), an experimental result shows that the proposed method provides 0.07% and 0.05% gain for RA HE and RA LC, respectively. The increase of encoding and decoding time is reported to be less than 1% for all results.

No action.

JCTVC-F485 Cross check report for Panasonic's improving method for adaptive DCT/DST (JCTVC-F225) [A. Ichigaya, S. Yasuko (NHK)] [initial version rejected as placeholder; corrected version late upload 07-06]

JCTVC-F656 Cross Check Report for Consideration of reference pixel availability for adaptive DCT/DST decision (JCTVC-F225) [Ankur Saxena, Felix Fernandes (Samsung)] [late reg. 07-05, upload 07-12]

JCTVC-F295 Harmonizing ROT and SDIP [Z. Ma, F. Fernandes, E. Alshina, A. Alshin (Samsung)]

The Rotational Transform (ROT) is a secondary transform applied to 8x8 DCT-coefficient blocks while Short Distance Intra Prediction (SDIP) improves intra prediction by partitioning spatial-domain blocks into squares or rectangles. These tools have formerly been tested separately in HM 2.0. In this contribution it is reportedly demonstrated that the tools can be harmonized so that their gains are almost additive when both tools are combined together in HM 3.0. Specifically, it is reportedly shown that for the All-Intra (AI) case, the ROT provides 0.7% (HE) / 0.8% (LC) additional gains over SDIP and for the Random-Access case, the ROT provides 0.4% (HE) / 0.4% (HE) additional gains over SDIP.

The reported gain is slightly lower (by 0.2%) than without SDIP.

JCTVC-F535 Crosscheck report for Samsung's harmonizing ROT and SDIP [C. Lai, L. Liu, J. Zheng(HiSilicon)] [late upload 07-07]

JCTVC-F553 Mode-Dependent DCT/DST for 4x4 Chroma Blocks [Ankur Saxena, Felix Fernandes, Elena Alshina, Jianle Chen (Samsung)]

The 4x4 mode-dependent DCT/DST proposal from JCTVC-E125 was adopted at the Geneva meeting in March 2011 for 4x4 Luma blocks. In this proposal, the mode-dependent DCT/DST scheme is extended to 4x4 Chroma blocks as well. Experimental results are provided with HM 3.0 as anchor for the test conditions as stipulated for Core Experiment 7. Average BD Rate gains of 0.3%, 0.7%, 0.6% and 0.6% are reported for Chroma components in Intra High Efficiency, Intra Low Complexity, Random Access High Efficiency, and Random Access Low Complexity settings.

Only for horizontal and vertical modes.

What is the additional hardware (number of gates) complexity?

It relies on how the mode is coded.

Further study (continuation of CE7).

JCTVC-F679 Cross Check Report for Samsung's Proposal "Mode-Dependent DCT/DST for 4x4 Chroma Blocks" (JCTVC-F553) by Panasonic [Y. Shibahara, T. Nishi (Panasonic)] [late reg. 07-07, upload 07-07]

JCTVC-F554 On secondary transforms for intra prediction residual [A. Saxena, F. Fernandes (Samsung)]

It was reportedly previously shown by Han, Saxena & Rose in ICASSP 2010, that following intra prediction, the optimal transform is not a DCT, but a DST Type-7 with performance close to KLT along the direction of prediction, for the horizontal and vertical modes. The 4x4 DST from JCTVC-E125 was adopted in the HEVC Geneva meeting in March 2011. Shibahara & Nishi had proposed a mode-dependent 2-step transform in JCTVC-D151. In this contribution, various mode-dependent secondary transforms (MD-ST) are presented which are used after DCT based on the intra prediction mode. The proposed DCT/MD-ST transform scheme is applied at block sizes 8x8 and higher. No additional signalling information or R-D search is required during the encoding, and the algorithm works in a single-pass. The conventional quantization tables for HM 3.0 are retained and no changes have been made to the scanning order. Experimental results are provided with HM 3.0 as anchor for the test conditions as stipulated for Core Experiment 7. Average BD Rate gains of 0.6%, 0.5%, 0.3% and 0.3% (respectively 0.4%, 0.3%, 0.3% and 0.2%) are reported for Intra High Efficiency, Intra Low Complexity, Random

Access High Efficiency, and Random Access Low complexity settings, respectively, for the 8x8 MD-ST (respectively 4x4 MD-ST).

Question: Is a forward DCT needed at the decoder side? Maybe, depending how it is implemented

Similarity with JCTVC-F224, using the same correlation model, gain due to the larger block sizes

Further Study (continuation of CE7).

JCTVC-F716 Cross-check of Samsung's proposal JCTVC-F554 [J Xu] [late reg. 07-12, upload 07-14]

JCTVC-F680 Cross Check Report for Samsung's Proposal "On secondary transforms for intra prediction residual" (JCTVC-F554) by Panasonic [Y. Shibahara, T. Nishi (Panasonic)] [late reg. 07-07, upload 07-07]

JCTVC-F591 Modified Selection of 4x4 Mode-Dependent Transforms [R. Cohen, A. Vetro, H. Sun (MERL)]

In the current Working Draft, for 4x4 Luma Intra prediction residuals, the horizontal and vertical transform types horizTrType and vertTrType depend upon the Intra prediction mode, as specified by a look-up table. In this contribution, for certain prediction modes in which horizTrType and vertTrType differ, the encoder performs a rate-distortion optimized decision on whether to swap the values of horizTrType and vertTrType. This swap is signaled using a TrToggle flag the first time a relevant applicable TU occurs in a PU, for each Intra-coded PU. The proposed method was implemented on top of HM 3.0. BD-Rate changes for class C and D sequences, using an unmodified HM 3.0 as a reference, with a reported average impact of about −0.1%, and with the change for larger sizes averaging to 0.0%. The encoding time percentages with the current software implemention are 109–114% for all-Intra cases and 98–100% for the random access and low-delay cases. Decoding time percentages range from 99–102%.

Due to need for signalling, the gain is low. Encoder time increased.

No action taken – further study by proponent is required to show an improved gain and complexity tradeoff.

6.17 IBDI and memory compression

JCTVC-F073 Joint Luma-Chroma adaptive reference picture memory compression [S. Liu, X. Zhang, S. Lei (MediaTek)]

This contribution proposes a localized adaptive scaling mechanism for compressing reference pictures, which can be used to reduce the hardware cost of IBDI technique in HEVC. The proposed mechanism compresses luma pixels and chroma pixels jointly, and was implemented in two versions. For the version 1 method, experimental results report average 0.07% BD-rate increase for random access (HE), and average 0.70% BD-rate increase for low delay (HE). For the version 2 method, experimental results report average 0.01% BD-rate increase for random access (HE), and average 0.29% BD-rate increase for low delay (HE). The average decoding time increases about 5-6% under current software implementation. The effect on encoding time is negligible. Furthermore, an offset was applied to each luma block in the proposed version 1 method (similarly to the method proposed in JCTVC-D035). Experimental results report average 0.03% BD-rate increase for random access (HE) and average 0.28% BD-rate increase for low delay (HE).

This technique still causes significant losses in LD cases, and seems to add some complexity. No action.

More general question: Is this topic relevant?

JCTVC-F079 Crosscheck of JCTVC-F073 proposal for joint luma-chroma adaptive reference picture memory compression [D. Hoang (Zenverge)] [late upload 07-07]

JCTVC-F075 Unified scaling with adaptive offset for reference frame compression [D. Hoang (Zenverge)]

Internal Bit Depth Increase (IBDI) is a technique that can often yield improved coding efficiency by increasing the arithmetic precision of the predictors, transforms, and loop filters in a video codec. The main drawback is an increase in memory storage and bandwidth requirements. Several reference frame compression techniques have been proposed to reduce the memory penalty of IBDI. This document describes two lightweight compression algorithms that operate on 4×4 blocks and can achieve compression ratios from 9:8 to 14:8. Unified Scaling with Adaptive Offset, the simpler of the two, introduces an average coding loss of about 0.5% for LB-HE and 0.1% for RA-HE. Unified Scaling with Adaptive Offset and DPCM, the better performing algorithm, reduces the coding loss to 0.3% for LB-HE and 0.1% for RA-HE.

Has it been tested with more evil structures? Could it cause visual artifacts?

The argument is brought that the MSE per block cannot become larger than 4 (in Toshiba's previous proposal, here it could be higher).

We should not only look for MSE, but for maximum pixel deviation that could occur in evil cases. With this method it is said to be 13 (Toshiba's original is said to be 4).

For 10-bit input (steam locomotive), a small gain (0.2%) is reported even when compared to 10-bit internal memory. This is however most likely due to the fact that the method works like an additional loop filter.

As usually the same buffer is used for DPB and reference buffer, it means that the decompression would again need to be performed before display.

How was the PSNR calculated? 8-bit or 10-bit reference?

JCTVC-F548 Cross-verification report of JCTVC-F075 [G. Li (Santa Clara University), L. Liu (Hisilicon)] [late upload 07-07]

JCTVC-F078 Cross verification report for JCTVC-F075 proposed by Zenverge [X. Zhang, S. Liu (MediaTek)]

JCTVC-F319 Adaptive scaling with offset for reference pictures memory compression [T. Chujoh, T. Yamakage (Toshiba)]

A reference pictures memory compression from N-bit to 8-bit on high efficiency anchor and a definition for standardization are proposed. This contribution merges two methods, one is adaptive scaling proposed by JCTVC-E133 (Toshiba) and the other is adaptive offset proposed by JCTVC-E432 (Zenverge) and its definition by compression distortion control is shown. As experimental results, the loss bitrate of adaptive scaling with offset is average of 0.49% while the loss bitrate of fixed rounding is average of 2.24% and the loss bitrate of internal 8-bit is average of 2.47%.

Proposal suggests that it is not necessary to define compression and decompression, but only "distortion control". Is lossless for 8-bit.

Decoding time increase 5% / 8%

Why doing it this way? It is said that number of operations is decreased, but this is not noticeable from the software runtime.

JCTVC-F620 Crosscheck of JCTVC-F319 Toshiba Adaptive Scaling with Offset RFC [D. Hoang (Zenverge)] [late upload 07-06]

JCTVC-F496 2x2 block-based reference pictures memory compression [Lijuan Kang, Yanzhuo Ma, Sixin Lin]

In this contribution, two adaptive reference pictures memory compression scheme from 10-bit/pix to 8-bit/pix based on 2x2 blocks are proposed. This contribution is to solve the redundant memory bandwidth accessing especially when the align/burst parameters are low. In the proposed scheme, both adaptive scaling and offset compensation are used on top of the first scheme. Results show that compared with the fixed rounding method, better coding efficiency is obtained, and compared with the existing 4x4 block based methods, little performance loss is introduced. In terms of memory access bandwidth, the proposed method decreased the memory access bandwidth by 15~17% compared with the 4x4 block based methods when burst parameter is smaller than 64, and about 9% when burst parameter is 128. For large burst parameters the memory bandwidth can be kept the same as the 4x4 block based compression methods by the non-normative trick that merges four 2x2 blocks to one 4x4 block as the basic unit for store and access.

General conclusion on memory compression:

- The added complexity of current schemes would be a burden for software; it is mainly interesting for hardware implementation. For software it would be implemented rather as an additional loop filter (that decreases the quality).
- Even for hardware, how to measure the benefit in terms of memory bandwidth is not completely clear. For some access sizes, the average bandwidth reductions that are reported are largely diverging among the different sequence classes. It would rather be relevant to study worst cases (either worst thinkable case or worst case found in any frame of the entire test set) instead of gross averages for memory bandwidth reduction.
- IBDI is not a good use case for memory compression. Could eventually become relevant for higher bit-depth sources such as 12 or 14-bit. We currently only have two 10-bit sequences, so that an assessment is difficult.
- Further study when we will assess higher bit depth material in the future

6.18 Parsing throughput, robustness and error resilience

JCTVC-F068 A study on HEVC parsing throughput issue [M. Zhou, V. Sze, Y. Matsuba (TI)]

Considered in BoG coordinated by B. Bross.

JCTVC-F699 Cross-check report of TI's proposal JCTVC-F068 on HEVC parsing throughput issue (combined study with JCTVC-F470 part) [T. Sugio, T. Nishi (Panasonic)] [late reg. 07-11, upload 07-11]

JCTVC-F074 Cross-check of TI's study on HEVC parsing throughput issue JCTVC-F068 [B. Bross (Fraunhofer HHI)] [late upload 07-04]

JCTVC-F347 A method of decoupling motion data reconstruction from entropy decoding [M. Zhou, V. Sze, Y. Matsuba (TI), T. Sugio, T. Nishi (Panasonic), J. Chen, T. Lee (Samsung), W. Wan, Y. Yu (Broadcom)]

Discussed in BoG coordinated by B. Bross.

JCTVC-F470 Parsing Robustness for Merge/AMVP [T. Sugio, T. Nishi (Panasonic)]

JCTVC-F090 Cross-verification of Panasonic's proposal JCTVC-F470 on parsing robustness for merge/AMVP [M. Zhou (TI)]

JCTVC-F402 MVP index parsing with fixed number of candidates [J. Chen, T. Lee (Samsung)]

Discussed in BoG coordinated by B. Bross.

JCTVC-F504 Cross check of Samsung proposal on MVP index parsing with fixed number of candidates (JCTVC-F402) [Guillaume Laroche (Canon), Tangi Poirier] [late upload 07-06]

Discussed in BoG coordinated by B. Bross.

JCTVC-F695 Cross-verification of Samsung's proposal JCTVC-F402 on MVP index parsing with fixed number of candidates (combined study with JCTVC-F470 part) [M. Zhou (TI)] [late reg. 07-09, upload 07-10]

JCTVC-F550 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)]

This contribution proposed to modify the residual coding in high efficiency usage in order to remove the dependency of the residual data parsing on the intra mode. Three modifications were introduced to attain this goal. First, coefficient level coding is made dependent on the scan position. For this part, the BD-rate for AI-HE, RA-HE and LB-HE configurations is reported as −0.05%, 0.07%, and −0.01%, respectively. Second, the last significant coefficient coding assumes that the scan is always zigzag. Adding this part, the BD-rate for AI-HE, RA-HE and LB-HE configurations is reported as −0.03%, 0.06%, and 0.01%, respectively. Finally, the significance map context for 4×4 and 8×8 blocks are modified to depend on the scan position, not the block-based position as in HM3.0. The BD-rate impact of the three parts combined for AI-HE, RA-HE, and LB-HE is reported as 0.13%, 0.18%, and 0.05%, respectively.

(Discussed in Track P – Thursday 07-21.)

This seems desirable, but may have interactions with other adoptions, so it was deferred for further study. We hope to do something like this.

JCTVC-F728 A Cross-check report for JCTVC-F550 proposal removing parsing dependency of residual coding on intra mode Kiran Misra, Andrew Segall (Sharp) [late reg. 07-12, upload 07-12]

JCTVC-F302 Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode [Y. Zheng, X. Wang, W.-J. Chien, M. Karczewicz (Qualcomm)]

This contribution proposed a change to the rules currently used in determining merge candidates for a PU under 2NxN, Nx2N or NxN mode. Based on the proposal, when a current PU under these partition modes is not the first PU in a CU, the previous PU's merge index is checked to determine if motion information of the previous PU can be used as a merge candidate for the current PU. It was asserted that the proposed changes can help solve the parsing robustness issue while preserving coding efficiency.

Compression improvement 0.1%. This contribution was noted to need to be discussed in the BoG on MV coding in the parsing category. The notes were thus moved to that section of the report. May benefit from investigation in CE9.

6.19 Complexity assessment

JCTVC-F043 Complexity assessment methodology [D. Alfonso (STM)]

This contribution presents a complexity assessment methodology based on three kinds of system modelling: algorithmic, software and hardware. It was proposed to adopt said methodology as standard practice in JCT-VC project management for the current HEVC standardization project.

It was proposed to consider:

- Resources consumed *statically*, not related to the notion of time. This refers to resources needed to realize the system, like silicon footprint, memory size, number of elementary processing units, et cetera.
- Resources consumed *dynamically*, depending on the time dimension. This refers to resources needed to operate the system, in particular computation (amount of elementary operations performed per time unit) and communication (amount of data transferred per time unit).

The proposed methodology is based on three classes of systems:

- Level 1 is based on *abstract modelling*, i.e. the system is realized as one or more algorithms, ideally executed on a theoretical architecture. At this level, complexity assessment is made by algorithmic analysis.
- Level 2 is based on *software modelling*, i.e. the system is a software implementation, running on a general-purpose hardware architecture such as a CPU. Practically, the HM software is the HEVC system implementation and the complexity is assessed by measuring HEVC software performance.
- Level 3 is based on *hardware modelling*, i.e. the system is a hardware implementation realized over a certain technology. At this level, it is possible to measure some other complexity dimensions that it is not possible to consider at level 2.

It was proposed that this be considered at least a starting point toward an agreed assessment methodology for the work.

Profiling was suggested as an important element of complexity study.

As general guidelines to be considered, the contribution contains useful suggestions and presents a good description of things to be done in a proper complexity analysis.

However, strict application of a methodology may not be fully practical for routine proposal evaluations in our work, and we must rely somewhat on expert judgment to enable moving forward in a timely fashion.

Contributors are encouraged to consider this methodology and use it in our work. Further study of complexity analysis methodology is also encouraged.

JCTVC-F487 Study of memory bandwidth to develop HEVC [Teruhiko Suzuki (Sony)] [late upload 07-11]

Presented Thu 07-21 2030.

The contribution suggests considering profile / level constraints based on memory bandwidth issues.

The contribution included an illustration of the memory bandwidth impact of restrictions, illustrating some cases where HEVC has higher bandwidth than AVC.

The concept was generally supported.

6.20 Encoder optimization

See also the section discussing HM settings and common conditions.

JCTVC-F045 Early Termination of CU Encoding to Reduce HEVC Complexity [R. H. Gweon, Y.-L. Lee (Sejong Univ.), J. Lim (SK Telecom)]

Comparing to AVC, the computational complexity in HEVC has been increased due to newly added efficient coding tools. One reason of the high complexity of HEVC is that every Prediction Unit such as 2Nx2N, 2NxN, Nx2N and NxN is encoded regardless of the performance of the previous encoded Prediction Unit. By using the signalling information coded_block_flag in the HEVC syntax, the Prediction Unit which could have the best performance can be predicted. Therefore, this contribution introduces a method to reduce encoding complexity of HEVC by simply investigating the coded_block_flag. The encoder complexity of the proposed method reduces encoding time by approximately 42% with Y BD-rate loss of 0.85% compared with that of the HM3.2 encoder.

This was noted to use only 6 lines of code.

The group agreed to adopt this into the reference software (switchable and disabled in the common conditions, with integration priority and timing to be determined in coordination with the software coordinator).

JCTVC-F092 Coding tree pruning based CU early termination [K. Choi, E. S. Jang (Hanyang Univ.)] [late upload 07-05]

In this proposal, coding tree pruning based CU early termination is suggested for reducing the encoding time in the HEVC test model software. The experimental results showed that the proposed method achieved about 42% reduction in encoding time compared to the HEVC test model 3.1 encoder with only a negligible loss of luma BD-bitrate (i.e., < 0.6%) and a small gain of chroma BD-bitrate (up to 0.8%).

4 lines of code.

The group agreed to adopt this into the reference software (switchable and disabled in the common conditions, with integration priority and timing to be determined in coordination with the software coordinator).

JCTVC-F296 Modifications for CAVLC RDOQ [M. Karczewicz, L. Guo, X. Wang (Qualcomm)] (also see cross-check JCTVC-F723)

In this contribution, two modifications to CAVLC RDOQ are presented. In the first modification, the encoder skips some locations for “last position” checking based on coefficient levels. The second modification aims at improving the bits estimation. The performance of each modification as well as their joint performance was reported. It is reported that combining them together can speed up the encoding process (5% for Intra and 1%-4% for inter) and also slightly improve the B-D rate performance (0.1%).

Cross-check reported in JCTVC-F723, and that contribution reports that the software is implementing what is described in the contributions.

The group agreed to adopt this into the reference software (switchable and *enabled* in the common conditions, with integration priority and timing to be determined in coordination with the software coordinator).

JCTVC-F386 Chroma RD cost computation in HM3.0 [T. K. Tan, F. Bossen (NTT Docomo)]

This contribution observes that the rate-distortion cost computation in the HM does not take into account the difference in the QP values between the luma and chroma components. This results in an inaccurate rate-distortion optimization that penalizes the quality of the chroma component at low bitrates. A rate-distortion cost computation that takes the difference into account was implemented. Simulation results show improvements in the chroma fidelity at the cost of a slight luma BD-rate loss.

The average Y BD-rate loss for all coding conditions is 0.7%. The average U and V BD-rate gains for all coding conditions are 7.0% and 7.2%, respectively.

A weighted YUV BD-rate is also reported, with the average Y, U and V PSNR’s of each sequence being weighted by the ratios 0.75:0.125:0.125, respectively. The average weighted YUV BD-rate gain for all coding conditions is 1.1%.

Adopted – *enabled* by default (and switchable, of course).

6.21 Not presented due to late arrival or lack of availability

JCTVC-F544 Improved arithmetic coding based on probability aggregation-more results [H. Zhu] [late upload 07-20]

Upload missing until 07-19; version of 07-19 rejected (no abstract, no IPR statement).

No presenter available Sat 18:25, Tue 17:14 & Wed 12:00.

JCTVC-F766 Additional results on Intra Mode Coding [E. François, N. Ouedraogo (Canon), J. Park (LGE), E. Maani, A. Tabatabai, C. Auyeung (Sony)] [late reg. 07-20, upload 07-20]

JCTVC-F768 An observation of the subjective viewing test results for deblocking filter proposals [X. Guo, S. Lei (MediaTek)] [late reg. 07-20, upload 07-21]

JCTVC-F770 Results for SCC with Transform Skip Mode (JCTVC-F077) [Marta Mrak, Andrea Gabriellini, David Flynn (BBC)] [late reg. 07-20, upload 07-20]

JCTVC-F772 Report on subjective viewing test for configurations in JCTVC-F320 [V. Sze (TI)] [late reg. 07-20, upload 07-21]

JCTVC-F773 Additional Performance Metric for Screen Content Coding [Wen Gao] [late reg. 07-21, upload 07-21]

7 Plenary discussions and BoG reports

7.1 Joint Meeting with MPEG Requirements, MPEG Video and VCEG

In a joint meeting session with MPEG Requirements, MPEG Video and VCEG on Wednesday at 1600, the following was recorded.

- Hypothetically-applicable JCT-VC docs for scalability issues
  - JCTVC-F194 Proposal on the support of interlace format in HEVC [S. Sekiguchi, K. Sugimoto, H. Sakate (Mitsubishi)]
  - JCTVC-F290 Scalability Support in HEVC [D. Hong, W. Jang, J. Boyce, A. Abbas (Vidyo)]
  - JCTVC-F292 Metrics for evaluation of scalable coding [J. Boyce (Vidyo)] [late upload 07-07]
  - JCTVC-F096 Scalable structures and inter-layer predictions for HEVC scalable extension [H. M. Choi, J. Nam, D. Sim (Kwangwoon Univ.)]
  - JCTVC-F618 Resampling filters for scalability and screen content applications [W. Dai, M. Krishnan, P. Topiwala (FastVDO)]
  - JCTVC-F488 / m20918 Requirements for Scalable extension of HEVC [Edouard Francois, Sebastien Lasserre, Fabrice Le Leannec (Canon)]
- m20291 Ad Hoc group recommendations
  - Phase 1: Multiview & 2D 4:2:0, Phase 2: Chroma and Bit Depth, Phase 3: 3D
  - Draft CfP Nov; Final CfP Feb …. discussion: Not (final) before Feb.
  - For MVC we will have a lot more information in Nov.
- Conclusion: It was agreed that until after responses to the WG11 3DV CfP (assuming this will happen in a timely fashion), we may include design aspects like, in high-level syntax, ref pic list management, temporal ID, view ID, quality ID, definitions of what subset of the bitstream those apply to, reserved extension bits, but we would not put in scalability-specific coding tools – e.g., specification of upsampling filters for spatial scalability.
- Interlace JCTVC-F194 / m20613 and m21411
  - Without block-level coding changes.
  - Tested field picture coding (20% better than frame-based for interlaced source).
  - Possibly include chroma MV alignment
  - SEI messages (or high-level signalling) don't require formal requirements justification
  - The requirements docs do not seem to prohibit consideration of interlaced video
- Conclusion: We don't have a positive requirement to support interlace, but we are not prohibited from carrying an indicator of interlace.

7.2 Break-out Group activities

JCTVC-F744 BoG Report on MV Coding and Parsing Throughput/Robustness [B. Bross] [upload 07-21]

This contribution summarizes the activities of the Break out Group (BoG) on MV Coding and Parsing Throughput/Robustness.

Some additional notes were agreed to be recorded in final uploaded version

- One aspect reportedly conflicts with a recommendation in another AHG, and the other solution was agreed to be used.
- JCTVC-F060 was checked and suggested to be OK; however, see additional notes elsewhere about this.
- JCTVC-F465 item 1 (not to be included) was checked.
- Put a flag in PPS to disable temporal MV predictor.

Decision: Adopt as suggested by BoG (context modification as per recommendation of context reduction BoG); in addition to BoG suggestion: Disable temporal candidate for merge mode and AMVP, flag at PPS (for error robustness, avoiding prediction from potentially corrupted motion vectors). However, see notes elsewhere regarding the status of JCTVC-F060.

A new CE13 was planned.

JCTVC-F745 BoG report on efficient binary representation of cu_qp_delta syntax for CABAC [Keiichi Chono(NEC), Hirofumi Aoki(NEC), Yuzo Senda(NEC), Kenji Kondo(Sony), Kazushi Sato(Sony), Jun Xu(Sony Electronics Inc.)] [upload 07-16]

Already discussed elsewhere (see under JCTVC-F422).

JCTVC-F746 BoG report on context reduction for CABAC [upload 07-21]

Specific recommendations:

- Reconciliation of JCTVC-F288 and JCTVC-F132 to be used – further context reduction.
- JCTVC-F606 CBF for chroma confirmed OK (see notes under JCTVC-F606)
- JCTVC-F429 for CBF luma.
- JCTVC-F497 aspect for further study.
- JCTVC-F060 had something for skip flag which would need extra checking – for further study.

Decision: Agreed.

Essentially duplicate notes were recorded as follows:

Adoptions recommended by BoG:

1. JCTVC-F429 – remove neighbors dependency for context selection for intra_chroma_pred_mode, merge_flag, ref_idx, mvd, no_residual_data_flag

JCTVC-F429/JCTVC-F133 – mvd (remove neighbors dependency for context selection of binIdx0)

JCTVC-F375 – last_significant_coeff_x/y (change binarization to reduce context coded bins)

JCTVC-F606 – inter_pred_flag (use depth to select context rather than neighbor top & left)

Decision pending cross-check

JCTVC-F455 – mvd (two fixed contexts for binIdx0 and binIdx1, shared between x/y components; exp-Golomb binarization =1 and bypass coding for other bins), and it is confirmed no confliction with JCTVC-F423 (the concatenation of bypass).

2. Other contributions reviewed in BoG:

JCTVC-F148, JCTVC-F132 – coeff_abs_level_greater1_flag & coeff_abs_level_greater2_flag, test low QP and RDOQ=off in CE11 (exact configuration to be discussed in CE11)

JCTVC-F132/JCTVC-F288 – significant_coeff_flag; Revisit after JCTVC-F288 (detailed notes in discussion) If JCTVC-F288 is adopted, reconcile with JCTVC-F132. If JCTVC-F288 not adopted, adopt JCTVC-F132.

3. No Consensus in BoG:

JCTVC-F497 – split_cu_flag (context selection based on depth rather than neighbors); some support but concerns on class E.

JCTVC-F606 – use depth to select context for on cbf_cr, cbf_cb for inter prediction (the associate changes (both RQT and context selection) were discussed at 2nd meeting. (Concern was raised regarding mismatch between SW and text noticed during integration 1) change to RQT, 2) change to RDOQ (at 4th meeting discussed that similar results are obtained without RDOQ change.)

Require additional results [July 20, 2011 – results for cbf_luma & cbf_chroma alone provided (see results section)]

JCTVC-F429 – cbf_luma (need to provide individual results). For cbf_luma without neighbours, the Y BD-rate is 0.02/−0.03/−0.02 for AI/RA/LC, for cbf_luma with only left, the Y BD-rate is 0.01/−0.01/−0.04 for AI/RA/LC.

JCTVC-F060 – skip_flag (change applicable if only one line buffer remaining in CABAC); cbf_luma (need to provide individual results). For cbf_luma, the Y BD-rate is 0.01/−0.02/−0.01 for AI/RA/LC. For cbf_chroma, the Y BD-rate is 0.01/−0.03/−0.01 for AI/RA/LC.

4. Clarification on WD:

Remove neighbor dependency for alf_cu_flag from WD for CABAC (not in HM)

Tests performed:

Combination of changes summarized below were integrated by T. Nguyen (HHI) who will also provide WD text. Results were cross-checked by Samsung. Coding efficiency results are 0.06% AI, 0.01 RA, -0.10 LD for savings of 29 contexts. Line buffer size requirement reduced.

mvd (14 -> 2), last_significant_coeff_x & y (41->31), merge_flag (3->1), intra_chroma_pred_mode (4->2), ref_idx (8->4), inter_pred_flag (3 -> 4), no_residual_data_flag (3->1)

JCTVC-F429 – remove neighbour dependency for context selection for intra_chroma_pred_mode, merge_flag, ref_idx, mvd, no_residual_data_flag

JCTVC-F429/JCTVC-F132 – mvd (remove neighbors dependency for context selection of binIdx0)

JCTVC-F375 – last_significant_coeff_x/y (clarification of context reduction required)

JCTVC-F606 – inter_pred_flag (use depth to select context rather than neighbor top & left)

JCTVC-F455 – mvd (two fixed contexts for binIdx0 and binIdx1, shared between x/y components; exp-Golomb binarization =1 and bypass coding for other bins)

Decision:

- Adopt suggestions as under 1) and 4) above
- Adopt from JCTVC-F288 reconciliation with JCTVC-F132 and JCTVC-F606 chroma cbf as reported elsewhere.
- Adopt JCTVC-F429 for cbf luma

JCTVC-F751 BoG report on CE2: Motion partitioning and OBMC [J. Boyce] [upload 07-17]

The purpose of this BoG was to evaluate the complexity and performance of the Core Experiment 2 on Motion partitioning and OBMC. The following contributions were reviewed: JCTVC-F049, JCTVC-

F299, JCTVC-F379, JCTVC-F410, JCTVC-F412, and JCTVC-F415. A list of recommended options for the JCT-VC to consider was provided.

The contributions were evaluated based upon encoder and decoder complexity, with special consideration given to worst-case decoder complexity. Recommended options for the JCT to consider were listed in an Excel document, in order of increasing worst-case decoder complexity, then increasing encoder complexity, in order to enable tradeoffs between complexity and gain for the tools under consideration.

In some cases, small modifications were proposed as options to the contributed tools. For NSQT in JCTVC-F412, 2x8 and 8x2 blocks were suggested to be excluded, to avoid adding a 2-point transform to the specification. For AMP in JCTVC-F379, it was proposed to consider adding the asymmetric partitions to the design, but not enabling their use in the common conditions.

The contributions included in the recommended list of options, JCTVC-F412, JCTVC-F379, and JCTVC-F299, all have provided text. The BoG reported that the recommended proposals are mature enough to be considered for adoption at this meeting.

Notes are recorded elsewhere in this report regarding the conclusions reached on the CE2 contributions.

JCTVC-F752 BoG report on quantization offset, adaptive reconstruction level [G. Martin-Cocher (RIM)] [upload 07-18]

Presented in Track B

In the CE4 subset 3, JCTVC-F119 and JCTVC-F276 as well as a new proposal JCTVC-F610 propose to define at the slice level, one or more offsets to be applied to the quantizer reconstruction level. The following concerns were raised by the committee and discussed in the BoG:

- Does the gain from those techniques come from bit allocation, what are their impacts on PSNR and RVM values?
- Could "encoder only" techniques provide similar gain/complexity?
- How could these techniques be evaluated against the above?

The BoG came to the conclusion that a CE is needed to evaluate these proposals as well as combinations of them.

The following tests would be performed:

1) Bit allocation/intra-boosting/reverse intra-boosting. (HM4 common condition)
    - Adjust proposed encoders so that the average bit rate for each class of frames (temporal level) is as close as possible to that of the anchor for each sequence. Intra picture remains the same. For each temporal level the lambda will be adjusted. A tolerance of 2% per temporal level is to be observed.
    - Compare the PSNR and the average bitrate for the sequence

Question: How to define actual rates of temporal levels? Deduced from the rates that the HM produces in default settings.

2) Encoder only technique (HM4 common condition)

This test aims at verifying if encoder only techniques could achieve similar functions/gains or if the gain could be cumulative.

The propose tests consist of using QP scaling. The current proposal is to use delta QP/Fractional offset (as illustrated in JCTVC-F610) and round the offset to the nearest QP value.

3) Comparison to Anchor. (HM4 common condition [6])

- Proposals with no lambda changes
- One or multiple offsets.

4) 4) RDOQ Off + EEM

This test aims at verifying if encoder only techniques could achieve similar functions/gains or if the gain could be cumulative.

- Adaptive rounding/EEM would need to be integrated in HM (for this CE).
- A volunteer is needed (Microsoft expresses interest; to be confirmed)

JCTVC-F753 BoG report on unified scans for the significance map and coefficient level coding in high efficiency (JCTVC-F288) [R. Joshi] [upload 07-17]

Presented in Track B

The objective of the break out group was to discuss adoption of JCTVC-F288. During the presentation of JCTVC-F288, some concerns were expressed. The break out group addressed these issues and tried to form a consensus.

The context initialization issue was discussed. Proponents shared some results when the context models for HM 3.0 are trained using class C and D and used to encode the same test sequences. It was shown that the performance improvement for trained HM.30 contexts over HM3.0 was very small (on average less than 0.05%).

The advantages of the proposal for software were discussed. It was agreed that for optimized software implementations, having unified scans would be beneficial over having two separate scans.

It was commented that the working draft text will be simpler if scans are unified.

The issue of hardware complexity was discussed. The proponents provided additional information to show that same reordering logic could be used for significance and level coding scans.

Sony still has some concerns about memory read/write for large scans. But they agreed that it could be implemented. Participants agreed that there could be a difference in the architectures of different companies.

It was also commented that 4x4 scan may be better to interface with other hardware blocks. Proponents clarified that for large block sizes, you have to wait for all the TU data is decoded and dequantized for the transform to be performed. This is very architecture dependent and it was agreed that there could be a difference in the architectures of different companies.

The existing level coding has a parsing issue as it needs to know the intra mode. It was commented that the proposed solution makes the parsing of coefficient level independent of the intra mode. There was no consensus on the significance of this issue.

The proposal also reduced the number of contexts for the significance map coding. Context removal was not in the original proposal (JCTVC-E335). It was agreed that this simplification was desirable and the additional contexts were not needed in the current design.

There was support for adoption of part 2 (unified scans) but no consensus.

One participant suggested that the adoption of reverse significance scan could be discussed in the breakout group on context reduction.

Main concern was raised w.r.t. hardware throughput (processing of 4x4 blocks as in current solution).

Discussion in track B: Fundamental question is whether the unification of scans is going in the wrong direction? If yes, it should be adopted, and further improvements could be suggested by next meeting.

Decision: Adopt in spirit the unified, possible harmonization with JCTVC-F132/JCTVC-F134 (studied in BoG on context simplification) After BoG report: Adopt, Reconcile JCTVC-F288 with JCTVC-F132.

JCTVC-F754 BoG report on CAVLC run-level coding [T. Davies] [upload 07-17]

Decision: Adopt JCTVC-F754. Change of VLC in JCTVC-F408 is for further study.

JCTVC-F755 BoG report on SDIP throughput [W. Gao] [upload 07-18]

Conclusion brought by the BoG:

- Recommend removing 1x16 and 16x1 transform from SDIP design since coding efficiency gain of those transforms doesn't justify the increased implementation cost.
- Coding efficiency gain of 8x2 is significant i.e., a drop of about 0.7% if disabled. The HW cost of 8x2 is however increased compared to 4x4 for the same throughput at the encoder side.

Question: What is the actual increase in complexity? Gate count for the transform is almost doubled (compared to the increase caused by 4x4).

Currently the same degree of optimization is used for rectangular and non-rectangular partitions.

Removing 1x16 decreases encoder time by around 3-4%.

JCTVC-F756 BoG Report on CE4: Quantization (Subtest yy: QP coding) [K. Chono (NEC), H. Aoki (NEC), K. Sugomoto (Mitsubishi), M. Shima (Canon), K. Panusopone (Motorola), X. Zhang (MediaTek), S. Liu (MediaTek), C. Yeo (I2R), M. Coban (Qualcomm), G. Martin-Cocher (RIM), K. Sato (Sony)] [upload 07-18]

Presented in Track B

The BoG suggest following subtests for CE4 / subtest of delta_qp

Subtest x.1 Signalling Unit Granularity

JCTVC-F577: QP adaptation at sub_CU level (Motorola)

Subtest x.2 Entropy Coding and Related

JCTVC-F174: Signalling of Max and Min QP in slice (Mitsubishi)

JCTVC-F492: A table-based delta QP coding method (Ericsson)

JCTVC-F495: Higher granularity of quantization parameter scaling and adaptive delta QP signalling (Samsung)

Subtest x.3 Chroma QP Derivation

JCTVC-F277: Method for deriving Chroma QP from Luma QP (MediaTek)

Subtest x.4 Spatial QP Prediction

JCTVC-F422: Improvement of delta-QP Coding (Sony)

JCTVC-F661: CE4 Subtest 2: Spatial QP prediction: combination of test 2.3.g, 2.3.f and 2.3.e (NEC, Canon, Sony)

JCTVC-F705: CE4 Subtest 2: Spatial QP prediction: combination of test 2.3.g with 2.3.b/2.3.c (Qualcomm)

Subtest x.5 Temporal QP Prediction

JCTVC-F103: CE4 Subtest 2: QP prediction based on intra/inter prediction (test 2.4.b) (NEC)

JCTVC-F499: Temporal QP Memory Compression (Qualcomm, NEC)

BoG participants agreed that TM-5 Step3, which has already been agreed to be implemented on HM-4.0, is realistic enough as evaluation criteria. Current software applies modulation of QP by +-6 but by +-12 will be better to see the differences of coding efficiency with each of the proposals.

Note that this is not to enhance BD-performance but to control subjective quality. TM-5 Step3 may not be the best technique but most adaptive quantization algorithms used in commercial products apply more or less similar techniques, combining with other advanced methods like facial recognition, etc.

BoG suggests that the new CE on Quantization inherits the following evaluation criteria from the previous CE:

BD performance including dQP bit increase/saving

Enc/Dec time as complexity measure

MaxCUDepthDQP=3 (8x8) as mandatory and 2 (16x16), 1(32x32), and 0(64x64) as option.

Additionally the proponent of Subtest x.5 will provide data on amount of storage as measure of implementation cost.

The BoG participants suggested to review JCTVC-F757. See notes under CE4.

JCTVC-F758 CE10: BoG Report [P. Topiwala, M. Budagavi, R. Joshi, A. Fuldseth, I. Kim] [upload 07-18]

- Test plan was set up to test the transforms currently investigated with same HW tool (Catapult C) and SW tool (SIMD, Intel Nehalem platform).
- Forward and inverse transforms should be tested
- Only one size? Would be desirable to have not only test 32pt. transforms, but may not be possible to test all (one more e.g.8x8?)

Establish CE

Further discussion seems necessary in the preparation of the CE about what is possible to test and what is important

JCTVC-F759 Report of the BoG on clean random access (CRA) picture [Y.-K. Wang (BoG chair)] [upload 07-19]

Decision: Reviewed and approved – revision to be uploaded as v2.

JCTVC-F760 BoG report on simplification of intra chroma-from-luma mode prediction J. Chen (BoG Chair) [upload 07-19]

Decision: Agreed.

JCTVC-F763 BoG report on review of non-CE related deblocking contributions [M. Zhou (TI)] [upload 07-21]

Primarily trying to reduce complexity – e.g. reducing line buffers.

Also sharing luma & chroma filtering logic.

JCTVC-F359 disable deblock around edges of constrained intra. Was not included in subjective viewing. Further study was suggested regarding subjective quality, relationship with ALF and SAO, complexity analysis.

JCTVC-F405 sends 28 weighting factors. Gives 1% objective benefit. Info from Toshiba indicates that fixed weight could give 0.4% benefit. Subjective quality seems variable see JCTVC-F765 – possibly some data got mixed up? Put into CE.

JCTVC-F465 reports an asserted sequential dependency issue. A participant remarked that there might have been some interaction between different decisions of the last meeting. Put into CE (e.g. to test relative to alternative proposal JCTVC-F214).

JCTVC-F556 non-square boundary filtering, potential subjective benefit (not tested at this meeting) – put into CE.

It was noted that MSE gains are seen as well as perceptual behaviour. It was noted that JCTVC-F118 had 1.2% and JCTVC-F258 had a similar gain (although JCTVC-F258 had a negative test result in one test case).

JCTVC-F764 BoG report of CE3 MC interpolation filter [T. Suzuki] [upload 07-21]

Complexity measurement – agreement on method. In later plenary discussion, there was some discussion of whether this is adequate – there is a desire to have a more realistic measure in next CE3. An NEC proposal is planned to be used in next CE.

CE3 and related new contributions were reviewed. The BoG identified 5 contributions as valuable to review by the JCT-VC plenary. Those were reviewed by JCT-VC plenary to make a decision. Other contributions are continued to study by CE.

These five were as follows:

Fixed interpolation filter:

- JCTVC-F247 6 tap filter for half pel, 7 taps for quarter pel, 0.1% coding loss
- JCTVC-F599 same complexity as current HM, 0.5% coding improvement, includes change of chroma interpolation, phase shift desirability questioned, gain is primarily low-delay P (low-delay is weighted more heavily in the average than random access)

AIF:

- JCTVC-F468 same length as JCTVC-F247, 0.5% benefit relative to HM, loss in HE case

Other:

- JCTVC-F248 shorter (4 tap) for bipred small block, 0.1 coding loss, average complexity the same.

- JCTVC-F100 different filter at boundary positions within block, 0.2% loss, 7% complexity reduction

It was noted that we will have a flag that disables 4x4 inter prediction, and this will be disabled in the common conditions.

The data in the BoG includes 4x4 inter prediction.

The disabling should be studied in future work.

Was testing done without ALF and SAO? Only for the AIF case, where more gain was shown with ALF and SAO disabled.

Among these five, the first two seem the most promising at the moment. A quarter-phase alternative to JCTVC-F599 was suggested to also be potentially interesting.

No action was taken on these – other than CE work planning.

It was suggested to check visual quality effects in the future work, including with ALF and SAO disabled. It was suggested that some filters might exhibit ringing.

JCTVC-F765 BoG report on intra mode coding with fixed number of MPM candidates [J. Chen] (BoG Chair) [upload 07-20]

This contribution summarizes the activities of the Break out Group (BoG) on intra mode coding with fixed number of MPM candidates.

Decision: "Solution A" is agreed.

Additionally take "Solution B"? Not at the moment; further testing in CE6.

JCTVC-F767 Report on subjective viewing test for deblocking filter proposals [V. Baroncini, A. Norkin, M. Narroschke, B. Jeon] [upload 07-21]

This contribution is a report on informal subjective viewing for the deblocking filtering that was held during the Torino meeting on July 18, 2011. The subjective viewing was conducted according to the mandate of core experiment 12 on deblocking filtering JCTVC-E712. The goal of the informal subjective viewing test was to determine how the deblocking filter proposals affect the subjective quality. In total, six proposals from CE12 and seven other proposals were evaluated in the subjective test.

Subjective test results – taken into account in preparation of JCTVC-F763.

Tuning parameters were proposed in JCTVC-F405, JCTVC-F143, JCTVC-F118, JCTVC-F175, JCTVC-F258.

More BoG discussion was held Thu 3pm.

Decision: Adopt intra TC Offset = 2 from JCTVC-F143 (just changing a constant, average 0.2% benefit).

Decision: Adopt luma part of JCTVC-F118: luma filter design and separate on/off decision for P/Q edge side (1.2% gain without subjective quality loss).

JCTVC-F771 BoG Report on Screen Content Coding [O. C. Au, J. Xu, H. Yu (BoG coordinators)] [upload 07-21]

Decision: Adopt "Class F" into common conditions (not generally required for all experiments, although encouraged).

The desire was expressed to have as much content in 4:4:4 format as can be made available, as well as in 4:2:0 format.

The BoG chose 4 sequences for this "Class F".

7.3 Thursday 21 afternoon

Plenary 1400-1600 Room 2 – Reviewed remaining BoG reports, revisits and remaining documents

(VCEG met 1600-1800, MPEG Video met 1630-1800)

JCT-VC Plenary resumed at 1800 (Lecture Hall 2).

Documents not yet reviewed were also handled, including JCTVC-F465, JCTVC-F550, JCTVC-F694, and JCTVC-F147.

7.4 Friday 22 morning

Plenary 0800-1300 (Lecture Hall 2) – Establishment of AHGs, CEs, software integration planning, approval of output documents and resolutions; if time allows, presentation of remaining late-arrived inputs (JCTVC-F766, JCTVC-F768, JCTVC-F770, JCTVC-F772, JCTVC-F773, JCTVC-F544)

8 Project planning

8.1 WD drafting and software

JCTVC-F333 The Art of Writing Standards: Some "Shalls" and "Shoulds" for Better Quality Interop Specs [G. J. Sullivan (Microsoft)]

This document provides informal comments and guidelines on writing standards for interoperability specifications. It was updated from a prior contribution of the previous meeting to include some additional guidance (esp. for spelling) from the higher levels of ITU-T and ISO/IEC.

JCTVC-F634 HEVC Reference Software Manual [F. Bossen, D. Flynn, K. Sühring (AHG chairs)] [late reg. 07-04, upload 07-18]

This document is a user manual describing usage of reference software for the HEVC project. It applies to version 3.3 of the software.

No detailed presentation was suggested to be needed for this. The contribution was appreciated.

JCTVC-F688 Revised HEVC Software Guidelines [K. Sühring, D. Flynn, F. Bossen (software coordinators)] [late reg. 07-08, upload 07-11]

This contribution provides guidelines for contributors to development of the reference software. It updates the prior JCTVC-C404. It includes updated information regarding the copyright declaration to be used, and provides some comments to help avoid some common problems that have been observed in the work. Some advice was included regarding common sources of bugs, such as improper use of unsigned variable types for loop counters. The excessive use of code duplication was particularly discouraged, as it creates significant problems for future maintenance of the software. Speed optimizations that harm software readability, such as loop unrolling, were discouraged. The use of company names and personal names in macro definitions and comments was discouraged.

It would be desirable if the software used in CEs was also written according to the guidelines.

This was endorsed by the group.

Agreed.

General issues

It was noted that design adoptions are only made under condition that software and text delivery is made in a reasonably timely fashion. Also, testing should be performed after integration to ensure that the tool is really performing its intended purpose and not conflicting with other tools. This was Agreed by the JCT-VC.

8.2 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 8 Nov. 2011.

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.

8.3 General issues for CEs and proposals

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 four 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 three weeks after the release of the HM 4.0 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 given to Ad Hoc Groups rather than designated as CEs.

CE and proposal descriptions need to fully document any relevant encoder search algorithms – especially if some R-D optimization enhancement or fast search technique has been used which may “disguise” the actual characteristics of the proposed technology (e.g. by making a proposed feature appear less complex, by introducing enhanced encoding search technology that may provide R-D benefits that could have also been obtained by non-normative modifications, or by rearranging the sequence of events for an algorithm in a way that may not be the way it should be done in some implementations).

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 expected to be reviewed and given tentative approval during the meeting (in some cases with guidance expressed to suggest modifications to be made in a subsequent revision). At this meeting, there was insufficient time for such plenary review of the CE plan documents.

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.

8.4 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.

8.5 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-F900.

8.6 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.

8.7 Subjective test plan for design

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.

Need to prepare JM & HM encodings, roughly as was done for the CfP.

9 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-F802 HEVC Test Model 4 (HM 4) Encoder Description • Produce and finalize JCTVC-F803 HEVC text specification Working Draft 4 • 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, 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 4.0 software version and the reference configuration encodings according to JCTVC-F900 based on common conditions suitable for use in most core experiments (expected within four weeks after the meeting). • Prepare and deliver HM 4.1 software (and additional "dot" version software releases as appropriate) and appropriate software branches that include additional items not integrated into the 4.0 version (expected within three weeks after the 4.0 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. • 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 technical proposals related to picture partitioning and alternative LCU scan processing including slices, tiles and wavefront • Identify and work to resolve issues relating to the draft text description of picture partitioning and LCU scan order, and the associated reference software functionality • Study interactions and combinations of picture partitioning and LCU scan order related technical proposals • Study the coding efficiency and loss resilience impact of picture partitioning and LCU scan order • Study the use of picture partitioning and LCU scan order for high-level parallelism • Study the use of picture partitioning and LCU scan order for ultra-low delay • Identify and discuss additional issues relating picture partitioning and LCU scan order	R. Sjöberg (chair), Y. Chen, F. Henry, M. Horowitz, K. Kazui, A. Segall (vice chairs)	N
Spatial transforms (AHG5) (jct-vc@lists.rwth-aachen.de) • Study the ("core" and additional) transforms in the HM design, including compression performance, computational complexity, dynamic range, clipping, storage requirements, etc. • Discuss transform-related Core Experiments, and identify potential synergies or incompatibilities related to the tools being tested in the CEs. • 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 and post-processing filtering (AHG6) (jct-vc@lists.rwth-aachen.de) • Study enhancement schemes of in-loop filtering, including de-blocking/de-banding/de-noising filters, and adaptive Wiener-based filters including variants with various inputs, and combination of filters • Study trade-offs and characteristics of filter designs including complexity and subjective and objective performance • Discuss relationships and evaluation procedures for the filtering techniques • Identify possibilities for harmonization of enhanced in-loop filtering technologies • Study the relationship between in-loop and post-processing filtering	T. Yamakage (chair), K. Chono, Y. J. Chiu, I. S. Chong, M. Narroschke (vice chairs)	N

Transform dynamic range (AHG7) (jct-vc@lists.rwth-aachen.de) • Study methods for managing transform dynamic range • Find solutions guaranteeing 16 bit buffers in inverse transform without overflow and with minimal clipping operations • Study hardware and software aspects of inverse transform implementations	E. Alshina, A. Segall (co-chairs)	N
Reference pictures memory compression (AHG8) (jct-vc@lists.rwth-aachen.de) • Study motion compensation memory access bandwidth of HM design and proposed reference picture memory compression schemes • Study reference picture memory compression schemes and other motion compensation memory access reduction schemes • Study data format alignment between reference picture memory compression and display processing • Study the visual quality impact of reference picture memory compression • Report on conclusions reached	K. Chono (chair), T. Chujoh, D. Hoang, C. S. Lim, A. Tabatabai, M. Zhou (vice chairs)	N
Entropy coding architecture (AHG9) (jct-vc@lists.rwth-aachen.de) • Study the entropy coding complexity and compression characteristics of single entropy coder architectures, scalable entropy coder architectures and switchable entropy coder architectures • Consider the potential for introducing scalability in the entropy coding options in the current HM and other potential means of harmonization of HE and LC entropy coding designs • Characterize entropy coding throughput, memory, silicon area, power requirements, etc. • Study interdependencies between entropy coding and other processes and the consequences of these interdependencies • Define practical use cases and corresponding HM configurations to enable testing of different entropy coding architectures in relevant environments • Study and develop approaches for hardware and software evaluation of entropy coding methods • Identify and discuss additional issues on entropy coding	K. McCann (primary), A. Fuldseth, J. Lainema, D. Marpe, A. Segall, K. Sugimoto, V. Sze, W. Wan, X. Wang (vice chairs)	N

Quantization (AHG10) (jct-vc@lists.rwth-aachen.de) • Study quantization issues in the HM design, including step size control, RDOQ, etc. • Study tradeoffs and characteristics of quantization design, including coding efficiency and complexity • Study the impact of quantization on subjective quality • Study proposed quantization schemes such as adaptive quantization level (AQL), quantization matrix support, and adaptive reconstruction offsets, and their effects • Study adequacy of current mapping of QP to quantizer step-size for rate control at different coding levels (LCU, slice, frame, etc.)	M. Budagavi (chair), M. Karczewicz, G. Martin-Cocher, K. Sato (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

Complexity assessment (AHG12)
(jct-vc@lists.rwth-aachen.de)
• Summarize and evaluate the various complexity assessment methods with regard to:
  ▪ computational complexity,
  ▪ parallelism,
  ▪ memory bandwidth,
  ▪ memory capacity,
  ▪ dynamic range requirements,
  ▪ any other aspects of complexity identified as being of interest.
• Develop and propose a set of general measurement metrics.
• Identify criteria to determine the hardware implementability of key hardware modules.
• Identify bottlenecks in the current design with regard to implementation complexity.
	D. Alfonso (chair), J. Ridge, X. Wen (vice chairs)	N

Screen content coding (AHG13) (jct-vc@lists.rwth-aachen.de) • To coordinate the submission, evaluation and selection of "screen content" video test material • To study characteristics of screen content video • Analyze the effects of existing and proposed coding technology on screen content video • To study and establish evaluation methods, test conditions, and metrics for coding of screen content video • Study technology that may be particularly well suited to the coding of screen content video • Study use cases in which screen content video is prevalent and identify potential associated technical implications	O. Au (chair), J. Xu, H. Yu (vice chairs)	N
Loss robustness (AHG14) (jct-vc@lists.rwth-aachen.de) • 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 • Identify techniques and conditions for testing the loss robustness of the design. • 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, J. Xu (vice chairs)	N

High-level syntax (AHG15) (jct-vc@lists.rwth-aachen.de) • Study NAL unit header, sequence parameter set, picture parameter set, proposed additional types of parameter sets, and slice header syntax designs • Study and identify needs for SEI messages and VUI • Study possible improvements to the reference picture list construction processes • Study possible simplifications and improvements to reference picture marking process (e.g., the need of the processes for generating and handling of "non-existing" pictures) • Study the hypothetical reference decoder behaviour • 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 (vice chairs)	N
Padding process (AHG16) (jct-vc@lists.rwth-aachen.de) • Study schemes of padding for unavailable neighbouring samples needed by intra prediction schemes of HEVC HM4.x/WD4, including the trade-offs between complexity and coding efficiency performance. • Identify possibilities for harmonization between the neighbouring sample padding process with the processing and usage of neighboring samples for intra prediction (such as MDIS, intra DC prediction mode, etc.). • Report the results and conclusions to the JCT-VC.	V. Wahadaniah (chair), K. Chono, Y. Lin (vice chairs)	N
Scalable coding investigation (AHG17) (jct-vc@lists.rwth-aachen.de) • Investigate hooks that would be needed for support of bitstream scalability in HEVC syntax • Study the applicability and effectiveness (e.g., relative to simulcast and single-layer coding) of scalability tools • Study potential experimental conditions for evaluation of scalable video coding technologies	J. Boyce (chair), J. Kang, K. Minoo, W. Wan, Y.-K. Wang (vice chairs)	N
Resolution adaption (AHG18) (jct-vc@lists.rwth-aachen.de) • Assess the complexity and efficiency of resolution adaption (as in JCTVC-F158) against alternative approaches e.g. increased QP, and pre-filtering. • Study loss robustness properties and compare with techniques such as adaptive reference frame selection. • Investigate suitable resolution switching filters. • Consider the implications in terms of signalling, HRD, DPB management, and random access.	T. Davies (chair), P. Topiwala, P. Wu (vice chair)	N

Transform skipping (AHG19) (jct-vc@lists.rwth-aachen.de) • Study the adequacy of different entropy coding tools (scans, contexts) with different transform skip modes • Study transform skip mode flags signalling in the context of the RQT design • Identify and discuss additional issues relating to transform skip mode • Study throughput and complexity issues in the context of transform skipping	M. Mrak (chair), J. Sole, I.-K. Kim, J. Xu, H. Yu (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 (vice chairs)	N

Reference picture buffering and list construction (AHG21)
(jct-vc@lists.rwth-aachen.de)
• Study possible improvements to the reference picture list construction processes
   ▪ Examine the behaviour of unified lists with the JCTVC-F493 proposed default list construction processes and identify any robustness issues.
   ▪ Examine the merits of the list 0/1, combined and unified lists
   ▪ Discuss and identify solutions for support of weighted prediction methods
• Produce a single candidate WD text specification for picture buffer management based on JCTVC-F493 for review at the next meeting
• Produce software supporting picture marking including the following features:
   ▪ Flexible support for cyclic picture structures and temporal layering
   ▪ Decoder support to decode a subset of temporal layers
   ▪ Rudimentary error concealment for lost reference picture slices (frame copy of closest picture based on POC, set all MVs of lost reference picture to zero)
	D. Flynn, R. Sjöberg (co-chairs), Y. Chen, T. K. Tan, W. Wan, Y. K. Wang (vice chairs)	N

Lossless coding (AHG22) (jct-vc@lists.rwth-aachen.de) • Study and investigate lossless coding techniques. • Consider complexity and efficiency tradeoffs. • Identify appropriate intra and inter predictive techniques for lossless coding. • Consider bit depth effects.	W. Gao (chair), K. Chono, J. Xu, M. Zhou (vice chairs)	N

10 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)]

JCTVC-F688 Revised HEVC Software Guidelines [K. Sühring, D. Flynn, F. Bossen (software coordinators)]

JCTVC-F800 Meeting Report of 6th JCT-VC Meeting [G. J. Sullivan, J.-R. Ohm]

JCTVC-F802 High Efficiency Video Coding (HEVC) Test Model 4 (HM 4) Encoder Description [K. McCann (primary), B. Bross, W.-J. Han, S. Sekiguchi, G. J. Sullivan] (WG 11 N 12185)

JCTVC-F803 High Efficiency Video Coding (HEVC) text specification Working Draft 4 [B. Bross (primary), W.-J. Han, G. J. Sullivan, J.-R. Ohm, T. Wiegand] (WG 11 N 12186)

JCTVC-F900 Common HM test conditions and software reference configurations [F. Bossen]

Software HM4.0 availability 4 weeks after the meeting (August 19th)

Document deadline of November 2011 meeting is likely to be Nov 8th.

JCTVC-F901 Core Experiment 1: Entropy Coding Investigation [R. Joshi (primary), E. Alshina, H. Kirchhoffer, J. Lainema, H. Sasai]

JCTVC-F902 Core Experiment 2: Motion Partitioning and OBMC [X. Zheng (primary), I. S. Chong, I.-K. Kim]

JCTVC-F903 Core Experiment 3: Motion Compensation [T. Chujoh, E. Alshina]

JCTVC-F904 Core Experiment 4: Quantization [K. Sato (primary), H. Aoki, M. Budagavi, M. Coban, X. Li]

JCTVC-F905 Core Experiment 5: CAVLC Entropy Coding Improvement [X. Wang (primary), P. Wu, C. Y. Kim]

JCTVC-F906 Core Experiment 6: Intra coding improvements [A. Tabatabai (primary), E. François, K. Chono, R. Joshi, J. Lainema, H. Yu]

JCTVC-F907 Core Experiment 7: Additional transforms [R. Cohen (primary), F. Fernandes, R. Joshi, C. Yeo]

JCTVC-F908 Core Experiment 8: Non-deblocking loop filtering [T. Yamakage (primary), I. S. Chong, M. Narroschke, Y.-W. Huang]

JCTVC-F909 Core Experiment 9: MV Coding and Skip/Merge Operation [B. Bross (primary), W. J. Chien, J. Jung, I. K. Kim, M. Zhou]

JCTVC-F910 Core Experiment 10: Core Transforms [P. Topiwala (primary), M. Budagavi, A. Fuldseth, R. Joshi, E. Alshina]

JCTVC-F911 Core Experiment 11: Coefficient Scanning and Coding [V. Sze (primary), J. Chen, T. Nguyen, K. Panusopone, J. Sole]

JCTVC-F912 Core Experiment 12: Deblocking Filter [A. Norkin (primary), X. Guo, B. Jeon, M. Narroschke]

JCTVC-F913 Core Experiment 13: Motion data parsing robustness and throughput [J. Jung (primary), B. Bross, J. Chen, P. Onno, M. Zhou]

11 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:

- 21–30 November 2011 under ITU-T auspices in Geneva, CH.
- 1–10 February 2012 under WG 11 auspices in San José, USA.
- 2–9 May 2012 under ITU-T auspices in Geneva, CH.
- 11–20 July 2012 under WG 11 auspices in Stockholm, SE.

UNINFO was thanked for its excellent hosting of the 6th meeting of the JCT-VC. Sisvel Technology and Vittorio Baroncini were thanked for providing the viewing equipment used at the meeting.

The JCT-VC meeting was closed at approximately 1315 hours on Friday 22 July 2011.

Annex A to JCT-VC report:
List of documents

JCT-VC number	MPEG number	Created	First upload	Last upload	Title	Source
JCTVC-F001	m20785	2011-07-01 04:37:08	2011-07-21 08:33:20	2011-07-21 08:33:20	JCT-VC AHG report: Project management (AHG 1)	G. J. Sullivan, J.-R. Ohm (co-chairs)
JCTVC-F002	m20454	2011-06-25 11:11:17	2011-07-13 22:08:25	2011-07-13 22:08:25	JCT-VC AHG report: HEVC Draft and Test Model editing (AHG 2)	K. McCann, T. Wiegand (co-chairs), B. Bross, W.-J. Han, J.-R. Ohm, S. Sekiguchi, G. J. Sullivan (vice-chairs)
JCTVC-F003	m21333	2011-07-13 06:09:58	2011-08-11 20:46:06	2011-08-11 20:46:06	JCT-VC AHG report: Software development and HM software technical evaluation (AHG 3)	F. Bossen (chair), D. Flynn, K. Sühring (vice-chairs)
JCTVC-F004	m21173	2011-07-08 23:29:53	2011-07-12 16:48:42	2011-07-12 16:48:42	JCT-VC AHG report: Slice support development and characterization (AHG 4)	R. Sjöberg (chair), Y. Chen, M. Horowitz, K. Kazui, A. Segall (vice-chairs)
JCTVC-F005	m20788	2011-07-01 05:30:03	2011-07-13 21:58:38	2011-07-15 06:48:34	JCT-VC AHG report: spatial transforms (AHG 5)	P. Topiwala (chair), M. Budagavi, R. Cohen, R. Joshi (vice-chairs)
JCTVC-F006	m21292	2011-07-12 04:49:45	2011-07-12 15:24:53	2011-07-14 12:02:21	JCT-VC AHG report: In-loop and post-processing filtering (AHG 6)	T. Yamakage (chair), K. Chono, Y. J. Chiu, I. S. Chong, M. Narroschke (vice-chairs)
JCTVC-F007	m21341	2011-07-13 21:34:02	2011-07-13 22:23:27	2011-07-19 05:55:00	JCT-VC AHG report: Coding block structures (AHG 7)	K. Panusopone (chair), W. J. Han, T. K. Tan, T. Wiegand (vice-chairs)
JCTVC-F008	m21205	2011-07-11 06:48:02	2011-07-11 07:23:05	2011-07-13 15:54:27	JCT-VC AHG report: Reference pictures memory compression (AHG 8)	K. Chono (chair), T. Chujoh, C. S. Lim, A. Tabatabai, M. Zhou (vice-chairs)

JCTVC-F009	m21331	2011-07-13 04:23:49	2011-07-13 04:36:15	2011-07-13 12:17:30	JCT-VC AHG report: Entropy coding (AHG 9)	M. Budagavi (chair), G. Martin-Cocher, A. Segall, W. Wan (vice-chairs)
JCTVC-F010	m21332	2011-07-13 04:37:52	2011-07-13 05:23:57	2011-07-13 05:23:57	JCT-VC AHG report: Quantization (AHG 10)	M. Budagavi (chair), M. Karczewicz, K. Sato, G. Martin-Cocher (vice-chairs)
JCTVC-F011	m21352	2011-07-14 10:32:42	2011-07-14 10:32:58	2011-07-14 10:32:58	JCT-VC AHG report: Video test material selection (AHG 11)	T. Suzuki (chair)
JCTVC-F012	m20451	2011-06-22 17:09:16	2011-06-22 18:16:11	2011-07-17 11:15:17	JCT-VC AHG report: Complexity assessment (AHG 12)	D. Alfonso (chair), J. Ridge, X. Wen (vice-chairs)
JCTVC-F013	m21107	2011-07-06 08:50:48	2011-07-13 17:30:50	2011-07-16 09:31:58	JCT-VC AHG report: Screen content coding (AHG 13)	O. C. Au (chair), J. Xu, H. Yu (vice-chairs)
JCTVC-F014	m21346	2011-07-13 23:09:10	2011-07-13 23:09:29	2011-07-13 23:09:29	JCT-VC AHG report: Loss robustness (AHG 14)	S. Wenger (chair)
JCTVC-F015	m20998	2011-07-02 01:35:50	2011-07-14 09:31:28	2011-07-14 12:18:16	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-F016	m21320	2011-07-12 17:58:07	2011-07-12 18:39:59	2011-07-14 15:55:10	JCT-VC AHG report: Decoder-side motion vector derivation (DMVD) (AHG 16)	Y.-J. Chiu (chair), E. Alshina, H. Yu (vice-chairs)
JCTVC-F017	m20714	2011-06-30 20:32:52	2011-07-08 22:07:26	2011-07-08 22:07:26	JCT-VC AHG report: Scalable coding investigation (AHG 17)	J. Boyce (chair), J. Kang, K. Minoo, W. Wan, Y.-K. Wang (vice-chairs)
JCTVC-F018	m20928	2011-07-01 16:50:22	2011-07-01 16:51:33	2011-07-01 17:35:43	JCT-VC AHG report: Weighted prediction (AHG 18)	P. Bordes, T. K. Tan (co-chairs)
JCTVC-F019	m20767	2011-07-01 03:31:17	2011-07-01 03:32:22	2011-07-11 16:27:40	JCT-VC AHG report: Alternative LCU scan processing (AHG 19)	M. Horowitz (chair), F. Henry, A. Segall (vice-chairs)
JCTVC-F020	m21351	2011-07-14 10:01:25	2011-07-14 12:06:27	2011-07-14 12:06:27	JCT-VC AHG report: Chroma format support (AHG 20)	D. Flynn, D. Hoang (co-chairs)

JCTVC-F021	m21070	2011-07-04 14:31:33	2011-07-05 15:37:26	2011-07-14 09:30:39	CE1: Summary report of Core Experiment on Motion Data Storage Reduction	J. Jung, P. Onno, Y.-W. Huang (CE coordinators)
JCTVC-F022	m20835	2011-07-01 09:17:41	2011-07-02 13:46:15	2011-07-16 08:56:38	CE2: Summary report of Core Experiment on motion partitioning and OBMC	X. Zheng, P. Bordes, P. Chen, I.-K. Kim (CE coordinators)
JCTVC-F023	m20663	2011-06-30 07:35:45	2011-07-02 06:15:06	2011-07-14 07:39:53	CE3: Summary report of Core Experiment on interpolation for MC	E. Alshina, T. Chujoh (CE coordinators)
JCTVC-F024	m20846	2011-07-01 09:55:33	2011-07-12 07:26:05	2011-07-12 07:26:05	CE4: Summary report of Core Experiment on quantization	K. Sato, M. Budagavi, M. Coban, H. H. Aoki, X. X. Li (CE coordinators)
JCTVC-F025	m21054	2011-07-02 12:36:58	2011-07-13 23:26:20	2011-07-13 23:26:20	CE5: Summary report of Core Experiment on CAVLC entropy coding improvements	X. Wang, P. Wu (CE coordinators)
JCTVC-F026	m20969	2011-07-01 20:31:00	2011-07-02 02:37:25	2011-07-15 09:45:01	CE6: Summary report of Core Experiment on intra prediction improvements	A. Tabatabai, M. Budagavi, K. Chono, R. Joshi, A. Segall, H. Yu (CE coordinators)
JCTVC-F027	m20736	2011-07-01 00:44:29	2011-07-08 22:52:41	2011-07-15 11:34:27	CE7: Summary report of Core Experiment on additional transforms	R. Cohen, C. Yeo, R. Joshi, F. Fernandes (CE coordinators)
JCTVC-F028	m21103	2011-07-06 02:08:01	2011-07-12 15:27:18	2011-07-14 18:15:35	CE8: Summary report of Non-deblocking Loop Filtering	T. Yamakage, I. S. Chong, M. Narroschke (CE Coordinators)
JCTVC-F029	m21061	2011-07-03 03:52:12	2011-07-13 21:12:37	2011-07-14 17:12:30	CE9: Summary report of Core Experiment on MV coding and skip/merge operations	Y.-W. Huang, B. Bross, M. Zhou, W.-J. Chien, I.-K. Kim (CE coordinators)
JCTVC-F030	m20789	2011-07-01 05:31:40	2011-07-12 13:27:06	2011-07-20 10:12:28	CE10: Summary report of Core Experiment on core transform design	P. Topiwala, M. Budagavi, I. Kim, R. Joshi (CE coordinators)
JCTVC-F031	m20551	2011-06-29 20:10:58	2011-07-11 22:36:32	2011-07-22 10:16:01	CE11: Summary report of Core Experiment on coefficient scanning and coding	V. Sze, J. Chen, T. Nguyen, K. Panusopone, J. Sole (CE coordinators)
JCTVC-F032	m20965	2011-07-01 20:07:52	2011-07-13 00:22:50	2011-07-16 01:12:34	CE12: Summary report of Core Experiment on deblocking filtering	A. Norkin, X. Guo, B. Jeon, M. Narroschke (CE coordinators)

JCTVC-F041	m20446	2011-06-22 13:44:01	2011-06-23 04:22:32	2011-07-12 03:17:08	CE8 Subtest 4: Adaptive Loop Filtering Using Two Filter Shapes	F. Kossentini, H. Guermazi, N. Mahdi, M. A. Ben Ayed, M. Horowitz (eBrisk)
JCTVC-F042	m20447	2011-06-22 13:53:13	2011-06-23 16:18:48	2011-07-12 03:30:16	CE8 Subtest 5: Adaptive Loop Filtering of Luminance and Chrominance Samples Using Same Filtering Shape, Structure and Map	F. Kossentini, H. Guermazi, N. Mahdi, M. A. Ben Ayed, M. Horowitz (eBrisk)
JCTVC-F043	m20450	2011-06-22 17:04:32	2011-06-22 18:22:44	2011-07-17 11:16:30	Complexity assessment methodology	D. Alfonso (STM)
JCTVC-F044	m20453	2011-06-24 06:00:16	2011-07-01 11:17:53	2011-07-16 10:35:24	Improving Deblocking filter Performance with SKIP-CU	M. Sadafale (TI)
JCTVC-F045	m20456	2011-06-27 06:42:32	2011-07-01 03:02:56	2011-07-12 04:32:30	Early Termination of CU Encoding to Reduce HEVC Complexity	R. H. Gweon, Y.-L. Lee (Sejong Univ.), J. Lim (SK Telecom)
JCTVC-F046	m20458	2011-06-28 09:03:34	2011-07-01 09:24:00	2011-07-14 13:09:40	Efficient binary representation of cu_qp_delta syntax for CABAC	K. Chono, H. Aoki (NEC)
JCTVC-F047	m20459	2011-06-28 10:24:20	2011-07-01 22:46:40	2011-07-21 17:20:20	Modifications of in-loop filter based on non-local means filter	M. Matsumura, Y. Bandoh, S. Takamura, H. Jozawa (NTT)
JCTVC-F048	m20460	2011-06-28 10:33:21	2011-07-01 14:05:44	2011-07-01 14:05:44	CE3: Modifications of region-based adaptive interpolation filter	S. Matsuo, Y. Bandoh, T. Ito, S. Takamura, H. Jozawa (NTT)
JCTVC-F049	m20461	2011-06-28 10:35:34	2011-07-01 17:49:20	2011-07-13 19:36:33	CE2: Report of OBMC with Motion Merging	C.-C. Chen, Y.-Y. Chen, C.-L. Lee, W.-H. Peng, H.-M. Hang (NCTU/ITRI)
JCTVC-F050	m20462	2011-06-28 14:29:51	2011-07-01 15:06:07	2011-07-15 12:02:15	CE9: Results of Experiment SP04	J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F051	m20463	2011-06-28 14:32:39	2011-07-01 15:04:54	2011-07-15 12:03:29	CE9: Results of Experiment ROB03	J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F052	m20464	2011-06-28 14:34:41	2011-07-01 15:03:04	2011-07-15 12:10:10	CE9: Results of Experiment ROB04	J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F053	m20465	2011-06-28	2011-07-01	2011-07-15	Deblocking Filter with Reduced Pixel Line Buffers for LCU-	C.-W. Hsu, J. An, X. Guo, J.-L.

		14:36:26	15:00:52	12:18:32	based Processing	Lin, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F054	m20466	2011-06-28 14:39:10	2011-07-01 14:59:22	2011-07-15 12:20:51	Adaptive Loop Filter with Zero Pixel Line Buffers for LCU-based Decoding	C.-Y. Chen, C.-Y. Tsai, C.-M. Fu, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F055	m20467	2011-06-28 14:40:43	2011-07-01 10:46:59	2011-07-15 12:22:40	Sample Adaptive Offset with Zero Pixel Line Buffers for LCU-based Decoding	C.-M. Fu, C.-Y. Chen, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F056	m20468	2011-06-28 14:44:09	2011-07-01 10:16:23	2011-07-15 18:40:45	Sample Adaptive Offset with LCU-based Syntax	C.-M. Fu, C.-Y. Chen, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek), I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-F057	m20469	2011-06-28 14:45:34	2011-07-01 10:14:51	2011-07-20 10:09:41	Sample Adaptive Offset for Chroma	C.-M. Fu, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek), S. Park, B. Jeon (LGE), A. Alshin, E. Alshina (Samsung)
JCTVC-F058	m20470	2011-06-28 14:47:02	2011-07-01 10:13:33	2011-07-15 12:26:57	Sample Adaptive Offset with PPS-level Syntax	C.-M. Fu, C.-Y. Tsai, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F059	m20471	2011-06-28 14:48:48	2011-07-01 10:12:16	2011-07-15 12:44:24	CABAC with Constrained Outstanding Bits	T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F060	m20472	2011-06-28 14:49:49	2011-07-01 09:52:45	2011-07-15 12:46:35	Reducing Line Buffers for Motion Data and CABAC	T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F061	m20473	2011-06-28 14:50:56	2011-07-01 09:49:33	2011-07-15 12:49:26	CABAC with a Reduced LPS Range Table	T.-D. Chuang, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F062	m20474	2011-06-28 14:51:53	2011-07-01 09:47:10	2011-07-15 12:52:37	Luma Intra Prediction Mode Coding	T.-D. Chuang, C.-Y. Chen, M. Guo, X. Guo, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F063	m20475	2011-06-28 14:52:53	2011-07-01 09:45:07	2011-07-15 12:29:48	Wavefront Parallel Processing with Tiles	C.-W. Hsu, C.-Y. Tsai, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F064	m20476	2011-06-28 14:54:45	2011-07-01 09:40:05	2011-07-01 09:40:05	CE1: Results of Experiments A.6, A.8, and A.10	Y.-W. Chen, J.-L. Lin, X. Guo, Y.-W. Huang (MediaTek)

JCTVC-F065	m20477	2011-06-28 14:56:05	2011-07-01 15:10:26	2011-07-03 04:01:04	CE9: Results of Experiments UNI03, SP10, and SP11	Y.-W. Chen, J.-L. Lin, Y.-W. Huang (MediaTek)
JCTVC-F066	m20478	2011-06-28 14:57:26	2011-07-01 09:32:14	2011-07-07 14:55:55	Crosscheck for LGE's Luma Intra Prediction Mode Coding in JCTVC-F106	T.-D Chuang, Y.-W. Huang (MediaTek)
JCTVC-F067	m20479	2011-06-28 14:58:17	2011-07-01 09:28:12	2011-07-01 09:28:12	CE8 Subtest 1: Crosscheck for Sharp and Qualcomm's Adaptive Loop Filter in JCTVC-F384	C.-Y. Chen, Y.-W. Huang (MediaTek)
JCTVC-F068	m20480	2011-06-28 18:10:49	2011-07-02 01:56:06	2011-07-06 04:10:06	A study on HEVC parsing throughput issue	M. Zhou, V. Sze, Y. Matsuba (TI)
JCTVC-F069	m20481	2011-06-28 18:14:35	2011-07-01 04:49:20	2011-07-22 10:29:32	Parallelized merge/skip mode for HEVC	M.Zhou (TI)
JCTVC-F070	m20482	2011-06-28 18:17:33	2011-07-01 04:29:47	2011-07-22 10:23:44	Sub-8x8 PU coding with fixed reference index	M. Zhou, M. Budagavi (TI)
JCTVC-F071	m20483	2011-06-28 18:26:49	2011-06-28 18:33:51	2011-06-28 18:37:44	CE9: 4.4 Method for improving partial CU merge by merging inter NxN partitions	X. Zhang, S. Liu, S. Lei (MediaTek)
JCTVC-F072	m20484	2011-06-28 18:40:11	2011-06-28 18:57:08	2011-06-28 18:57:08	CE9: Results of Experiments for PART-series	X. Zhang, S. Liu, S. Lei (MediaTek)
JCTVC-F073	m20485	2011-06-28 19:14:20	2011-06-29 07:09:17	2011-06-29 07:09:17	Joint Luma-Chroma adaptive reference picture memory compression	S. Liu, X. Zhang, S. Lei (MediaTek)
JCTVC-F074	m20486	2011-06-28 19:34:26	2011-07-04 12:58:11	2011-07-06 14:49:09	Cross-check of TI's study on HEVC parsing throughput issue JCTVC-F068	B. Bross (Fraunhofer HHI)
JCTVC-F075	m20487	2011-06-28 20:55:06	2011-07-02 08:40:26	2011-07-19 15:12:00	Unified scaling with adaptive offset for reference frame compression	D. Hoang (Zenverge)
JCTVC-F076	m20488	2011-06-28 23:03:21	2011-06-28 23:08:24	2011-06-28 23:08:24	ALF coefficient prediction	K. Andersson (Ericsson)
JCTVC-F077	m20489	2011-06-28 23:57:22	2011-07-01 21:55:05	2011-07-15 16:51:40	Transform skip mode	M. Mrak, A. Gabriellini, N. Sprljan, D. Flynn (BBC)
JCTVC-F078	m20490	2011-06-29	2011-06-29	2011-07-08	Cross verification report for JCTVC-F075 proposed by	X. Zhang, S. Liu (MediaTek)

		00:06:08	00:18:00	21:20:39	Zenverge	
JCTVC-F079	m20491	2011-06-29 00:22:57	2011-07-07 08:42:37	2011-07-11 08:27:47	Crosscheck of JCTVC-F073 proposal for joint luma-chroma adaptive reference picture memory compression	D. Hoang (Zenverge)
JCTVC-F080	m20492	2011-06-29 00:35:30	2011-07-01 04:15:53	2011-07-01 04:15:53	CE9: Cross-check results on SP05, SP06, SP08, SP13 and PART16	M. Zhou (TI)
JCTVC-F081	m20493	2011-06-29 00:37:08	2011-07-01 04:18:27	2011-07-11 00:41:46	CE1: Evaluation results on A.09, A.13-16 and an alternative solution	M. Zhou (TI)
JCTVC-F082	m20494	2011-06-29 00:39:02	2011-07-01 21:47:24	2011-07-01 21:47:24	CE9: A study on partial CU merge (PART13, PART18)	M.Zhou (TI)
JCTVC-F083	m20495	2011-06-29 00:40:24	2011-07-01 04:19:30	2011-07-01 04:19:30	CE9: Evaluation results on disabling TMVP from AMVP list construction (ROB05)	M. Zhou (TI)
JCTVC-F084	m20496	2011-06-29 00:41:57	2011-07-01 04:20:42	2011-07-01 04:20:42	CE9: Evaluation results on SP01, SP02, SP03 and SP14	M. Zhou (TI)
JCTVC-F085	m20497	2011-06-29 00:44:29	2011-07-01 04:21:50	2011-07-22 10:45:16	Further study on compact representation of quantization matrices	M. Zhou, V. Sze (TI)
JCTVC-F086	m20498	2011-06-29 01:00:31	2011-07-01 04:23:24	2011-07-01 04:23:24	Cross verification of LGE's proposal JCTVC-F105 on MVP pruning process	M. Zhou (TI)
JCTVC-F087	m20499	2011-06-29 01:01:45	2011-07-01 13:28:23	2011-07-01 13:28:23	Cross verification of LGE's proposal JCTVC-F104 on intra smoothing	M. Zhou (TI)
JCTVC-F088	m20500	2011-06-29 01:09:22	2011-07-01 04:24:35	2011-07-01 04:24:35	CE9: Simplified AMVP design (SP06S1, SP06S2)	M. Zhou, M. Sinangil, V. Sze (TI), S. Park, J. Park, B. Jeon (LGE)
JCTVC-F089	m20501	2011-06-29 01:16:18	2011-07-01 04:25:59	2011-07-01 04:25:59	A study on simplification of spatial/temporal MVP scaling (CE9 SP01+SP06S2+SP07)	S. Park, J. PARK, B. Jeon (LGE), S. Sekiguchi (Mitsubishi), M. Zhou, M. Sinangil, V. Sze (TI)
JCTVC-F090	m20502	2011-06-29 01:21:11	2011-07-01 14:28:38	2011-07-09 22:46:45	Cross-verification of Panasonic's proposal JCTVC-F470 on parsing robustness for merge/AMVP	M. Zhou (TI)
JCTVC-F091	m20503	2011-06-29	2011-07-02	2011-07-18	Unifying binarizations of Intra modes in HE and LC	E. Maani, A. Tabatabai (Sony)

		04:23:45	01:56:16	12:50:29		
JCTVC-F092	m20504	2011-06-29 04:37:04	2011-07-05 07:39:14	2011-07-15 18:29:55	Coding tree pruning based CU early termination	K. Choi, E. S. Jang (Hanyang Univ.)
JCTVC-F093	m20505	2011-06-29 04:45:22	2011-07-01 15:16:34	2011-07-15 12:35:49	Sample Adaptive Offset with Padding at LCU, Slice, and Image Boundaries	C.-M. Fu, C.-Y. Tsai, C.-Y. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F094	m20506	2011-06-29 06:23:33	2011-07-01 19:28:30	2011-07-21 11:59:34	Coding order of luma and chroma intra prediction modes	H. Nakamura, S. Fukushima (JVC Kenwood)
JCTVC-F095	m20507	2011-06-29 08:06:54	2011-07-01 09:56:27	2011-07-16 14:34:57	Chroma intra prediction based on residual luma samples	K. Kawamura, T. Yoshino, H. Kato, S. Naito (KDDI)
JCTVC-F096	m20509	2011-06-29 09:30:38	2011-07-01 21:25:00	2011-07-18 10:23:11	Scalable structures and inter-layer predictions for HEVC scalable extension	H. M. Choi, J. Nam, D. Sim (Kwangwoon Univ.)
JCTVC-F097	m20510	2011-06-29 10:16:38	2011-07-01 14:16:27	2011-07-03 08:42:37	Cross-check for KDDI's proposal on intra coding (JCTVC-F095)	M. Matsumura, S. Matsuo, Y. Bandoh, S. Takamura, H. Jozawa (NTT)
JCTVC-F098	m20511	2011-06-29 10:17:46	2011-07-01 14:16:57	2011-07-03 08:43:26	Cross-check for JVC KENWOOD's proposal on intra coding (JCTVC-F094)	M. Matsumura, S. Matsuo, Y. Bandoh, S. Takamura, H. Jozawa (NTT)
JCTVC-F099	m20512	2011-06-29 10:48:17	2011-07-01 07:47:54	2011-07-01 07:47:54	Performance report of temporal motion vector prediction	H. Aoki, K. Chono, Y. Senda (NEC)
JCTVC-F100	m20514	2011-06-29 10:59:28	2011-07-01 11:48:11	2011-07-19 12:05:58	CE3: Results on MC boundary filter (tool 4)	K. Kondo, T. Suzuki (Sony)
JCTVC-F101	m20515	2011-06-29 11:02:44	2011-07-01 11:48:50	2011-07-19 12:12:27	CE3: Results on Bi/Uni MC filter (tool 5)	K. Kondo, T. Suzuki (Sony)
JCTVC-F102	m20516	2011-06-29 11:10:27	2011-07-01 07:51:20	2011-07-06 06:51:44	CE4 Subtest 2: Cross-check report of HKUST’s proposal JCTVC-F156 (test 2.1.a)	H. Aoki, K. Chono, Y. Senda (NEC)
JCTVC-F103	m20517	2011-06-29 11:15:54	2011-07-01 08:19:54	2011-07-01 08:19:54	CE4 Subtest 2: QP prediction based on intra/inter prediction (test 2.4.b)	H. Aoki, K. Chono, Y. Senda (NEC)
JCTVC-F104	m20518	2011-06-29	2011-07-01	2011-07-01	On Intra Smoothing	Y. Jeon, B. Jeon (LGE)

		12:24:02	10:09:50	10:09:50		
JCTVC-F105	m20519	2011-06-29 12:25:00	2011-07-01 10:11:11	2011-07-01 10:11:11	On MVP list pruning process	Y. Jeon, B. Jeon (LGE)
JCTVC-F106	m20520	2011-06-29 12:26:57	2011-07-01 10:40:46	2011-07-16 09:43:21	CAVLC coding for Intra Pred mode	J. Park, B. Jeon (LGE)
JCTVC-F107	m20521	2011-06-29 12:29:08	2011-07-01 10:41:18	2011-07-18 10:19:47	Redundancy removal of residual information for CAVLC in merge 2Nx2N	J. Park, B. Jeon (LGE)
JCTVC-F108	m20522	2011-06-29 12:35:04	2011-07-01 10:41:44	2011-07-01 10:41:44	Cross-verification results of MediaTek's improved Intra Mode Coding (JCTVC-F062) by LG	J. Park, B. Jeon (LGE)
JCTVC-F109	m20523	2011-06-29 12:39:01	2011-07-01 10:42:06	2011-07-15 18:58:35	Remaining mode redundancy removal	J. Lim, B. Jeon (LGE)
JCTVC-F110	m20524	2011-06-29 12:40:07	2011-07-01 10:42:28	2011-07-15 08:30:05	CE6.b Test 4: LM mode harmonization on SDIP	J. Lim, B. Jeon (LGE)
JCTVC-F111	m20525	2011-06-29 12:40:52	2011-07-01 10:42:51	2011-07-15 08:31:09	Intra prediction mode coding with CAVLC on SDIP	J. Lim, B. Jeon (LGE)
JCTVC-F112	m20526	2011-06-29 12:44:40	2011-07-01 10:43:15	2011-07-01 10:43:15	CE1: Results of Experiments A.3, A.7, A.9, A.11	S. Park, J. Park, B. Jeon (LGE)
JCTVC-F113	m20527	2011-06-29 12:46:30	2011-07-01 10:43:37	2011-07-01 10:43:37	CE 9: Result of a simplified MVP list construction (SP06)	S. Park, J. Park, B. Jeon (LGE), S. Sekiguchi (Mitsubishi)
JCTVC-F114	m20528	2011-06-29 12:49:17	2011-07-01 10:43:56	2011-07-11 09:01:32	CE1: crosscheck for A.1	Hendry, S. Park, J. Park, B. Jeon (LGE)
JCTVC-F115	m20529	2011-06-29 12:50:23	2011-07-01 10:44:23	2011-07-11 09:01:56	CE9 : crosscheck for SP09	Hendry, J. Park, S. Park, B. Jeon (LGE)
JCTVC-F116	m20530	2011-06-29 12:52:10	2011-07-01 10:44:43	2011-07-11 09:02:17	Cross-verification results of TI's Sub-8x8 PU coding with fixed reference index (JCTVC-F070) by LG	Hendry, S. Park, B. Jeon (LGE)
JCTVC-F117	m20531	2011-06-29 13:16:23	2011-07-11 09:02:40	2011-07-11 09:02:40	Cross-verification results of ZTE's inter mode coding (JCTVC-F418) by LG	Hendry, J. Lim, B. Jeon (LGE)

JCTVC-F118	m20535	2011-06-29 10:39:06	2011-07-02 02:37:53	2011-08-09 15:59:11	CE12: Ericsson's and MediaTek's deblocking filter	A. Norkin, K. Andersson, R. Sjöberg (Ericsson), Q. Huang, J. An, X. Guo, S. Lei (MediaTek)
JCTVC-F119	m20536	2011-06-29 10:42:00	2011-07-01 13:29:26	2011-07-14 15:21:56	CE4 Subtest3: Adaptive De-Quantization Offset	X. Li, X. Guo, S. Lei (MediaTek)
JCTVC-F120	m20537	2011-06-29 10:48:36	2011-07-01 16:08:46	2011-07-01 16:08:46	Simplification of Chroma Deblocking Filter in JCTVC-F118	Q. Huang, J. An, X. Guo, S. Lei (MediaTek)
JCTVC-F121	m20538	2011-06-29 10:59:03	2011-07-01 16:10:20	2011-07-16 09:08:42	Intra Chroma LM Mode with Reduced Line Buffer	M. Guo, X. Guo, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F122	m20539	2011-06-29 11:01:10	2011-07-01 16:12:08	2011-07-15 18:09:55	Direction based Angular Intra Prediction	M. Guo, X. Zhao, X. Guo, S. Lei (MediaTek)
JCTVC-F123	m20540	2011-06-29 11:04:12	2011-07-01 16:13:41	2011-07-15 18:10:35	Updated CAVLC Tables of Intra Mode Coding with Separated DC and Planar	M. Guo, X. Guo, S. Lei (MediaTek)
JCTVC-F124	m20541	2011-06-29 11:35:09	2011-07-01 16:16:16	2011-07-16 09:09:33	Extended Mode-Dependent Coefficient Scanning	X. Zhao, X. Guo, M. Guo, S. Lei (MediaTek), S. Ma, W. Gao (PKU)
JCTVC-F125	m20542	2011-06-29 11:38:42	2011-07-01 13:30:57	2011-07-15 17:33:38	Progressive MV Resolution	J. An, X. Li, X. Guo, S. Lei (MediaTek)
JCTVC-F126	m20543	2011-06-29 12:09:20	2011-07-02 04:24:57	2011-07-15 20:02:23	CE6.e: Mode-Dependent Intra Smoothing Modifications	G. Van der Auwera, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-F127	m20544	2011-06-29 19:44:24	2011-07-04 12:58:40	2011-07-04 12:58:40	CE9: Cross-check of TI's study on partial merge JTVC-F082 (PART18)	B. Bross (Fraunhofer HHI)
JCTVC-F128	m20545	2011-06-29 13:01:15	2011-06-30 18:43:21	2011-07-22 10:17:10	CE11: Reduced neighboring dependency in context selection of significant_coeff_flag for parallel processing (JCTVC-E330)	V. Sze, M. Budagavi (TI)
JCTVC-F129	m20546	2011-06-29 13:02:13	2011-06-30 11:44:08	2011-07-22 10:18:11	CE11: Parallelization of HHI_TRANSFORM_CODING (Fixed Diagonal Scan)	V. Sze, M. Budagavi (TI)
JCTVC-F130	m20547	2011-06-29	2011-06-30	2011-07-22	Parallel Context Processing of Coefficient Level	V. Sze, M. Budagavi (TI)

		13:04:08	18:46:07	10:20:40		
JCTVC-F131	m20548	2011-06-29 13:04:57	2011-06-30 19:44:23	2011-07-22 10:22:51	Modifications to slice header termination for low delay encoding	V. Sze, M. Budagavi, A. Osamoto (TI)
JCTVC-F132	m20549	2011-06-29 13:06:18	2011-07-01 03:32:51	2011-07-22 10:24:30	Reduction in contexts used for significant_coeff_flag and coefficient level	V. Sze (TI)
JCTVC-F133	m20550	2011-06-29 13:06:58	2011-06-30 19:52:54	2011-07-22 10:25:55	Simplified MVD context selection (Extension of JCTVC-E324)	V. Sze (TI), A. P. Chandrakasan (MIT)
JCTVC-F134	m20552	2011-06-29 13:13:48	2011-07-02 03:05:17	2011-07-15 07:02:25	CE11.A: Cross checking of JCTVC-C227 and proposal on semantic, syntax, and implementation	C. Auyeung (Sony)
JCTVC-F135	m20553	2011-06-29 13:17:34	2011-06-30 19:51:40	2011-07-18 20:04:06	Analysis of Multi-core Processing approaches	V. Sze, M. Budagavi, M. Zhou (TI)
JCTVC-F136	m20554	2011-06-29 13:31:50	2011-06-30 20:03:05	2011-07-06 20:31:48	CE11: Cross-check of Qualcomm's Unified scans for the significance map and coefficient level coding in high coding efficiency (JCTVC-E335 Part 2)	V. Sze (TI)
JCTVC-F137	m20555	2011-06-29 20:34:27	2011-07-07 17:09:50	2011-07-07 17:09:50	Cross-check results of Panasonic's Modified MVD coding for CABAC (JCTVC-F423)	V. Sze (TI)
JCTVC-F138	m20556	2011-06-30 10:18:37	2011-07-01 10:58:42	2011-07-01 10:58:42	CE7: Tool 1 - Mode dependent intra residual coding for 8x8 blocks	R. Joshi, P. Chen, M. Karczewicz (Qualcomm), A. Tanizawa, J. Yamaguchi (Toshiba), C. Yeo, Y. H. Tan, Z. Li (I2R)
JCTVC-F139	m20557	2011-06-30 10:21:16	2011-07-04 11:53:38	2011-07-04 11:53:38	CE6.b: Cross-check of Test 2 Case 1 (Huawei JCTVC-F506)	J. Jung, J. Le Tanou (Orange Labs)
JCTVC-F140	m20558	2011-06-30 10:22:19	2011-07-01 07:34:41	2011-07-15 10:53:59	Support of very low delay coding in Tile	K. Kazui, S. Shimada, J. Koyama, A. Nakagawa (Fujitsu)
JCTVC-F141	m20559	2011-06-30 10:23:28	2011-07-01 10:55:58	2011-07-04 02:43:00	CE7: Cross-check of Samsung's proposed Tools 2 (JCTVC-F282) and 6 (JCTVC-F283)	C. Yeo, H. L. Tan, Y. H. Tan (I2R)
JCTVC-F142	m20560	2011-06-30 10:39:26	2011-07-01 07:55:12	2011-07-15 10:47:17	Improvement on derivation process for luma motion vector prediction	S. Shimada, K. Kazui, J. Koyama, A. Nakagawa (Fujitsu)

JCTVC-F143	m20561	2011-06-30 10:40:35	2011-06-30 10:46:30	2011-07-14 20:46:57	CE12: Deblocking filter parameter adjustment in slice level	T. Yamakage, S. Asaka, T. Chujoh (Toshiba), M. Karczewicz, I. S. Chong (Qualcomm)
JCTVC-F144	m20562	2011-06-30 10:41:29	2011-07-01 08:10:34	2011-07-01 08:24:02	CE9: Result of Subtest OPT01	K. Kazui, S. Shimada, J. Koyama, A. Nakagawa (Fujitsu)
JCTVC-F145	m20563	2011-06-30 10:42:53	2011-07-01 08:16:20	2011-07-01 08:26:28	CE9: Cross-verification result of Subtest SP07	K. Kazui, S. Shimada, J. Koyama, A. Nakagawa (Fujitsu)
JCTVC-F146	m20564	2011-06-30 10:44:40	2011-07-01 08:48:58	2011-07-04 01:55:13	Cross-verification result of JCTVC-F172 proposed by Mitsubishi	K. Kazui, S. Shimada, J. Koyama, A. Nakagawa (Fujitsu)
JCTVC-F147	m20565	2011-06-30 10:46:19	2011-06-30 11:31:00	2011-07-01 05:14:38	Industry needs of very low delay coding	K. Kazui, A. Nakagawa, J. Koyama (Fujitsu)
JCTVC-F148	m20566	2011-06-30 10:47:09	2011-07-04 04:12:19	2011-07-16 11:36:33	Context simplification for coefficients entropy coding	X. Che, W. Ding, Y. Shi (Beijing Univ. Tech.)
JCTVC-F149	m20567	2011-06-30 10:47:43	2011-07-01 03:13:50	2011-07-03 09:42:01	CE11: Cross-check of TI's proposal on diagonal coefficient scans (JCTVC-F129)	C. Yeo, Y. H. Tan (I2R)
JCTVC-F150	m20568	2011-06-30 10:49:45	2011-07-04 04:03:29	2011-07-13 06:05:10	Inter modes for screen content coding	W. Zhu, W. Ding, Y. Shi, B. Yin (Beijing Univ. Tech.)
JCTVC-F151	m20569	2011-06-30 10:51:10	2011-07-01 03:12:42	2011-07-03 09:53:01	CE6 Subtest A: Cross-check report on Bidirectional UDI mode (JCTVC-F509)	H. L. Tan, Y. H. Tan, C. Yeo (I2R)
JCTVC-F152	m20570	2011-06-30 10:52:34	2011-07-01 12:43:50	2011-07-05 12:32:03	Cross-check of JCTVC-F077 Transform Skip Mode	T. Davies (Cisco)
JCTVC-F153	m20571	2011-06-30 10:53:52	2011-07-01 10:59:59	2011-07-15 18:11:18	On fast implementation of 4-point ODST-3 in HM3	C. Yeo, Y. H. Tan, Z. Li (I2R)
JCTVC-F154	m20573	2011-06-30 10:54:48	2011-07-07 11:25:09	2011-07-07 11:25:09	Cross-check of JCTVC-F091 on Intra prediction mode coding	T. Davies (Cisco)
JCTVC-F155	m20574	2011-06-30 10:56:34	2011-07-01 10:53:03	2011-07-01 10:53:03	CE6 Subtest B: Cross-check report on SDIP Test 2b (JCTVC-F506)	C. Yeo, Y. H. Tan (I2R)

JCTVC-F156	m20575	2011-06-30 11:00:06	2011-07-01 19:22:00	2011-07-04 05:11:27	CE4 Subtest2: QP prediction with previous CU (subtest 2.1.a)	C. Pang, O. C. Au, X. Wen, F. Zou, J. Dai, X. Zhang (HKUST)
JCTVC-F157	m20576	2011-06-30 11:04:01	2011-07-01 02:08:22	2011-07-12 09:51:43	CE8.5: Unified Chroma Filter Shapes with Luma's Shapes for ALF	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-F158	m20577	2011-06-30 11:08:24	2011-07-01 12:14:31	2011-07-15 15:18:42	Resolution switching for coding efficiency and error resilience	T. Davies (Cisco)
JCTVC-F159	m20578	2011-06-30 11:09:00	2011-07-01 08:18:34	2011-07-01 08:18:34	CE4 Subtest 2: QP prediction based on intra prediction (test 2.3.g)	H. Aoki, K. Chono (NEC), M. Kobayashi, M. Shima (Canon)
JCTVC-F160	m20579	2011-06-30 11:12:16	2011-06-30 18:06:52	2011-07-16 11:06:54	CAVLC table-size reduction for Inter/chroma run-level coding	T. Davies (Cisco)
JCTVC-F161	m20580	2011-06-30 11:23:01	2011-06-30 09:27:54	2011-07-10 17:20:35	Complexity Scalable ALF	M. Li, P. Wu, Z. Li, W. Zhang (ZTE)
JCTVC-F162	m20581	2011-06-30 11:23:08	2011-07-01 12:08:08	2011-07-15 08:14:14	Entropy coding performance simulations	T. Davies, A. Fuldseth (Cisco)
JCTVC-F163	m20582	2011-06-30 11:31:37	2011-07-06 10:58:45	2011-07-06 10:58:45	CE8.2: Verification results of Sony's PALF JCTVC-F285	T. Yamakage, T. Watanabe (Toshiba)
JCTVC-F164	m20583	2011-06-30 11:34:05			Withdrawn	
JCTVC-F165	m20584	2011-06-30 11:35:03			Withdrawn	
JCTVC-F166	m20585	2011-06-30 11:44:21	2011-07-01 06:47:33	2011-07-01 06:47:33	CE9:Cross-verification on disabling spatial MVP scaling process for smaller PUs(SP01/02) (JCTVC-F084)	Y. Itani, S. Sekiguchi (Mitsubishi)
JCTVC-F167	m20586	2011-06-30 11:45:01	2011-07-01 06:55:21	2011-07-01 06:55:21	CE9:Cross-verification on optimization of MV prediction (OPT01) (JCTVC-F144) of MV prediction (OPT01)	Y. Itani, S. Sekiguchi (Mitsubishi)

JCTVC-F168	m20587	2011-06-30 11:45:25	2011-07-01 06:56:17	2011-07-01 06:56:17	CE9:Modified AMVP Scaling Process(SP05)	Y. Itani, S. Sekiguchi (Mitsubishi)
JCTVC-F169	m20588	2011-06-30 11:45:51	2011-07-01 06:57:16	2011-07-01 06:57:16	CE9: Temporal vector restriction for small PUs (SP07/SP09/SP12)	Y. Itani, S. Sekiguchi (Mitsubishi)
JCTVC-F170	m20589	2011-06-30 11:46:30	2011-07-11 11:55:13	2011-07-11 11:55:13	CE8 Subtest2: Cross-verification on Sony's Parametric Adaptive Loop Filter (JCTVC-F285)	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-F171	m20590	2011-06-30 11:46:57	2011-07-01 06:59:29	2011-07-01 06:59:29	CE6.e: Cross-verification report on Qualcomm's improved MDIS (JCTVC-F126)	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-F172	m20591	2011-06-30 11:47:18	2011-07-01 07:04:04	2011-07-17 08:10:29	An improved intra vertical and horizontal prediction	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-F173	m20592	2011-06-30 11:47:38	2011-07-01 07:04:55	2011-07-17 08:12:13	An improvement to chroma intra prediction from luma	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-F174	m20593	2011-06-30 11:47:58	2011-07-01 11:14:44	2011-07-15 18:52:19	Signaling of Max and Min QP in slice	K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-F175	m20594	2011-06-30 11:48:59	2011-07-01 07:06:13	2011-07-11 14:13:34	Signaling of boundary filtering strength of deblocking filter for intra	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-F176	m20595	2011-06-30 11:49:21	2011-07-01 08:15:12	2011-07-25 12:41:27	Improved PIPE/V2F for low complexity entropy coding	K. Sugimoto, R. Hattori, S. Sekiguchi, K. Asai (Mitsubishi)
JCTVC-F177	m20596	2011-06-30 11:49:38	2011-07-01 07:08:15	2011-07-16 08:52:13	Fast bypass mode for CABAC	R. Hattori, K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-F178	m20597	2011-06-30 11:49:58	2011-07-01 08:09:36	2011-07-22 09:56:32	Removing availability checking for Intra DC prediction filtering	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-F179	m20598	2011-06-30 11:50:37	2011-07-01 11:16:57	2011-07-12 06:43:52	An improvement on pixel classification for ALF based on edge direction	K. Sugimoto, K. Miyazawa, A. Minezawa, S. Sekiguchi, T. Murakami (Mitsubishi)
JCTVC-F180	m20599	2011-06-30 11:55:09	2011-07-12 03:42:24	2011-07-12 03:42:24	Cross-check of HHI's proposal (JCTVC-F268) on Unified PIPE-based Coding	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)

JCTVC-F181	m20600	2011-06-30 11:55:29	2011-07-12 03:22:26	2011-07-12 18:38:35	Cross-check of NEC's proposal (JCTVC-F046) on cu_qp_delta syntax for CABAC	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-F182	m20601	2011-06-30 11:55:48	2011-07-16 05:51:06	2011-07-16 05:51:06	Cross-check of MediaTek, Qualcomm, Sharp and Toshiba's proposal (JCTVC-F522) on Enhancement of ALF	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-F183	m20602	2011-06-30 11:56:11	2011-07-01 09:30:06	2011-07-01 09:30:06	Cross-verification report on Fujitsu's proposal (JCTVC-F142) on AMVP	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-F184	m20603	2011-06-30 11:57:30	2011-06-30 12:50:36	2011-07-14 17:17:31	Evaluation of PU-level vs TU-level intra prediction	A. Gabriellini, M. Mrak (BBC)
JCTVC-F185	m20604	2011-06-30 12:01:13	2011-07-01 03:18:32	2011-07-01 03:18:32	CE11: Cross-check result of TI proposal on context simplification of the significance map (JCTVC-F128).	C. Rosewarne, M. Maeda (Canon)
JCTVC-F186	m20605	2011-06-30 12:08:12	2011-06-30 12:20:28	2011-06-30 12:39:42	Predicted neighbour for context selection of significant_coeff_flag for parallel processing	C. Rosewarne, M. Maeda (Canon)
JCTVC-F187	m20606	2011-06-30 12:11:55	2011-06-30 09:29:06	2011-06-30 09:29:06	Comments on Slice Common Information Sharing	M. Li, P. Wu (ZTE)
JCTVC-F188	m20607	2011-06-30 12:20:44	2011-07-01 05:40:08	2011-07-01 05:40:08	CE8.5: Verification results of eBrisk Video's Proposal JCTVC-F042	T. Yamakage, T. Watanabe (Toshiba)
JCTVC-F189	m20608	2011-06-30 12:26:02	2011-07-01 02:51:45	2011-07-12 04:24:08	CE12: Verification results of Ericsson/MediaTek's deblocking filter JCTVC-F118	T. Yamakage, S. Asaka (Toshiba)
JCTVC-F190	m20609	2011-06-30 12:31:13	2011-07-02 13:50:00	2011-07-17 11:35:14	Planar Mode Mapping for Intra Mode Coding	F. Zou, O. C. Au, C. Pang, J. Dai, X. Zhang, X. Wen (HKUST)
JCTVC-F191	m20610	2011-06-30 12:44:21	2011-07-01 17:56:33	2011-07-13 11:18:00	CE12: Results for decisions for deblocking	M. Narroschke, T. Wedi (Panasonic)
JCTVC-F192	m20611	2011-06-30 12:50:35	2011-07-01 14:01:53	2011-07-15 12:19:20	A study on addition of 64x64 transform to HM 3.0	Y. Sugito, A. Ichigaya, S. Sakaida (NHK), K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-F193	m20612	2011-06-30 12:51:46	2011-07-01 14:10:17	2011-07-14 07:21:26	Accuracy improvement of Cisco and TI's transform (JCTVC-E243)	Y. Sugito, A. Ichigaya, S. Sakaida (NHK)

JCTVC-F194	m20613	2011-06-30 12:57:48	2011-06-30 06:26:47	2011-07-01 04:37:43	Proposal on the support of interlace format in HEVC	S. Sekiguchi, K. Sugimoto, H. Sakate (Mitsubishi)
JCTVC-F195	m20614	2011-06-30 12:59:24	2011-07-01 10:45:16	2011-07-11 09:03:02	CE6.b Test 4: Cross-verification results of Microsoft's LM mode harmonization on SDIP(JCTVC-F196) by LG	J. Lim, B. Jeon (LGE)
JCTVC-F196	m20615	2011-06-30 13:04:50	2011-07-01 18:52:53	2011-07-12 15:03:41	CE6.b Report of Test 4: Harmonization of LM mode and the chroma prediction in SDIP	X. Peng (USTC), J. Xu (Microsoft)
JCTVC-F197	m20616	2011-06-30 13:05:04	2011-07-01 18:55:19	2011-07-12 15:04:05	CE6.b Report of Test 3: Interaction between SDIP and MDCS	X. Peng (USTC), J. Xu (Microsoft)
JCTVC-F198	m20617	2011-06-30 13:05:16	2011-07-01 18:56:35	2011-07-12 16:03:22	CE12, Subset 1: Report of Deblocking for Large Size Blocks	Z. Shi (USTC), X. Sun, J. Xu (Microsoft)
JCTVC-F199	m20618	2011-06-30 13:05:29	2011-07-01 19:45:03	2011-07-16 11:22:28	A further improvement of inter prediction direction and reference frame index combined coding in CAVLC	B. Li (USTC), J. Xu (Microsoft), H. Li (USTC)
JCTVC-F200	m20619	2011-06-30 13:05:41	2011-07-01 18:59:21	2011-07-12 13:21:55	Improvements of the BCIM modes in screen content coding	C. Lan (Xidian Univ.), J. Xu, G. J. Sullivan, F. Wu (Microsoft)
JCTVC-F201	m20620	2011-06-30 13:05:53	2011-07-01 18:59:55	2011-07-17 13:42:43	High-level Syntax: Temporal Information Decoding Refresh	B. Li (USTC), J. Xu (Microsoft), H. Li (USTC)
JCTVC-F202	m20621	2011-06-30 13:06:07	2011-07-01 19:01:10	2011-07-01 19:01:10	CE1: Cross-check of experiment A.8	B. Li (USTC), J. Xu (Microsoft)
JCTVC-F203	m20622	2011-06-30 13:06:23	2011-07-01 19:02:50	2011-07-01 19:02:50	CE4.3.a Cross-check of Adaptive De-Quantization Offset	B. Li (USTC), G. J. Sullivan, J. Xu (Microsoft)
JCTVC-F204	m20623	2011-06-30 13:06:41	2011-07-01 19:04:55	2011-07-01 19:04:55	CE6.a: Cross-check of cases 7 and 8 for BUDI	X. Peng (USTC), J. Xu (Microsoft)
JCTVC-F205	m20624	2011-06-30 13:06:55	2011-07-01 19:08:03	2011-07-01 19:08:03	CE9: Cross-check of ROB01 and ROB02 (JCTVC-F474)	B. Li (USTC), J. Xu (Microsoft)
JCTVC-F206	m20625	2011-06-30 13:07:08	2011-07-12 16:03:44	2011-07-12 16:03:44	CE12: Cross-check of harmonized deblocking filter with additional chroma processing (JCTVC-F262)	Z. Shi (USTC), J. Xu (Microsoft)
JCTVC-F207	m20626	2011-06-30	2011-07-13	2011-07-13	Cross-check of adaptive loop filter merge in temporal domain	B. Li (USTC), J. Xu (Microsoft)

		13:07:22	04:11:25	04:11:25	(JCTVC-F498)	
JCTVC-F208	m20627	2011-06-30 13:07:35	2011-07-01 19:08:36	2011-07-01 19:08:36	Cross-check of parallelized merge/skip mode (JCTVC-F069)	B. Li (USTC), J. Xu (Microsoft)
JCTVC-F209	m20628	2011-06-30 13:07:54	2011-07-12 13:22:25	2011-07-12 13:22:25	Cross-check of complexity scalable ALF (JCTVC-F161)	B. Li (USTC), J. Xu (Microsoft)
JCTVC-F210	m20629	2011-06-30 13:08:15	2011-07-12 13:23:17	2011-07-12 13:23:17	Cross-check of simplified filtering decision for chroma deblokcing filter (JCTVC-F120)	Z. Shi (USTC), J. Xu (Microsoft)
JCTVC-F211	m20630	2011-06-30 13:08:28	2011-07-12 13:25:16	2011-07-12 13:25:16	Cross-check of planar intra prediction improvement (JCTVC-F483)	X. Peng (USTC), J. Xu (Microsoft)
JCTVC-F212	m20631	2011-06-30 13:08:40	2011-07-12 13:27:16	2011-07-12 13:27:16	Cross-check of intra mode parsing (JCTVC-F378)	X. Peng (USTC), J. Xu (Microsoft)
JCTVC-F213	m20632	2011-06-30 13:13:21	2011-07-01 10:30:46	2011-07-01 10:30:46	CE9 4.4: Results and verifications for the inferred merge	Y. Suzuki, T.K. Tan (NTT DOCOMO)
JCTVC-F214	m20633	2011-06-30 13:16:10	2011-07-01 14:45:34	2011-07-17 19:06:36	Parallel deblocking improvement	M. Ikeda, J. Tanaka, T. Suzuki (Sony)
JCTVC-F215	m20634	2011-06-30 13:21:17	2011-07-01 14:44:25	2011-07-16 11:15:42	Vertical tap length reduction to reduce line memory in deblocking filter	M. Ikeda, T. Suzuki (Sony)
JCTVC-F216	m20635	2011-06-30 13:24:40	2011-07-02 00:14:23	2011-07-14 16:00:58	CE3: An Adaptive Interpolation Filtering Technique	F. Kossentini, N. Mahdi, H. Guermazi, M. A. Ben Ayed, M. Horowitz (eBrisk)
JCTVC-F217	m20636	2011-06-30 06:33:13	2011-07-01 14:34:47	2011-07-08 10:21:35	CE12: Cross-verification of Panasonic's proposal JCTVC-F191	M. Ikeda, T. Suzuki (Sony)
JCTVC-F218	m20637	2011-06-30 06:34:27	2011-07-01 14:26:06	2011-07-08 10:20:48	CE12: Cross-verification of SK Telecom/SKKU's proposal JCTVC-F258	M. Ikeda, T. Suzuki (Sony)
JCTVC-F219	m20638	2011-06-30 06:36:27	2011-07-01 14:23:42	2011-07-18 18:19:51	Cross-verification of TI's proposal JCTVC-F044	M. Ikeda, T. Suzuki (Sony)
JCTVC-F220	m20639	2011-06-30 06:37:20	2011-07-01 14:23:08	2011-07-08 10:19:39	Cross-verification of TI's proposal JCTVC-F256	M. Ikeda, T. Suzuki (Sony)

JCTVC-F221	m20640	2011-06-30 06:40:33	2011-07-01 19:22:39	2011-07-04 05:11:58	CE4 Subtest1: the signaling of minCUDQPsize at LCU level	C. Pang, O. C. Au, X. Wen, J. Dai, F. Zou, X. Zhang (HKUST)
JCTVC-F222	m20641	2011-06-30 06:46:07	2011-07-02 01:35:18	2011-07-11 18:31:02	CE3: Cross-check report for Sony's test JCTVC-F100 by eBrisk Video	F. Kossentini, N. Mahdi (eBrisk)
JCTVC-F223	m20642	2011-06-30 06:55:56	2011-06-30 17:50:37	2011-07-11 21:44:09	CE8.1: Verification results of Samsung's Proposal	F. Kossentini, H. Guermazi (eBrisk)
JCTVC-F224	m20643	2011-06-30 07:00:21	2011-07-01 23:42:07	2011-07-18 15:02:40	CE7: Mode Dependent 2-step Transform for Intra Coding	Y. Shibahara, T. Nishi (Panasonic)
JCTVC-F225	m20644	2011-06-30 07:00:40	2011-07-01 23:43:10	2011-07-18 14:59:04	Consideration of reference pixel availability for mode-dependent DCT/DST decision	Y. Shibahara, T. Nishi (Panasonic)
JCTVC-F226	m20645	2011-06-30 07:00:50	2011-07-01 23:43:43	2011-07-01 23:43:43	CE7: Cross Check Report for NHK's proposal (JCTVC-F229) by Panasonic	Y. Shibahara, T. Nishi (Panasonic)
JCTVC-F227	m20646	2011-06-30 07:01:02	2011-07-01 23:45:00	2011-07-01 23:45:00	Cross-check report for Huawei's proposal JCTVC-F501	Y. Shibahara, T. Nishi (Panasonic)
JCTVC-F228	m20647	2011-06-30 07:05:25	2011-07-08 17:36:25	2011-07-18 11:40:26	A study of SCC test sequences	X. Zhang, O. Au, W. Dai, S. Li, C. Pang, X. Wen (HKUST)
JCTVC-F229	m20648	2011-06-30 07:06:02	2011-07-01 14:47:01	2011-07-14 20:46:49	CE7.5: Performance analysis of adaptive DCT/DST selection	A. Ichigaya, Y. Sugito, S. Sakaida (NHK)
JCTVC-F230	m20649	2011-06-30 07:11:16	2011-07-01 14:49:25	2011-07-07 06:45:50	CE7: Cross Check Report for Panasonic's proposal (JCTVC-F224) by NHK	A. Ichigaya, Y. Sugito (NHK)
JCTVC-F231	m20650	2011-06-30 07:12:18	2011-06-30 07:42:42	2011-06-30 07:42:42	CE6.b: Cross-check report of Test 3 : Interaction between SDIP and MDCS, proposal JCTVC-F197	R. Boitard, L. Guillo (INRIA)
JCTVC-F232	m20651	2011-06-30 07:24:18	2011-06-30 23:22:30	2011-06-30 23:22:30	SAO LCU boundary processing	M. Budagavi (TI)
JCTVC-F233	m20652	2011-06-30 07:25:16	2011-06-30 23:15:55	2011-06-30 23:15:55	Luma-based chroma intra prediction simplification	M. Budagavi, A. Osamoto (TI)
JCTVC-F234	m20653	2011-06-30	2011-06-30	2011-06-30	CE8, Subset 4, Tool 3: ALF decode with reduced vertical filter	M. Budagavi, V. Sze, M. Zhou

		07:27:05	23:17:44	23:17:44	size (JCTVC-E060)	(TI)
JCTVC-F235	m20654	2011-06-30 07:28:23	2011-06-30 23:19:10	2011-06-30 23:19:10	CE8, Subset 5, Tool 3: Chroma ALF with reduced vertical filter size (JCTVC-E287)	M. Budagavi, V. Sze, M. Zhou (TI)
JCTVC-F236	m20655	2011-06-30 07:29:30	2011-07-01 06:45:29	2011-07-01 06:45:29	IDCT pruning and scan dependent transform order	M. Budagavi, V. Sze (TI)
JCTVC-F237	m20656	2011-06-30 07:31:33	2011-07-01 13:44:38	2011-07-23 13:14:19	CE4: Crosscheck of RIM ARL proposal (Subtest 3.3.2.b, RDOQ off) (JCTVC-F276)	M. Budagavi (TI)
JCTVC-F238	m20657	2011-06-30 14:33:23	2011-07-01 06:03:33	2011-07-23 13:19:54	CE4: Crosscheck of Sony proposal on dQP prediction (2.3e mod) (JCTVC-F420)	M. Budagavi (TI)
JCTVC-F239	m20658	2011-06-30 07:33:58	2011-06-30 21:35:56	2011-07-23 13:23:04	CE6.b: Crosscheck of SDIP+Mode dependent DCT/DST (test2, case3) (JCTVC-F506)	M. Budagavi (TI)
JCTVC-F240	m20659	2011-06-30 14:34:27	2011-06-30 21:47:02	2011-07-23 13:26:46	CE6.c: Crosscheck of DCIM (case 4) (JCTVC-F566)	M. Budagavi (TI)
JCTVC-F241	m20660	2011-06-30 07:35:02	2011-06-30 20:39:50	2011-06-30 20:39:50	CE10: Crosscheck of Samsung/FastVDO's contribution on core transform - normal QP range (JCTVC-F251)	M. Budagavi (TI)
JCTVC-F242	m20661	2011-06-30 07:35:09	2011-07-01 12:54:37	2011-07-01 12:54:37	Bilinear chroma interpolation for small block sizes	K. Ugur, J. Lainema (Nokia), K. Kondo, T. Suzuki (Sony)
JCTVC-F243	m20662	2011-06-30 07:35:26	2011-06-30 20:16:39	2011-07-23 13:17:29	CE10: Cross-check of Qualcomm's contribution on core transform - low and high QP range (JCTVC-F352)	M. Budagavi (TI)
JCTVC-F244	m20664	2011-06-30 07:37:36	2011-07-10 17:15:07	2011-07-10 17:15:07	CE8: Crosscheck of CE8 Subtest 4: ALF using vertical-size 5 filters with up to 9 coefficients (JCTVC-F303)	M. Budagavi (TI)
JCTVC-F245	m20665	2011-06-30 07:38:08	2011-07-10 16:36:22	2011-07-10 16:46:00	CE8: Crosscheck of CE8.5: Unified Chroma Filter Shapes with Luma's Shapes for ALF (JCTVC-F157)	M. Budagavi (TI)
JCTVC-F246	m20666	2011-06-30 07:38:25	2011-07-06 10:52:46	2011-07-06 10:52:46	CE3: Cross-check report by Nokia for JCTVC-F247, JCTVC-F100	K. Ugur (Nokia)
JCTVC-F247	m20667	2011-06-30 07:39:29	2011-07-02 06:28:48	2011-07-21 08:08:15	CE3: DCT derived interpolation filter test by Samsung.	E. Alshina, A.Alshin (Samsung)

JCTVC-F248	m20668	2011-06-30 07:40:50	2011-07-01 17:13:31	2011-07-14 12:01:49	CE3: Interpolation filter with shorter tap-length for small PU's	K. Ugur, J. Lainema, O. Bici (Nokia)
JCTVC-F249	m20669	2011-06-30 07:41:21	2011-07-10 17:40:00	2011-07-10 17:40:00	Crosscheck results for Samsung JCTVC-F252 (Block-size and pixel position independent boundary smoothing for non-directional Intra prediction)	M. Budagavi (TI)
JCTVC-F250	m20670	2011-06-30 07:41:52	2011-07-10 18:27:09	2011-07-10 18:27:09	Crosscheck results for Samsung JCTVC-F494 (Complexity reduction of chroma intra LM prediction mode)	M. Budagavi (TI)
JCTVC-F251	m20671	2011-06-30 07:44:56	2011-07-02 06:38:36	2011-07-15 13:48:54	CE10: Full-factorized core transform test by Samsung/FastVDO	E. Alshina, A. Alshin, I.-K. Kim (Samsung), P. Topiwala (FastVDO)
JCTVC-F252	m20672	2011-06-30 07:52:59	2011-07-02 06:41:31	2011-07-17 11:32:22	Block-size and pixel position independent boundary smoothing for non-directional Intra prediction	E. Alshina, A. Alshin (Samsung)
JCTVC-F253	m20673	2011-06-30 07:54:36	2011-07-01 04:30:10	2011-07-16 17:22:21	Simplified Bidirectional Intra Prediction	T. Shiodera, A. Tanizawa, T. Chujoh, T. Yamakage (Toshiba)
JCTVC-F254	m20674	2011-06-30 07:55:15	2011-07-02 06:44:12	2011-07-12 12:59:27	Multi-parameter probability up-date for CABAC	A. Alshin, E. Alshina (Samsung)
JCTVC-F255	m20675	2011-06-30 07:57:00	2011-06-30 09:11:29	2011-06-30 09:11:29	CE4 Subtest3: Cross-check report of RIM's proposal JCTVC-F276 (Subtest 3.3.2.a)	X. Li, X. Guo (MediaTek)
JCTVC-F256	m20676	2011-06-30 07:58:19	2011-07-01 11:20:27	2011-07-16 10:36:24	Improving Deblocking filter efficiency	M. Sadafale (TI)
JCTVC-F257	m20677	2011-06-30 07:59:13	2011-07-02 06:46:21	2011-07-12 13:27:01	About clip operation removal from de-quantization part of HM	E. Alshina, A. Alshin (Samsung)
JCTVC-F258	m20678	2011-06-30 08:07:11	2011-07-01 21:19:46	2011-07-18 17:44:26	CE12: SK Telecom/SKKU Deblocking Filter	J. Yang, K. Won, B. Jeon (SKKU), J. Lim (SK Telecom)
JCTVC-F259	m20679	2011-06-30 08:11:00	2011-07-01 11:49:18	2011-07-19 14:47:41	CE3: Cross-check report for test1 JCTVC-F315	K. Kondo, T. Suzuki (Sony)
JCTVC-F260	m20680	2011-06-30 08:11:26	2011-07-01 11:49:47	2011-07-01 11:49:47	CE3: Cross-check report for test2.1 JCTVC-F247	K. Kondo, T. Suzuki (Sony)

JCTVC-F261	m20681	2011-06-30 08:11:46	2011-07-01 11:50:17	2011-07-19 14:48:44	CE3: Cross-check report for test3 JCTVC-F248	K. Kondo, T. Suzuki (Sony)
JCTVC-F262	m20682	2011-06-30 08:11:53	2011-07-01 21:34:34	2011-07-04 11:06:40	CE12: SK Telecom/SKKU Harmonized Deblocking Filter with Additional Chroma Processing	J. Yang, K. Won, B. Jeon (SKKU), J. Lim (SK Telecom)
JCTVC-F263	m20683	2011-06-30 08:20:53	2011-07-01 17:27:49	2011-07-01 17:27:49	CE12: Cross-verification Results of Ericsson and MediaTek Deblocking Filter (JCTVC-F118) by SKT/SKKU	J. Yang, K. Won, B. Jeon (SKKU), J. Lim (SK Telecom)
JCTVC-F264	m20684	2011-06-30 08:23:46	2011-07-01 17:34:15	2011-07-08 04:00:04	CE12: Cross-verification Results of Microsoft Deblocking Filter (JCTVC-F198) by SKT/SKKU	J. Yang, K. Won, B. Jeon (SKKU), J. Lim (SK Telecom)
JCTVC-F265	m20685	2011-06-30 08:27:06	2011-06-30 08:35:53	2011-07-18 16:42:34	Weighted Prediction	P. Bordes (Technicolor)
JCTVC-F266	m20686	2011-06-30 08:32:11	2011-07-12 16:15:27	2011-07-14 09:56:04	CE1: Cross-check of experiment A6 (JCTVC-F064), A9 and A11 (JCTVC-F112), A14 (JCTVC-F081), and results for C1 and C2	J. Jung, J.-M. Thiesse (Orange Labs)
JCTVC-F267	m20687	2011-06-30 08:55:17	2011-07-04 10:49:48	2011-07-04 10:49:48	Cross-verification Results of Sony's Parallel Deblocking Improvement (JCTVC-F214) by SKT/SKKU	J. Yang, K. Won, B. Jeon (SKKU), J. Lim (SK Telecom)
JCTVC-F268	m20688	2011-06-30 09:43:51	2011-07-01 22:32:11	2011-07-15 22:59:12	Unified PIPE-Based Entropy Coding for HEVC	D. Marpe, H. Kirchhoffer, B. Bross, V. George, T. Nguyen, M. Preiß, M. Siekmann, J. Stegemann, T. Wiegand (Fraunhofer HHI)
JCTVC-F269	m20689	2011-06-30 10:00:26	2011-07-01 18:35:18	2011-07-16 18:27:32	Modified Intra Mode Coding	E. Francois, S. Pautet, C. Gisquet (Canon)
JCTVC-F270	m20690	2011-06-30 10:19:21	2011-07-01 02:53:54	2011-07-01 02:53:54	On BD-rate calculation	J. Wang, X. Yu, D. He (RIM)
JCTVC-F271	m20691	2011-06-30 10:21:51	2011-07-01 18:25:02	2011-07-15 17:23:22	Grid displacements for in-loop filtering	S. Esenlik, M. Narroschke, T. Wedi (Panasonic)
JCTVC-F272	m20692	2011-06-30 10:24:06	2011-07-01 17:43:31	2011-07-14 19:09:53	CE8 subtest 3: Line memory reduction for in-loop filtering	S. Esenlik, M. Narroschke, T. Wedi (Panasonic)

JCTVC-F273	m20693	2011-06-30 10:32:03	2011-07-01 02:41:43	2011-07-01 02:41:43	CE4: Cross-check MediaTek's proposal (Subtest 3.3.1.b)	X. Yu, J. Wang, D. He (RIM)
JCTVC-F274	m20694	2011-06-30 18:07:43	2011-07-01 14:20:25	2011-07-16 09:40:03	Wavefront Parallel Processing for HEVC Encoding and Decoding	C. Gordon, F. Henry, S. Pateux (Orange FT)
JCTVC-F275	m20695	2011-06-30 18:12:11	2011-07-01 14:23:36	2011-07-15 09:01:42	Wavefront and Cabac Flush: Different Degrees of Parallelism Without Transcoding	G. Clare, F. Henry, S. Pateux (Orange FT)
JCTVC-F276	m20696	2011-06-30 18:18:07	2011-07-01 02:43:35	2011-07-12 17:10:53	CE4-subtest3.3.2: Quantization with Adaptive Reconstruction Levels	X. Yu, J. Wang, D. He (RIM)
JCTVC-F277	m20697	2011-06-30 18:31:19	2011-06-30 18:35:50	2011-07-12 02:12:20	Method for deriving Chroma QP from Luma QP	X. Zhang, S. Liu (MediaTek)
JCTVC-F278	m20698	2011-06-30 18:40:40	2011-07-01 23:39:09	2011-07-11 12:04:08	Results about CE1 experiments related to A.1, A.5 and B.x tests	G. Laroche, P. Onno, T. Poirier (Canon)
JCTVC-F279	m20699	2011-06-30 18:43:51	2011-07-13 20:37:11	2011-07-13 20:37:11	Cross-check Report for ZTE's Proposal JCTVC-F418	Z. Zhou, S. Liu (MediaTek)
JCTVC-F280	m20700	2011-06-30 18:44:51	2011-07-01 23:58:48	2011-07-01 23:58:48	CE1: cross-check by Canon of experiment B.1 and B.7 from ETRI (JCTVC-F353)	G. Laroche, P. Onno, T. Poirier (Canon)
JCTVC-F281	m20701	2011-06-30 18:57:11	2011-07-02 07:01:20	2011-07-11 23:57:40	CE 7: Cross Check Report for Mode Dependent Intra Residual Coding for 8x8 blocks (JCTVC-F138) by Samsung	A. Saxena, F. Fernandes (Samsung)
JCTVC-F282	m20702	2011-06-30 18:58:58	2011-07-02 06:46:47	2011-07-11 23:58:31	CE 7: Mode-Dependent 8x8 DCT/DST for Intra Prediction	A. Saxena, F. Fernandes (Samsung)
JCTVC-F283	m20703	2011-06-30 19:03:41	2011-07-02 08:24:05	2011-07-02 08:24:05	CE 7: On fast implementation of 4-point DST Type-7 with 5 multiplications	A. Saxena, F. Fernandes (Samsung)
JCTVC-F284	m20704	2011-06-30 19:16:06	2011-07-01 11:55:51	2011-07-01 11:55:51	Cross-check of Mitsubishi Electric's improved PIPE/V2F for low complexity entropy coding proposal JCTVC-F176	J. Stegemann (Fraunhofer HHI)
JCTVC-F285	m20705	2011-06-30 19:28:19	2011-07-02 01:11:23	2011-07-14 11:37:32	CE8: Parametric Adaptive Loop Filter	E. Maani, W. Liu (Sony)
JCTVC-F286	m20706	2011-06-30	2011-07-01	2011-07-16	Redundancy removal for Run-mode in CAVLC	J. Xu, A. Tabatabai (Sony)

		19:48:55	03:40:48	08:40:18		
JCTVC-F287	m20707	2011-06-30 20:13:24	2011-07-01 06:54:06	2011-07-16 08:40:58	Improvements on last nonzero position coding of 4x4 TU in CAVLC	J. Xu, A. Tabatabai (Sony)
JCTVC-F288	m20708	2011-06-30 20:25:36	2011-07-02 05:46:52	2011-07-15 15:13:22	CE11: Unified scans for the significance map and coefficient level coding in high efficiency	J. Sole, R. Joshi, M. Karczewicz (Qualcomm)
JCTVC-F289	m20709	2011-06-30 20:27:47	2011-07-02 02:37:06	2011-07-02 02:37:06	On VUI syntax parameters	M. Haque, A. Tabatabai, T. Suzuki (Sony)
JCTVC-F290	m20710	2011-06-30 20:29:07	2011-07-01 21:25:15	2011-07-13 00:17:35	Scalability Support in HEVC	D. Hong, W. Jang, J. Boyce, A. Abbas (Vidyo)
JCTVC-F291	m20711	2011-06-30 20:29:10	2011-07-01 22:42:30	2011-07-13 00:17:54	Picture Orientation Information	D. Hong, J. Boyce, S. Wenger (Vidyo)
JCTVC-F292	m20712	2011-06-30 20:29:12	2011-07-07 00:00:04	2011-07-19 12:55:35	Recommendations for evaluation of scalable coding	J. Boyce, A. Abbas, D. Hong, W. Jang (Vidyo)
JCTVC-F293	m20713	2011-06-30 20:32:19	2011-07-02 22:33:22	2011-07-05 19:46:19	CE11: Cross-check of TI's fixed diagonal scan (JCTVC-F129)	J. Sole (Qualcomm)
JCTVC-F294	m20715	2011-06-30 22:09:49	2011-07-02 01:17:08	2011-07-15 08:59:22	CE 7: Experimental Results for the Rotational Transform	Z. Ma, F. Fernandes, E. Alshina, A. Alshin (Samsung)
JCTVC-F295	m20716	2011-06-30 22:25:39	2011-07-02 01:19:11	2011-07-18 11:38:10	Harmonizing ROT and SDIP	Z. Ma, F. Fernandes, E. Alshina, A. Alshin (Samsung)
JCTVC-F296	m20717	2011-06-30 22:59:24	2011-07-02 08:33:21	2011-07-15 10:05:17	Modifications for CAVLC RDOQ	M. Karczewicz, L. Guo, X. Wang (Qualcomm)
JCTVC-F297	m20718	2011-06-30 23:01:36	2011-07-02 09:56:33	2011-07-14 00:32:56	CE9: Unified Merge and AMVP candidates selection (UNI03)	Y. Zheng, X. Wang, W.-J. Chien, M. Karczewicz (Qualcomm)
JCTVC-F298	m20719	2011-06-30 23:02:28	2011-07-02 09:26:33	2011-07-16 09:07:12	Run-level Table Reduction for CAVLC	L. Guo, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-F299	m20720	2011-06-30 23:04:07	2011-07-02 08:54:28	2011-07-15 08:50:42	CE2:Overlapped Block Motion Compensation for 2NxN and Nx2N Motion Partitions	L. Guo, P. Chen, I. S. Chong, R. Joshi, X. Wang, M. Karczewicz (Qualcomm)

JCTVC-F300	m20721	2011-06-30 23:30:02	2011-07-01 13:58:20	2011-07-01 13:58:20	CE4 Subtest 2: Delta QP prediction results of test 2.2.b and 2.3.f	M. Kobayashi, M. Shima (Canon)
JCTVC-F301	m20722	2011-06-30 23:47:36	2011-07-02 04:30:13	2011-07-14 19:20:16	CE8 Subtest 1: Block-based filter adaptation with features on subset of pixels	P. Lai, F. C. A. Fernandes, E. Alshina, I.-K Kim (Samsung)
JCTVC-F302	m20723	2011-06-30 23:48:03	2011-07-02 12:17:17	2011-07-17 09:15:41	Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode	Y. Zheng, X. Wang, W.-J. Chien, M. Karczewicz (Qualcomm)
JCTVC-F303	m20724	2011-06-30 23:52:23	2011-07-02 04:31:55	2011-07-14 12:57:56	CE8 Subtest 4: ALF using vertical-size 5 filters with up to 9 coefficients	P. Lai, F. C. A. Fernandes (Samsung), H. Guermazi, F. Kossentini, M. Horowitz (eBrisk)
JCTVC-F304	m20725	2011-06-30 23:54:48	2011-07-02 05:00:43	2011-07-03 01:47:28	CE8 Subtest 4: Cross-check of TI's proposal (JCTVC-F234) on ALF decode with reduced vertical filter size	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-F305	m20726	2011-06-30 23:55:36	2011-07-02 05:53:54	2011-07-03 01:48:29	CE8 Subtest 4: Cross-check of eBrisk's proposal (JCTVC-F041) on adaptive loop filtering using two filter shapes	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-F306	m20727	2011-06-30 23:56:28	2011-07-02 08:19:03	2011-07-03 20:22:03	CE9: Crosscheck report of CE9-UNI01 (JCTVC-F380)	Y. Zheng (Qualcomm)
JCTVC-F307	m20728	2011-06-30 23:56:43	2011-07-02 06:44:07	2011-07-03 01:49:40	CE8 Subtest 1: Cross-check of MediaTek, Qualcomm and Toshiba's proposal (JCTVC-F321) on block based ALF and temporal prediction of ALF coefficients	P. Lai, F. C. A. Fernandes (Samsung)
JCTVC-F308	m20729	2011-07-01 00:07:18	2011-07-01 06:57:10	2011-07-01 07:19:15	CE6.b Cross-check of Test1: Interaction between SDIP and RQT	J. Xu, A. Tabatabai (Sony)
JCTVC-F309	m20730	2011-07-01 00:10:28	2011-07-01 07:26:17	2011-07-01 07:26:17	CE6.b Cross-check of Test3: Interaction between SDIP and MDCS	J. Xu, A. Tabatabai (Sony)
JCTVC-F310	m20731	2011-07-01 00:19:07	2011-07-02 03:34:35	2011-07-15 07:04:30	CE4 Subset 3: Cross checking of MediaTek proposal JCTVC-E091 on adaptive quantization offset with SAO off.	C. Auyeung (Sony)
JCTVC-F311	m20732	2011-07-01 00:24:32	2011-07-02 06:09:38	2011-07-02 06:09:38	CE11.A: Cross checking of TI proposal JCTVC-E330 on context simplification of significance map	C. Auyeung (Sony)
JCTVC-F312	m20733	2011-07-01 00:36:52	2011-07-01 22:26:21	2011-07-03 17:30:27	CE8 Subset 2: Cross-Verification of SONY's adaptive loop filter (JCTVC-F285) by Qualcomm	I. S. Chong, M. Karczewicz (Qualcomm)

JCTVC-F313	m20734	2011-07-01 00:37:32	2011-07-02 01:16:51	2011-07-06 02:21:17	Verification Results of run-level CAVLC table-size reduction (JCTVC-F160)	E. Maani (Sony)
JCTVC-F314	m20735	2011-07-01 00:40:16	2011-07-01 20:49:40	2011-07-19 08:42:58	CE3 Subset 2.4: Cross-Verification of Samsung's interpolation filter (JCTVC-F247) by Qualcomm	I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-F315	m20737	2011-07-01 00:59:36	2011-07-01 17:06:29	2011-07-18 16:33:29	CE3: Non-uniform tap length filtering for bidirectional prediction	T. Chujoh, T. Yamakage (Toshiba)
JCTVC-F316	m20738	2011-07-01 01:01:47	2011-07-01 17:00:52	2011-07-01 17:00:52	CE3: Cross-check report for Samsung's tool 2.3 (JCTVC-F247)	T. Chujoh, T. Yamakage (Toshiba)
JCTVC-F317	m20739	2011-07-01 01:02:27	2011-07-01 17:02:28	2011-07-18 16:34:46	CE3: Cross-check report for Sony's tool 5 (JCTVC-F101)	T. Chujoh, T. Yamakage (Toshiba)
JCTVC-F318	m20740	2011-07-01 01:03:06	2011-07-02 02:06:06	2011-07-17 08:47:41	On the precision of interpolation processing	T. Chujoh, T. Yamakage (Toshiba)
JCTVC-F319	m20741	2011-07-01 01:03:48	2011-07-02 02:04:24	2011-07-17 08:45:48	Adaptive scaling with offset for reference pictures memory compression	T. Chujoh, T. Yamakage (Toshiba)
JCTVC-F320	m20742	2011-07-01 01:11:21	2011-07-01 17:12:23	2011-07-01 17:19:20	Subjective tests on ALF and SAO	O. G. Sezer, M. Budagavi (TI)
JCTVC-F321	m20743	2011-07-01 01:20:03	2011-07-01 05:24:36	2011-07-12 09:56:28	CE8.1: Block based Adaptive Loop Filter by MediaTek, Qualcomm and Toshiba	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-F322	m20744	2011-07-01 01:21:24	2011-07-01 01:27:12	2011-07-04 16:33:05	CE3 : Cross-check for NTT's proposal on Region-Based Adaptive Interpolation Filter (JCTVC-F048)	T. Yoshino, K. Kawamura, S. Naito (KDDI)
JCTVC-F323	m20745	2011-07-01 01:22:11	2011-07-01 01:28:09	2011-07-04 16:34:04	Cross-check for NTT's proposal on in-loop filter based on non-local means filter (JCTVC-F047)	T. Yoshino, K. Kawamura, S. Naito (KDDI)
JCTVC-F324	m20746	2011-07-01 01:27:08	2011-07-01 20:51:29	2011-07-12 01:35:34	CE8 Subset 4: Cross-Verification of Samsung and eBrisk's adaptive loop filter (JCTVC-F303) by Qualcomm	I. S. Chong, M. Karczewicz (Qualcomm)

JCTVC-F325	m20747	2011-07-01 02:31:16	2011-07-01 04:28:59	2011-07-16 08:54:30	Modified temporal MV derivation process for merge/skip mode	T. Shiodera, A. Tanizawa, T. Chujoh, T. Yamakage (Toshiba)
JCTVC-F326	m20748	2011-07-01 02:31:51	2011-07-01 04:29:37	2011-07-21 10:04:15	Explicit Weighted Prediction with simple WP parameter estimation	A. Tanizawa, T. Chujoh, T. Yamakage (Toshiba)
JCTVC-F327	m20749	2011-07-01 02:32:15	2011-07-01 05:12:45	2011-07-07 12:29:10	CE1: Cross check report of subtest A.3	A. Tanizawa, T. Shiodera (Toshiba)
JCTVC-F328	m20750	2011-07-01 02:32:39	2011-07-01 05:13:54	2011-07-07 12:32:10	CE6.d: Cross check report of Sharp's proposal (JCTVC-F605)	A. Tanizawa, T. Shiodera (Toshiba)
JCTVC-F329	m20751	2011-07-01 02:33:01	2011-07-01 05:14:20	2011-07-07 12:30:56	CE7: Cross check report of Samsung's proposal (Tool6 : JCTVC-F283)	A. Tanizawa, J. Yamaguchi (Toshiba)
JCTVC-F330	m20752	2011-07-01 02:33:24	2011-07-01 05:14:46	2011-07-07 12:38:59	Cross check report of BBC's proposal of JCTVC-F184	A. Tanizawa (Toshiba)
JCTVC-F331	m20753	2011-07-01 02:33:45	2011-07-01 05:15:17	2011-07-06 12:27:42	Cross check report of Technicolor's proposal of JCTVC-F265 on Weighted Prediction	A. Tanizawa (Toshiba)
JCTVC-F332	m20754	2011-07-01 02:36:43	2011-07-01 23:06:14	2011-07-11 06:21:58	CE4 Subtest 2: QP prediction from spatially neighboring CUs (test 2.3.b, 2.3.c)	M. Coban, M. Karczewicz (Qualcomm)
JCTVC-F333	m20755	2011-07-01 02:43:15	2011-07-01 02:45:03	2011-07-01 02:45:03	The Art of Writing Standards: Some “Shalls” and “Shoulds” for Better Quality Interop Specs	G. J. Sullivan (Microsoft)
JCTVC-F334	m20756	2011-07-01 02:46:47			Withdrawn	
JCTVC-F335	m20757	2011-07-01 02:55:10	2011-07-01 03:03:38	2011-07-16 08:24:29	Tiles	A. Fuldseth (Cisco), M. Horowitz, S. Xu (eBrisk Video), A. Segall (Sharp), M. Zhou (TI)
JCTVC-F336	m20758	2011-07-01 03:09:27	2011-07-02 00:26:58	2011-07-06 00:15:49	CE6.b.5 Report: Harmonization of SDIP and MDIS	G. Li, N. Ling (Santa Clara Univ.), L. Liu, C. Lai, J. Zheng, P. Zhang (Hisilicon)
JCTVC-F337	m20759	2011-07-01 03:12:39	2011-07-01 15:44:52	2011-07-01 15:44:52	CE1: Results of partition size based selection for motion vector compression (A.12)	S. Fukushima, M. Nishitani, M. Ueda, K. Arakage, H. Takehara

						(JVC KENWOOD)
JCTVC-F338	m20760	2011-07-01 03:14:17	2011-07-01 15:45:36	2011-07-01 15:45:36	CE9: Results of temporal MVP restriction for small blocks (SP08, SP10, SP11)	H. Takehara, S. Fukushima (JVC KENWOOD)
JCTVC-F339	m20761	2011-07-01 03:15:43	2011-07-01 15:15:35	2011-07-15 23:00:29	Intra prediction mode coding based on direction difference	T. Kumakura, S. Fukushima (JVC KENWOOD)
JCTVC-F340	m20762	2011-07-01 03:16:54	2011-07-01 15:16:47	2011-07-15 23:01:35	Fixing the number of mpm candidates	T. Kumakura, S. Fukushima, M. Ueda (JVC KENWOOD)
JCTVC-F341	m20763	2011-07-01 03:18:27	2011-07-01 23:41:40	2011-07-16 11:08:59	Decoder Performance Restrictions due to Merge/MVP Index Parsing	T. Hellman, Y. Yu (Broadcom)
JCTVC-F342	m20764	2011-07-01 03:22:47	2011-07-01 17:08:43	2011-07-16 11:10:00	ALF Complexity Analysis	T. Hellman (Broadcom)
JCTVC-F343	m20765	2011-07-01 03:23:20	2011-07-02 01:02:41	2011-07-14 10:42:17	Evaluation of SDIP	J. Xu, Ehsan Maani, A. Tabatabai, T. Suzuki (Sony)
JCTVC-F344	m20766	2011-07-01 03:27:28	2011-07-01 03:29:41	2011-07-18 14:32:49	CE3: Cross-check report on CE3 Subtest 4.1 and 4.4 (JCTVC-F100)	K. Chono, H. Aoki (NEC)
JCTVC-F345	m20768	2011-07-01 03:31:26	2011-07-01 03:33:04	2011-07-06 02:49:32	CE5: Cross-check report on modifications for inter mode and split flags coding in CAVLC (JCTVC-F524)	K. Chono, H. Aoki (NEC)
JCTVC-F346	m20769	2011-07-01 03:36:29	2011-07-01 10:46:24	2011-07-01 10:46:24	CE4 Subtest 2.3: Cross-check of Qualcomm's proposal(JCTVC-F332) on delta QP prediction	J. Jia, J. Park (LGE)
JCTVC-F347	m20770	2011-07-01 03:36:59	2011-07-02 04:49:51	2011-07-02 12:33:36	A method of decoupling motion data reconstruction from entropy decoding	M. Zhou, V. Sze, Y. Matsuba (TI), T. Sugio, T. Nishi (Panasonic), J. Chen, T. Lee (Samsung), W. Wan, Y. Yu (Broadcom)
JCTVC-F348	m20771	2011-07-01 03:37:46	2011-07-01 03:42:04	2011-07-05 12:40:00	CE6: Cross-check report on CE6.a BUDI	K. Chono, H. Aoki (NEC)
JCTVC-F349	m20772	2011-07-01 03:45:19	2011-07-01 03:47:00	2011-07-05 12:41:32	CE6: Cross-check report on CE6.b SDIP	K. Chono, H. Aoki (NEC)

JCTVC-F350	m20773	2011-07-01 03:51:17	2011-07-01 09:10:03	2011-07-01 10:12:54	Cross-check report on JCTVC-F340	K. Chono, H. Aoki (NEC)
JCTVC-F351	m20774	2011-07-01 03:52:02	2011-07-11 09:03:23	2011-07-11 09:03:23	Cross-check report on orange-ft's wavefront parallel processing (JCTVC-F275)	Hendry, J. Park, S. Park (LG Electronics)
JCTVC-F352	m20775	2011-07-01 03:56:33	2011-07-02 05:32:15	2011-07-12 03:40:15	CE10: Scaled orthogonal integer transforms supporting recursive factorization structure	R. Joshi, Y. Reznik, J. Sole, M. Karczewicz (Qualcomm)
JCTVC-F353	m20776	2011-07-01 04:07:41	2011-07-01 22:58:22	2011-07-10 09:55:05	CE1: Results of experiments B.1 and B.7	S.-C. Lim, H. Y. Kim, J. Lee, J. S. Choi (ETRI)
JCTVC-F354	m20777	2011-07-01 04:08:02	2011-07-01 23:49:39	2011-07-08 03:29:04	CE1: Cross-check result of experiments B.2, B.3, B.4, B.5, B.6, B.8, B.9, B.10, B.11, and B.12 (JCTVC-F278) by ETRI	S.-C. Lim, H. Y. Kim, J. Lee (ETRI)
JCTVC-F355	m20778	2011-07-01 04:08:22	2011-07-01 22:58:58	2011-07-01 22:58:58	CE4 Subtest2: Cross-check report of Sony’s proposal JCTVC-F420 (tests 2.3.d and 2.3.e) by ETRI	S.-C. Lim, H. Y. Kim, J. Lee (ETRI)
JCTVC-F356	m20779	2011-07-01 04:08:39	2011-07-01 23:16:45	2011-07-21 10:30:57	Motion compensation 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-F357	m20780	2011-07-01 04:08:56			Withdrawn	
JCTVC-F358	m20781	2011-07-01 04:09:06	2011-07-01 18:27:05	2011-07-12 15:18:08	Mode dependent filtering for intra predicted samples	J. Lee, S.-C. Lim, H. Y. Kim, J. S. Choi (ETRI)
JCTVC-F359	m20782	2011-07-01 04:09:19	2011-07-01 19:59:05	2011-07-12 15:18:52	Deblocking filtering modification for constrained intra prediction	J. Lee, S.-C. Lim, H. Y. Kim, J. S. Choi (ETRI)
JCTVC-F360	m20783	2011-07-01 04:09:29	2011-07-11 14:00:59	2011-07-11 14:00:59	Cross-check result of Sejong Univ.'s proposal (JCTVC-F416) on Intra Mode Coding considering MPM by ETRI	J. Lee, S.-C. Lim, H. Y. Kim (ETRI)
JCTVC-F361	m20784	2011-07-01 04:26:42	2011-07-12 05:28:48	2011-07-12 05:28:48	Cross-verification of Sejong Univ.'s proposal on pixel based illumination compensation	Y. Jeon, B. Jeon (LGE)
JCTVC-F362	m20786	2011-07-01 04:42:47	2011-07-01 13:55:39	2011-07-16 10:13:22	Proposal to support quantization matrix in HEVC	T. Suzuki, A. Tabatabai (Sony), M. Zhou, V. Sze (TI)

JCTVC-F363	m20787	2011-07-01 05:23:29	2011-07-02 23:48:37	2011-07-05 17:58:57	CE 10: FastVDO/Samsung Core Transform Proposal	P. Topiwala, W. Dai, M. Krishnan (FastVDO), I. Kim (Samsung)
JCTVC-F364	m20790	2011-07-01 05:39:15	2011-07-01 22:03:09	2011-07-16 11:35:21	Cross-Verification of MediaTek's proposal on sample adaptive offset of chroma (JCTVC-F057) by Qualcomm	I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-F365	m20791	2011-07-01 05:41:29	2011-07-01 22:03:54	2011-07-09 02:56:39	Cross-Verification of MediaTek's proposal on sample adaptive offset (JCTVC-F093) by Qualcomm	I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-F366	m20792	2011-07-01 05:44:35	2011-07-01 22:15:07	2011-07-09 03:00:00	Cross-Verification of MediaTek's proposal on sample adaptive offset (JCTVC-F055) by Qualcomm	I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-F367	m20793	2011-07-01 05:46:49	2011-07-01 22:10:37	2011-07-09 02:51:23	Cross-Verification of MediaTek's proposal on adaptive loop filter (JCTVC-F054) by Qualcomm	I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-F368	m20794	2011-07-01 05:57:23	2011-07-01 11:45:46	2011-07-12 04:19:29	CE4 Subtest 3.3.1.a: Cross-check MediaTek proposal JCTVC-E091	X. Shen, X. Zhu, B. Yu (Zhejiang Univ.)
JCTVC-F369	m20795	2011-07-01 06:26:15	2011-07-01 15:53:18	2011-07-01 15:53:18	CE11:Cross-check report for Qualcomm's proposal JCTVC-F288 part2	H. Sasai, T. Nishi (Panasonic)
JCTVC-F370	m20796	2011-07-01 06:34:44	2011-07-01 15:54:46	2011-07-01 15:54:46	Cross-check report for TI's proposal JCTVC-F130 on Parallel Context Processing	H. Sasai, T. Nishi (Panasonic)
JCTVC-F371	m20797	2011-07-01 06:38:18	2011-07-01 15:55:40	2011-07-12 07:07:36	Cross-check report for LGE's proposal JCTVC-F107	H. Sasai, T. Nishi (Panasonic)
JCTVC-F372	m20798	2011-07-01 06:57:20	2011-07-01 17:17:25	2011-07-15 22:59:12	Bi-derivative merge candidate	H. Takehara, S. Fukushima, H. Nakamura (JVC KENWOOD)
JCTVC-F373	m20799	2011-07-01 06:58:38	2011-07-01 17:17:56	2011-07-15 20:14:10	Merge based mvd transmission	S. Fukushima, M. Ueda, K. Arakage, S. Sakazume (JVC KENWOOD)
JCTVC-F374	m20800	2011-07-01 06:59:57	2011-07-05 07:20:32	2011-07-05 07:20:32	Cross-verification report of JCTVC-F099 by JVC KENWOOD	S. Fukushima (JVC KENWOOD)
JCTVC-F375	m20801	2011-07-01 07:33:39	2011-07-02 01:59:22	2011-07-16 06:18:21	Binarisation modification for last position coding	V. Seregin, I.-K Kim (Samsung)

JCTVC-F376	m20802	2011-07-01 07:35:09	2011-07-02 02:00:31	2011-07-16 06:15:07	Utilisation of CABAC equal probability mode for intra mode coding	V. Seregin, I.-K Kim (Samsung)
JCTVC-F377	m20803	2011-07-01 07:35:58	2011-07-07 13:03:07	2011-07-07 13:12:01	Arithmetic coding in high level syntax	T. Suzuki (Sony)
JCTVC-F378	m20804	2011-07-01 07:36:51	2011-07-02 02:01:40	2011-07-18 16:06:34	Intra mode parsing without access neighbouring information	V. Seregin, T. Lee, J. Chen (Samsung)
JCTVC-F379	m20805	2011-07-01 07:38:42	2011-07-02 02:02:22	2011-07-12 03:15:22	CE2: Test result of asymmetric motion partition (AMP)	I.-K Kim, W.-J Han, J. H. Park (Samsung), X. Zheng (HiSilicon)
JCTVC-F380	m20806	2011-07-01 07:40:15	2011-07-02 02:02:53	2011-07-02 02:02:53	CE9: Test result of UNI01	I.-K Kim, W.-J Han, JH Park (Samsung)
JCTVC-F381	m20807	2011-07-01 07:50:02	2011-07-01 12:01:19	2011-07-01 12:01:19	Clean decoding refresh definition and decoding process	T. K. Tan, A. Fujibayashi (NTT DOCOMO)
JCTVC-F382	m20808	2011-07-01 07:53:13	2011-07-03 07:27:20	2011-07-03 07:27:20	CE1: Cross-check report for A05 (JCTVC-F278)	I.-K. Kim (Samsung)
JCTVC-F383	m20809	2011-07-01 07:53:54	2011-07-03 07:28:01	2011-07-03 07:28:01	CE1: Cross-check report for A13, A15 and A16 (JCTVC-F081)	I.-K. Kim (Samsung)
JCTVC-F384	m20810	2011-07-01 07:54:10	2011-07-01 10:59:02	2011-07-14 08:45:15	CE8.1:Block based Adaptive Loop Filter with flexible syntax and additional BA mode by Sharp and Qualcomm	T. Ikai (Sharp), M. Karczewicz, I. S. Chong (Qualcomm), Y. Yasugi, T. Yamazaki (Sharp)
JCTVC-F385	m20811	2011-07-01 07:54:35	2011-07-03 07:28:31	2011-07-03 07:28:31	CE2: Cross-check report for Qualcomm's OBMC for 2NxN and Nx2N motion partitions (JCTVC-F299)	I.-K. Kim (Samsung)
JCTVC-F386	m20812	2011-07-01 07:54:46	2011-07-01 12:00:21	2011-07-16 08:30:05	Chroma RD cost computation in HM3.0	T. K. Tan, F. Bossen (NTT DOCOMO)
JCTVC-F387	m20813	2011-07-01 07:54:59	2011-07-01 09:47:48	2011-07-01 09:47:48	CE8.1: Cross-check result of Samsung's adaptive loop filter (JCTVC-F301)	T. Ikai, Y. Yasugi (SHARP)
JCTVC-F388	m20814	2011-07-01 07:55:22	2011-07-03 07:29:08	2011-07-03 07:29:08	CE9: Cross-check report for SP03, SP06S1 and SP06S2 (JCTVC-F084, JCTVC-F088)	I.-K. Kim (Samsung)

JCTVC-F389	m20815	2011-07-01 07:55:24	2011-07-05 04:49:49	2011-07-05 04:49:49	Cross-check result of MediaTek's adaptive loop filter for LCU-based decoding	T. Ikai, Y. Yasugi (SHARP)
JCTVC-F390	m20816	2011-07-01 07:55:55	2011-07-01 09:05:16	2011-07-01 09:05:16	CE5: Simplification of transform coefficient coding in CAVLC	Y. Yasugi, T. Yamamoto (SHARP)
JCTVC-F391	m20817	2011-07-01 07:56:00	2011-07-03 07:29:40	2011-07-03 07:29:40	CE9: Cross-check report for SP04 (JCTVC-F050)	I.-K. Kim (Samsung)
JCTVC-F392	m20818	2011-07-01 07:56:27	2011-07-01 08:57:47	2011-07-04 01:13:43	CE6.b: Cross-check of Short Distance Intra Prediction (SDIP)	T. Yamamoto (SHARP)
JCTVC-F393	m20819	2011-07-01 07:56:35	2011-07-03 07:30:13	2011-07-03 07:30:13	Cross-check report on TI's slice header termination for low delay encoding (JCTVC-F131)	I.-K. Kim (Samsung)
JCTVC-F394	m20820	2011-07-01 07:56:44	2011-07-12 09:53:01	2011-07-12 09:53:01	CE4 subtest 2: Cross check of Spatial QP prediction: combination of test 2.3.g, 2.3.f and 2.3.e (JCTVC-F661)	T. Yamamoto (SHARP)
JCTVC-F395	m20821	2011-07-01 07:57:54	2011-07-01 09:06:31	2011-07-16 09:37:36	CAVLC Adaptation using Difference Counter	T. Yamamoto (SHARP)
JCTVC-F396	m20822	2011-07-01 07:58:26	2011-07-01 09:21:04	2011-07-15 09:45:56	Improvement of Sample Adaptive Offset with modified bit accuracy and restricted offsets	T. Yamazaki, T. Ikai, Y. Yasugi, T. Yamamoto (SHARP)
JCTVC-F397	m20823	2011-07-01 08:07:45	2011-07-01 14:24:45	2011-07-16 19:26:45	Weighted Prediction with Parameter Estimation	S. Takamura, Y. Bandoh, S. Matsuo, K. Kamikura, H. Jozawa (NTT)
JCTVC-F398	m20824	2011-07-01 08:26:03			Withdrawn	
JCTVC-F399	m20825	2011-07-01 08:30:15	2011-07-01 17:57:45	2011-07-13 11:02:21	Restart of CABAC after coding of ALF and SAO slice header data	M. Narroschke, T. Wedi, S. Esenlik (Panasonic)
JCTVC-F400	m20826	2011-07-01 08:32:30	2011-07-01 13:57:37	2011-07-01 13:57:37	CE4 Subtest 2: Delta QP prediction results	M. Kobayashi, M. Shima (Canon)
JCTVC-F401	m20827	2011-07-01 08:37:19	2011-07-01 17:59:06	2011-07-13 09:49:52	CE12: Cross-check results of the deblocking filter of MediaTek and Ericsson (JCTVC-F118)	M. Narroschke, S. Esenlik (Panasonic)

JCTVC-F402	m20828	2011-07-01 08:39:33	2011-07-02 09:33:37	2011-07-12 09:10:39	MVP index parsing with fixed number of candidates	J. Chen, T. Lee, I.-K. Kim (Samsung)
JCTVC-F403	m20829	2011-07-01 08:40:09	2011-07-01 18:00:45	2011-07-13 10:11:05	CE12: Cross-check results of the deblocking filter of Microsoft (JCTVC-F198)	M. Narroschke, S. Esenlik (Panasonic)
JCTVC-F404	m20830	2011-07-01 08:40:12	2011-07-06 10:57:09	2011-07-06 10:57:09	CE5: Cross-check of Yonsei Univ. and Samsung's proposal (JCTVC-F408)	Y. Yasugi (SHARP)
JCTVC-F405	m20831	2011-07-01 08:43:33	2011-07-01 22:07:48	2011-07-14 14:32:52	Deblocking filter using adaptive weighting factors	M. Narroschke, A.-K. Seifert (Panasonic)
JCTVC-F406	m20832	2011-07-01 08:46:28	2011-07-12 13:15:21	2011-07-12 13:15:21	Cross-verification of Qualcomm’s proposal on simplification of transform coefficient coding in CAVLC (JCTVC-F298)	S. Kim, J. Lee, K. Lim, D. Pak, S. Lee (Yonsei Univ.), J. Chen, J. Park (Samsung),
JCTVC-F407	m20833	2011-07-01 08:51:58	2011-07-01 14:59:37	2011-07-16 11:05:12	Run-mode coding improvement with table reduction in CAVLC	J. Lee, S. Kim, S. Lee (Yonsei Univ.), J. Chen, J. Park (Samsung)
JCTVC-F408	m20834	2011-07-01 08:58:59	2011-07-01 15:50:01	2011-07-14 18:47:16	CE5: Run and level mode coding improvement in CAVLC	S. Kim, J. Lee, S. Lee (Yonsei Univ.), J. Chen, J. Park (Samsung)
JCTVC-F409	m20836	2011-07-01 09:19:46	2011-07-12 13:17:19	2011-07-12 13:17:19	CE5: Crosscheck for Sharp's proposal (JCTVC-F390)	J. Lee, S. Kim, K. Lim, D. Pak, S. Lee (Yonsei Univ.), J. Chen, J. Park (Samsung)
JCTVC-F410	m20837	2011-07-01 09:22:48	2011-07-02 09:36:07	2011-07-12 18:30:03	CE2: Non-Square Quadtree Transform for symmetric motion partitions	Y. Yuan (Tsinghua), X. Zheng (HiSilicon), X. Peng (USTC), J. Xu (Microsoft), L. Liu (HiSilicon), Y. Wang, X. Cao (Tsinghua Univ.), C. Lai, J. Zheng (HiSilicon), Y. He (Tsinghua Univ.), H. Yu (Huawei)
JCTVC-F411	m20838	2011-07-01 09:24:26	2011-07-04 08:20:05	2011-07-06 08:36:31	CE6.e: Cross-check of Intra Smoothing	G. Van Wallendael, S. Van Leuven, J. De Cock, R. Van de Walle (Ghent Univ.)

JCTVC-F412	m20839	2011-07-01 09:26:43	2011-07-02 09:41:09	2011-07-12 18:31:42	CE2: Non-Square Quadtree Transform for symmetric and asymmetric motion partitions	Y. Yuan (Tsinghua), X. Zheng (HiSilicon), X. Peng (USTC), J. Xu (Microsoft), I.-K Kim (Samsung), L. Liu (HiSilicon), Y. Wang, X. Cao (Tsinghua Univ.), C. Lai, J. Zheng (HiSilicon), Y. He (Tsinghua Univ.), H. Yu (Huawei)
JCTVC-F413	m20840	2011-07-01 09:27:24	2011-07-01 14:21:20	2011-07-06 08:37:08	CE6.c: Cross-check of Differential Coding of Intra Mode (DCIM)	G. Van Wallendael, S. Van Leuven, J. De Cock, R. Van de Walle (Ghent Univ.)
JCTVC-F414	m20841	2011-07-01 09:32:51	2011-07-01 11:08:57	2011-07-16 11:04:41	Reference sample padding harmonization for intra DC mode	V. Wahadaniah, C. S. Lim (Panasonic), K. Chono, H. Aoki (NEC)
JCTVC-F415	m20842	2011-07-01 09:32:56	2011-07-02 09:11:01	2011-07-02 09:11:01	CE2: Non-rectangular motion partitioning	X. Zheng (HiSilicon), H. Yu (Huawei), S. Li, Y. He (Tsinghua Univ.), P. Bordes (Technicolor)
JCTVC-F416	m20843	2011-07-01 09:33:34	2011-07-01 09:40:03	2011-07-16 16:32:09	Intra Mode Coding considering MPM	C.-W. Seo, J.-K. Han, H.-K. Kim (Sejong Univ.), J. L. (SK telecom)
JCTVC-F417	m20844	2011-07-01 09:48:07	2011-07-01 12:23:08	2011-07-16 19:15:29	Pixel Based Illumination Compensation	C.-W. Seo, J.-K. Han (Sejong Univ.), J. Lim (SK telecom)
JCTVC-F418	m20845	2011-07-01 09:52:05	2011-07-08 17:57:09	2011-07-13 18:05:51	Joint Coding of CU splitting flag and inter modes based on HM 3.1	W. Zhang (ZTE)
JCTVC-F419	m20847	2011-07-01 09:58:30	2011-07-01 19:30:06	2011-07-22 18:13:43	Unification of derivation process for merge mode and MVP	H. Nakamura, S. Fukushima, M. Nishitani (JVC Kenwood)
JCTVC-F420	m20848	2011-07-01 09:59:56	2011-07-01 12:41:03	2011-07-11 06:50:06	CE4: Result of 2.3.d and 2.3.e	K. Sato (Sony)
JCTVC-F421	m20849	2011-07-01 10:02:17	2011-07-01 12:41:54	2011-07-11 08:12:21	CE4: X-check of 2.2.b and 2.3.f	K. Sato (Sony)
JCTVC-F422	m20850	2011-07-01	2011-07-01	2011-07-12	Improvement of delta-QP Coding	K. Kondo, K. Sato, J. Xu (Sony)

		10:04:54	12:42:39	10:07:56		
JCTVC-F423	m20851	2011-07-01 10:06:43	2011-07-01 15:58:22	2011-07-16 07:47:24	Modified MVD coding for CABAC	H. Sasai, T. Nishi (Panasonic)
JCTVC-F424	m20852	2011-07-01 10:06:48	2011-07-01 10:43:10	2011-07-01 10:43:10	CE9: Skip/Merge Simplification with Reduced Candidate Set (SP13)	Y. H. Tan, C. Yeo, Z. Li (I2R)
JCTVC-F425	m20853	2011-07-01 10:07:14	2011-07-01 12:43:28	2011-07-11 08:16:03	CE1: Result of Test A2	K. Sato (Sony)
JCTVC-F426	m20854	2011-07-01 10:09:12	2011-07-01 15:57:17	2011-07-16 13:03:31	Fixed probability coding for Intra mode	H. Sasai, T. Nishi (Panasonic)
JCTVC-F427	m20855	2011-07-01 10:10:03	2011-07-01 12:45:48	2011-07-16 14:27:28	Consideration on Temporal Predictor	K. Sato (Sony)
JCTVC-F428	m20857	2011-07-01 10:13:15	2011-07-11 04:10:28	2011-07-11 04:10:28	X-check of JCTVC-F395 by Sharp	Y. Morigami, K. Sato (Sony)
JCTVC-F429	m20858	2011-07-01 10:13:51	2011-07-01 15:56:40	2011-07-21 09:57:27	Modified Context Derivation for neighboring dependency reduction	H. Sasai, T. Nishi (Panasonic)
JCTVC-F430	m20860	2011-07-01 10:22:43	2011-07-09 03:36:14	2011-07-09 03:36:14	Crosscheck for Canon's proposal JCTVC-F269	M. Guo, X. Guo (MediaTek)
JCTVC-F431	m20861	2011-07-01 10:23:42	2011-07-01 14:12:06	2011-07-16 16:56:48	Complexity Reduction of Chroma Intra Prediction by Reconstructed Luma Samples	K. Sato (Sony)
JCTVC-F432	m20862	2011-07-01 10:30:28	2011-07-09 03:37:02	2011-07-09 03:37:02	Crosscheck for JVC's proposal JCTVC-F339	M. Guo, X. Guo (MediaTek)
JCTVC-F433	m20863	2011-07-01 10:43:59	2011-07-01 13:08:36	2011-07-15 10:01:45	Reference Lists For Low Delay Settings	C. S. Lim, S. M. Thet Naing (Panasonic)
JCTVC-F434	m20864	2011-07-01 10:44:20	2011-07-01 11:11:51	2011-07-01 11:11:51	CE1 Test A7: Cross-check report from Institute for Infocomm Research for JCTVC-F112	Y. H. Tan, C. Yeo (I2R)
JCTVC-F435	m20865	2011-07-01 11:04:56	2011-07-06 10:42:31	2011-07-11 10:46:41	CE2: Cross-check of Non-Square Quadtree Transform JCTVC-F379, JCTVC-F410 & JCTVC-F412	S. Oudin (Fraunhofer HHI)

JCTVC-F436	m20866	2011-07-01 11:09:32	2011-07-01 16:42:40	2011-07-07 16:48:23	AHG18: Cross-check report of Weighted Prediction, proposal JCTVC-F265	R. Boitard, L. Guillo (INRIA)
JCTVC-F437	m20867	2011-07-01 11:11:17	2011-07-04 10:21:41	2011-07-04 10:21:41	CE6.b: Crosscheck Report of Qualcomm's Proposal JCTVC-F556	M. Guo, X. Guo (MediaTek)
JCTVC-F438	m20868	2011-07-01 11:13:39	2011-07-04 04:55:42	2011-07-04 04:55:42	Cross-check of Toshiba's Intra bi-prediction (JCTVC-F253) by Institute for Infocomm Research	Y. H. Tan, C. Yeo (I2R)
JCTVC-F439	m20869	2011-07-01 11:20:58	2011-07-07 12:31:32	2011-07-07 12:31:32	Cross-check of MediaTek's and Qualcomm's proposal on Sample Adaptive Offset (JCTVC-F056) by Samsung	E. Alshina (Samsung)
JCTVC-F440	m20870	2011-07-01 11:22:53	2011-07-02 06:49:23	2011-07-07 10:17:58	CE4: Cross check for MediaTek's proposal JCTVC-F119 by Samsung	E. Alshina (Samsung)
JCTVC-F441	m20871	2011-07-01 11:24:11	2011-07-02 06:50:51	2011-07-07 10:27:54	CE4: Cross check for RIM's proposal JCTVC-F276 by Samsung	E. Alshina (Samsung)
JCTVC-F442	m20872	2011-07-01 11:25:49	2011-07-02 07:13:28	2011-07-07 10:29:34	F442 Cross-check for SAO LCU boundary processing (JCTVC-F232) by Samsung	E. Alshina (Samsung)
JCTVC-F443	m20873	2011-07-01 11:27:10	2011-07-07 10:31:07	2011-07-19 12:28:41	CE3: Cross-check by Samsung for Motorola Mobility tests on interpolation filters (JCTVC-F574, JCTVC-F576)	E. Alshina (Samsung)
JCTVC-F444	m20874	2011-07-01 11:27:12	2011-07-01 17:00:21	2011-07-04 14:05:13	Cross-check results for Sony's proposal JCTVC-F215	S. Esenlik, M. Narroschke (Panasonic)
JCTVC-F445	m20875	2011-07-01 11:27:47	2011-07-01 20:40:02	2011-07-12 05:50:42	Cross-check of Parallel deblocking improvement (JCTVC-F214) by Sony	M. Sadafale (TI)
JCTVC-F446	m20876	2011-07-01 11:48:42	2011-07-01 23:15:51	2011-07-15 12:47:36	CE10: Core transform design for HEVC	A. Fuldseth, Gisle Bjøntegaard (Cisco), M. Sadafale, M. Budagavi (TI)
JCTVC-F447	m20877	2011-07-01 11:48:50	2011-07-01 23:16:40	2011-07-14 15:59:10	SIMD optimization of proposed HEVC core transforms	A. Fuldseth, L. P. Endresen, S. Selnes (Cisco), V. Arbatov, F. Franchetti (SpiralGen Inc. and Carnegie Mellon University), M. Püschel (ETH Zurich)

JCTVC-F448	m20878	2011-07-01 11:48:54	2011-07-01 12:40:30	2011-07-06 21:31:58	Cross-check of NHK's contribution on accuracy improvement of the JCTVC-E243 core transforms (JCTVC-F193)	A. Fuldseth (Cisco)
JCTVC-F449	m20879	2011-07-01 11:48:59	2011-07-01 12:41:23	2011-07-16 09:15:17	Cross-check of Samsung's contribution on clip operation removal from de-quantization part of HM (JCTVC-F257)	A. Fuldseth (Cisco)
JCTVC-F450	m20880	2011-07-01 11:49:05	2011-07-01 12:41:51	2011-07-14 00:29:02	Cross-check of MediaTek's contribution on wavefront parallel processing with tiles (JCTVC-F063)	A. Fuldseth (Cisco), M. Zhou (TI)
JCTVC-F451	m20881	2011-07-01 12:12:26	2011-07-01 19:47:55	2011-07-14 17:23:46	CE11: Crosscheck - Reduced neighboring dependency in context selection of significant_coeff_flag for parallel processing (E330/F128)	T. Nguyen (Fraunhofer HHI)
JCTVC-F452	m20882	2011-07-01 12:13:50	2011-07-01 19:49:15	2011-07-14 00:53:11	Crosscheck - CABAC with Constrained Outstanding Bits (JCTVC-F059)	T. Nguyen (Fraunhofer HHI)
JCTVC-F453	m20883	2011-07-01 12:14:27	2011-07-01 19:50:04	2011-07-14 00:53:33	Crosscheck - CABAC with a Reduced LPS Range Table (JCTVC-F061)	T. Nguyen (Fraunhofer HHI)
JCTVC-F454	m20884	2011-07-01 12:18:46	2011-07-01 17:02:08	2011-07-01 17:02:08	CE8 subtest 5: Cross-check results for proposal JCTVC-F157	S. Esenlik, M. Narroschke (Panasonic)
JCTVC-F455	m20885	2011-07-01 12:19:09	2011-07-01 19:51:11	2011-07-16 14:39:50	Modified binarization and coding of MVD for PIPE/CABAC	T. Nguyen, D. Marpe, H. Schwarz, T. Wiegand (Fraunhofer HHI)
JCTVC-F456	m20886	2011-07-01 12:31:18	2011-07-01 14:26:35	2011-07-16 14:49:36	Directional intra prediction smoothing	J. Lainema, K. Ugur (Nokia)
JCTVC-F457	m20887	2011-07-01 12:31:23	2011-07-01 12:35:52	2011-07-12 10:57:01	AHG18: Cross-check report of Explicit Weighted Prediction with simple WP parameters estimator, proposal JCTVC-F326	P. Bordes (Technicolor)
JCTVC-F458	m20888	2011-07-01 12:37:03	2011-07-01 13:08:24	2011-07-12 03:58:47	Improvement of CAVLC run- coding by prediction mode	C. Kim, Y. Park (Samsung)
JCTVC-F459	m20889	2011-07-01 12:40:20	2011-07-02 10:10:53	2011-07-15 14:01:17	Parsing friendly intra mode coding	W.-J. Chien, X. Wang, M.Karczewicz (Qualcomm)
JCTVC-F460	m20890	2011-07-01 12:49:38	2011-07-01 17:44:26	2011-07-15 04:49:46	Getting rid of non-existing pictures	Q. Shen, Y.-K. Wang (Huawei)

JCTVC-F461	m20891	2011-07-01 12:51:53	2011-07-01 20:18:37	2011-07-14 10:28:15	Reference picture loss/error detection	Y.-K. Wang, Q. Shen (Huawei)
JCTVC-F462	m20892	2011-07-01 12:53:44	2011-07-01 22:47:35	2011-07-06 03:17:20	On reference picture marking	Y.-K. Wang (Huawei), Y. Chen (Qualcomm)
JCTVC-F463	m20893	2011-07-01 12:54:54	2011-07-02 01:18:27	2011-07-02 01:18:27	On NAL unit header	Y.-K. Wang (Huawei)
JCTVC-F464	m20894	2011-07-01 12:57:00	2011-07-01 17:45:25	2011-07-01 17:45:25	On CDR picture	Y.-K. Wang (Huawei), M. M. Hannuksela (Nokia), Y. Chen (Qualcomm)
JCTVC-F465	m20895	2011-07-01 13:07:44	2011-07-01 13:14:36	2011-07-12 17:00:35	Experiments on tools in Working Daft (WD) and HEVC Test Mode (HM-3.0)	I.-K. Kim, E. Alshina, J. Chen, T. Lee, W.-J. Han, J. H. Park (Samsung), V. Sze, M. Budagavi, M. Zhou (TI)
JCTVC-F466	m20896	2011-07-01 13:12:22	2011-07-01 13:14:48	2011-07-12 04:03:46	Handling for exception cases regarding to code-word larger than 32bit in CAVLC	C. Kim, Y. Park(Samsung)
JCTVC-F467	m20897	2011-07-01 13:16:56	2011-07-01 13:18:29	2011-07-12 04:05:37	Improvement of CAVLC table adaptation for coefficient coding	C. Kim, Y. Park (Samsung)
JCTVC-F468	m20898	2011-07-01 13:20:06	2011-07-02 01:31:57	2011-07-14 16:04:10	CE3: An Adaptive Interpolation Filtering Technique Using 1/2 6-tap filter and 1/4 7-tap filter	F. Kossentini, N. Mahdi, H. Guermazi, M. A. Ben Ayed, M. Horowitz (eBrisk)
JCTVC-F469	m20899	2011-07-01 13:20:46	2011-07-01 13:23:19	2011-07-01 13:23:19	Syntax improvement for fine granularity slices	C. Kim, Y. Park (Samsung)
JCTVC-F470	m20900	2011-07-01 13:27:35	2011-07-01 19:53:58	2011-07-22 10:30:57	Parsing Robustness for Merge/AMVP	T. Sugio, T. Nishi (Panasonic)
JCTVC-F471	m20901	2011-07-01 13:34:19	2011-07-01 19:54:31	2011-07-15 20:51:25	Picture Adaptive 1/8-pel Motion Compensation Method	T. Sugio, T. Nishi (Panasonic)
JCTVC-F472	m20902	2011-07-01 13:36:14	2011-07-01 19:55:01	2011-07-15 19:58:34	Modified motion data storage reduction method	T. Sugio, T. Nishi (Panasonic)

JCTVC-F473	m20903	2011-07-01 13:37:48	2011-07-01 19:55:30	2011-07-01 19:55:30	CE1: Cross-check report of experiment A.2 and A.10 by Panasonic	T. Sugio, T. Nishi (Panasonic)
JCTVC-F474	m20904	2011-07-01 13:41:10	2011-07-01 18:43:57	2011-07-15 12:11:05	CE9: Description of experiments ROB01 and ROB02	G. Laroche, P. Onno, T. Poirier, C. Gisquet (Canon)
JCTVC-F475	m20905	2011-07-01 13:42:00	2011-07-01 15:23:12	2011-07-11 11:06:22	Enhancement of quantization matrix coding for HEVC	J. Tanaka, Y. Morigami, T. Suzuki (Sony)
JCTVC-F476	m20906	2011-07-01 13:42:31	2011-07-06 10:04:18	2011-07-06 10:04:18	CE9: cross-check by Canon of experiment ROB03 and ROB04 from Mediatek	G. Laroche, P. Onno, T. Poirier (Canon)
JCTVC-F477	m20907	2011-07-01 13:43:01	2011-07-01 13:46:15	2011-07-12 04:08:10	Unification of the Availability Checking method for Intra prediction	C. Kim, H. Yang (Samsung)
JCTVC-F478	m20908	2011-07-01 13:45:08	2011-07-06 15:06:28	2011-07-06 15:06:28	CE9: cross-check by Canon of experiment PART14 and PART16 from Mediatek	P. Onno, G. Laroche (Canon)
JCTVC-F479	m20909	2011-07-01 13:45:14	2011-07-01 13:54:30	2011-07-17 07:44:30	Chroma DC offset for intra coding	T. Matsunobu, H. Sasai, T. Nishi (Panasonic)
JCTVC-F480	m20910	2011-07-01 13:47:58	2011-07-01 14:04:20	2011-07-12 04:10:28	Unified design for motion compensation filter	C. Kim, S. Jeon (Samsung)
JCTVC-F481	m20911	2011-07-01 14:22:22	2011-07-08 02:46:05	2011-07-08 02:46:05	Verification result of Sony's Improvement of delta-QP Coding (JCTVC-F422)	M. Shima (Canon)
JCTVC-F482	m20912	2011-07-01 14:25:46	2011-07-08 02:46:55	2011-07-08 02:46:55	Verification result of Qualcomm and NEC's Temporal QP Memory Compression (JCTVC-F499)	M. Shima (Canon)
JCTVC-F483	m20913	2011-07-01 14:36:39	2011-07-01 16:29:03	2011-07-14 09:33:52	Planar intra prediction improvement	J. Chen, T. Lee (Samsung)
JCTVC-F484	m20914	2011-07-01 14:40:34	2011-07-01 20:41:45	2011-07-16 10:36:57	Improving Worst-Case performance of Deblocking filter	M. Sadafale (TI)
JCTVC-F485	m20915	2011-07-01 14:53:12	2011-07-01 15:34:39	2011-07-07 11:07:18	Cross check report for Panasonic's improving method for adaptive DCT/DST (JCTVC-F225)	A. Ichigaya, Y. Sugito (NHK)
JCTVC-F486	m20916	2011-07-01	2011-07-04	2011-07-04	Cross-check of Orange Lab's Wavefront Parallel Processing for	A. Henkel (Fraunhofer HHI)

		14:57:05	18:30:39	18:30:39	HEVC Encoding and Decoding JCTVC-F274	
JCTVC-F487	m20917	2011-07-01 15:32:03	2011-07-11 13:03:54	2011-07-12 10:13:39	Study of memory bandwidth of HEVC Motion Compensation	T. Suzuki (Sony)
JCTVC-F488	m20918	2011-07-01 15:48:32	2011-07-01 18:06:11	2011-07-01 18:06:11	Requirements for Scalable extension of HEVC	E. Francois, S. Lasserre, F. Le Leannec (Canon)
JCTVC-F489	m20919	2011-07-01 15:50:48	2011-07-01 18:44:05	2011-07-06 08:55:16	CE6.b test6 : Cross-checking of results of JCTVC-F518 from Hisilicon on SDIP+Planar	E. Francois (Canon)
JCTVC-F490	m20920	2011-07-01 15:51:40	2011-07-01 18:47:29	2011-07-05 10:08:48	Cross-checking of results of JCTVC-F123 from MediaTek	E. Francois (Canon)
JCTVC-F491	m20921	2011-07-01 16:20:13	2011-07-01 20:34:52	2011-07-21 16:38:02	High level syntax for scalability support in HEVC	T. Rusert, R. Sjöberg, P. Fröjdh, Z. Wu (Ericsson)
JCTVC-F492	m20922	2011-07-01 16:21:50	2011-07-01 22:26:00	2011-07-16 00:49:52	A table-based delta QP coding method	R. Sjöberg, J. Sun, P. Wennersten, A. Norkin (Ericsson)
JCTVC-F493	m20923	2011-07-01 16:22:19	2011-07-01 22:29:29	2011-07-22 13:48:38	Absolute signaling of reference pictures	R. Sjöberg, J. Samuelsson (Ericsson)
JCTVC-F494	m20924	2011-07-01 16:31:20	2011-07-01 16:33:13	2011-07-17 08:41:23	Complexity reduction of chroma intra LM prediction mode	J. Chen, V. Seregin, T. Lee, E. Alshina (Samsung)
JCTVC-F495	m20925	2011-07-01 16:36:24	2011-07-02 05:57:12	2011-07-15 19:56:00	Higher granularity of quantization parameter scaling and adaptive delta QP signaling	J. Chen, T. Lee (Samsung)
JCTVC-F496	m20926	2011-07-01 16:37:02	2011-07-01 16:44:07	2011-07-16 06:59:17	2x2 block-based reference pictures memory compression	L. Kang, Y. Ma, S. Lin (Huawei)
JCTVC-F497	m20927	2011-07-01 16:37:28	2011-07-02 06:23:57	2011-07-12 11:09:24	Simplified context model selection for block level syntax coding	J. Chen, T. Lee (Samsung)
JCTVC-F498	m20929	2011-07-01 17:33:19	2011-07-01 18:24:19	2011-07-11 10:32:52	Adaptive Loop Filter Merge in Temporal Domain	X. Zhang, R. Xiong, S. Ma, W. Gao (PKU)
JCTVC-F499	m20930	2011-07-01 17:44:04	2011-07-01 17:49:44	2011-07-15 19:54:26	Temporal QP Memory Compression	M. Coban, M. Karczewicz (Qualcomm), Hirofumi A., K. Chono (NEC)

JCTVC-F500	m20931	2011-07-01 17:50:56	2011-07-02 08:22:18	2011-07-16 08:56:10	Report of self derivation of motion estimation techniques at video decoder side on HM3.0	Y. Chiu, W. Zhang, L. Xu, H. Jiang (Intel)
JCTVC-F501	m20932	2011-07-01 17:53:24	2011-07-01 19:03:02	2011-07-16 08:14:10	Mode dependent coefficient scan for inter blocks	J. Song, M. Yang, H. Yang, H. Yu, X. Zheng (Huawei)
JCTVC-F502	m20933	2011-07-01 17:53:47	2011-07-02 13:15:49	2011-07-18 11:05:45	Cross-channel techniques to improve intra chroma prediction	Y.-J. Chiu, Y. Han, L. Xu, Wenhao Zhang, H. Jiang (Intel)
JCTVC-F503	m20934	2011-07-01 17:58:38	2011-07-01 23:24:03	2011-07-16 09:49:07	Results on slice header modifications	N. Ouedraogo, P. Onno (Canon)
JCTVC-F504	m20935	2011-07-01 18:05:31	2011-07-06 13:47:09	2011-07-06 13:47:09	Cross check of Samsung proposal on MVP index parsing with fixed number of candidates (JCTVC-F402)	G. Laroche, T. Poirier (Canon)
JCTVC-F505	m20936	2011-07-01 18:07:48	2011-07-01 19:04:48	2011-07-16 07:10:23	A chroma coding scheme for SDIP mode	J. Song, H. Yang, M. Yang, H. Yu (Huawei), C. Lai (Hisilicon), J. Xu (Microsoft)
JCTVC-F506	m20937	2011-07-01 18:10:32	2011-07-01 19:05:21	2011-07-14 19:46:59	CE6.b: Harmonization of SDIP and MDDT	H. Yang, J. Zhou, H. Yu, C. Lai (Huawei)
JCTVC-F507	m20938	2011-07-01 18:12:15	2011-07-01 19:05:54	2011-07-01 19:05:54	CE4: Cross-check of NEC and Canon's proposal JCTVC-F159 by Huawei	H. Yang, H. Yu (Huawei)
JCTVC-F508	m20939	2011-07-01 18:13:44	2011-07-01 19:07:52	2011-07-01 19:07:52	CE4: Cross-check of NEC's proposal JCTVC-F103 by Huawei	H. Yang, H. Yu (Huawei)
JCTVC-F509	m20940	2011-07-01 18:14:25	2011-07-01 19:19:34	2011-07-14 15:28:41	CE6.a: Report of Bidirectional UDI mode for Intra prediction	Y. Lin (HiSilicon), H. Yang (Huawei), C. Lai (HiSilicon), J. Zheng (HiSilicon), L. Liu (HiSilicon)
JCTVC-F510	m20941	2011-07-01 18:15:55	2011-07-01 18:59:23	2011-07-06 03:30:46	CE7: Cross-check of JCTVC-F138 by Huawei	H. Yang, H. Yu (Huawei)
JCTVC-F511	m20942	2011-07-01 18:18:04	2011-07-01 19:00:41	2011-07-01 19:00:41	CE7: Cross-check of Panasonic's proposal JCTVC-F224 by Huawei	H. Yang, H. Yu (Huawei)
JCTVC-F512	m20943	2011-07-01	2011-07-01	2011-07-01	CE9: Cross-check report for SP14 and ROB05 by Huawei	Q. Shen, H. Yu (Huawei)

		18:19:57	19:01:26	19:01:26		
JCTVC-F513	m20944	2011-07-01 18:20:27	2011-07-03 03:11:14	2011-07-03 03:11:14	CE1: Results of experiment A.4	Y. Chiu, L. Xu, W. Zhang, Y. Han (Intel)
JCTVC-F514	m20945	2011-07-01 18:21:23	2011-07-01 19:02:31	2011-07-13 07:54:32	Crosscheck of Samsung's proposal JCTVC-F376 by Huawei	Q. Shen, H. Yang, H. Yu (Huawei)
JCTVC-F515	m20946	2011-07-01 18:22:17	2011-07-04 10:39:03	2011-07-04 10:39:03	CE2: Cross verification results of NCTU's OBMC with motion merging (JCTVC-F049) by Intel	Y.-J. Chiu, L. Xu, W. Zhang, Y. Han (Intel)
JCTVC-F516	m20947	2011-07-01 18:26:53	2011-07-03 18:29:59	2011-07-03 18:29:59	CE8 Subtest 1: Cross verification of MQT's proposal by Intel	Y. Chiu, L. Xu, W. Zhang, Y. Han (Intel)
JCTVC-F517	m20948	2011-07-01 18:28:20	2011-07-04 05:41:35	2011-07-04 05:41:35	Cross verification of MediaTek's direction based angular intra prediction (JCTVC-F122) by Intel	Y.-J. Chiu, L. Xu, W. Zhang, Y. Han (Intel)
JCTVC-F518	m20949	2011-07-01 18:29:28	2011-07-01 18:54:58	2011-07-03 10:29:28	CE6.b Test6: Report of harmonization on Planar prediction in SDIP	Y. Lin, C. Lai (HiSilicon), X. Cao (Tsinghua), J. Zheng, L. Liu (HiSilicon)
JCTVC-F519	m20950	2011-07-01 18:46:53	2011-07-12 13:28:20	2011-07-12 13:28:20	Cross-check of reference lists for low delay settings (JCTVC-F433)	B. Li (USTC), J. Xu (Microsoft)
JCTVC-F520	m20951	2011-07-01 18:47:13	2011-07-14 08:44:48	2011-07-14 08:44:48	CE2: Cross-check of non-rectangular motion partitioning (JCTVC-F415)	B. Li (USTC), J. Xu (Microsoft)
JCTVC-F521	m20952	2011-07-01 18:59:28	2011-07-01 20:47:57	2011-07-09 03:01:46	CE8 Subset 3: Cross-Verification of Panasonic's adaptive loop filter (JCTVC-F272) by Qualcomm	I. S. Chong, M. Karczewicz (Qualcomm)
JCTVC-F522	m20953	2011-07-01 19:03:01	2011-07-02 02:22:00	2011-07-12 01:45:51	Enhancing block/region based Adaptive Loop Filter by MediaTek, Qualcomm, Sharp and Toshiba	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), T. Ikai, A. Segall, T. Yamamoto, Y. Yasugi, T. Yamazaki (Sharp)
JCTVC-F523	m20954	2011-07-01 19:21:42	2011-07-01 19:24:44	2011-07-14 18:50:36	Improvements of SPS syntax	V. Drugeon, T. Wedi (Panasonic)

JCTVC-F524	m20955	2011-07-01 19:26:32	2011-07-01 20:00:06	2011-07-14 18:47:42	CE5: Results on modified inter mode coding and joint coding of split flags for CAVLC	A. Kotra, V. Drugeon, T. Wedi (Panasonic)
JCTVC-F525	m20956	2011-07-01 19:27:51	2011-07-08 22:27:22	2011-07-09 00:58:53	CE4 Subtest 1: signaling of minCUDQPsize at LCU level per JCTVC-E346	D. Hoang (Zenverge)
JCTVC-F526	m20957	2011-07-01 19:28:58			Withdrawn	
JCTVC-F527	m20958	2011-07-01 19:30:19	2011-07-08 18:52:50	2011-07-12 16:56:15	Cross-check of JCTVC-F274 from Orange Labs	V. Drugeon (Panasonic)
JCTVC-F528	m20959	2011-07-01 19:41:16	2011-07-02 01:54:35	2011-07-15 19:51:20	Simplified Bilateral Intra Smoothing Filter	G. Li, N. Ling (Santa Clara University), L. Liu, J. Zheng, P. Zhang (Hisilicon)
JCTVC-F529	m20960	2011-07-01 19:52:21	2011-07-04 01:37:29	2011-07-12 17:48:15	CE12: cross-check of SKT/SKKU deblocking filter (JCTVC-F258) by Ericsson	K. Andersson, A. Norkin, R. Sjöberg (Ericsson)
JCTVC-F530	m20961	2011-07-01 19:53:49	2011-07-04 01:32:08	2011-07-12 18:04:45	CE12: Cross-verification of deblocking filter parameter adjustment on a slice level (JCTVC-F143) by Ericsson	A. Norkin (Ericsson)
JCTVC-F531	m20962	2011-07-01 19:58:42	2011-07-12 17:15:32	2011-07-12 17:15:32	Cross-verification of MediaTek's line buffer reduction proposal (F053) by Ericsson	A. Norkin (Ericsson)
JCTVC-F532	m20963	2011-07-01 20:02:22	2011-07-01 21:09:45	2011-07-18 15:19:01	CE6.b Test Summary and spec text of SDIP	X. Cao, Y. Wang, Y. He (Tsinghua), X. Peng (USTC), G. Li (Santa Clara University), J. Xu (Microsoft), H. Yang, H. Yu (Huawei), C. Lai, Y. Lin, L. Liu, J. Zheng (HiSilicon)
JCTVC-F533	m20964	2011-07-01 20:06:58	2011-07-01 21:11:16	2011-07-01 21:11:16	CE6.b Report on test1 Harmonization of SDIP and RQT	X. Cao, Y. Wang, Y. He (Tsinghua), X. Peng (USTC), J. Xu (Microsoft), H. Yang, H. Yu (Huawei), C. Lai, Y. Lin, L. Liu, J. Zheng (HiSilicon)
JCTVC-F534	m20966	2011-07-01 20:13:07	2011-07-07 15:47:29	2011-07-07 15:47:29	CE6.c Crosscheck report for DCIM	C. Lai, L. Liu, J. Zheng (HiSilicon)

JCTVC-F535	m20967	2011-07-01 20:16:12	2011-07-07 15:50:05	2011-07-07 15:50:05	Crosscheck report for Samsung's harmonizing ROT and SDIP	C. Lai, L. Liu, J. Zheng (HiSilicon)
JCTVC-F536	m20968	2011-07-01 20:19:01	2011-07-01 21:14:36	2011-07-01 21:14:36	CE6.b Report on test7 Harmonization of SDIP and deblocking filter	X. Cao, Y. He (Tsinghua), X. Peng (USTC), J. Xu, F. Wu (Microsoft), C. Lai, J. Zheng(HiSilicon), H. Yu (Huawei)
JCTVC-F537	m20970	2011-07-01 20:33:50	2011-07-02 01:49:38	2011-07-13 10:16:37	On the motion compensation process	F. Bossen (DOCOMO USA Labs)
JCTVC-F538	m20971	2011-07-01 20:45:27	2011-07-03 05:54:36	2011-07-03 05:54:36	Cross-check of Samsung's binarisation modification for last position coding (JCTVC-F375)	J. Sole (Qualcomm)
JCTVC-F539	m20972	2011-07-01 20:53:04	2011-07-10 16:49:36	2011-07-10 16:49:36	CE6.b test 8 & test 3 crosscheck report for Qualcomm results in JCTVC-F556	C. Lai, L. Liu, J. Zheng (HiSilicon)
JCTVC-F540	m20973	2011-07-01 21:05:17	2011-07-07 15:58:03	2011-07-07 15:58:03	Crosscheck report for Canon's Modified Intra Mode Coding (JCTVC-F269)	C. Lai, L. Liu, J. Zheng (HiSilicon), H. Yu (Huawei)
JCTVC-F541	m20974	2011-07-01 21:24:50	2011-07-01 21:26:30	2011-07-01 21:26:30	Syntax to express a constraint on reordering latency	G. J. Sullivan (Microsoft)
JCTVC-F542	m20975	2011-07-01 21:27:49	2011-07-01 23:17:22	2011-07-17 12:30:18	ALF with low latency and reduced complexity for HEVC	A. Fuldseth, G. Bjøntegaard (Cisco)
JCTVC-F543	m20976	2011-07-01 22:00:18	2011-07-01 22:07:06	2011-07-17 13:03:36	Tableless run-length coding for transform coefficients in CAVLC	A. Hallapuro, J. Kang, J. Lainema, K. Ugur (Nokia)
JCTVC-F544	m20977	2011-07-01 22:04:15	2011-07-19 19:33:50	2011-07-20 19:18:36	Improved arithmetic coding based on probability aggregation-more results	H. Zhu
JCTVC-F545	m20978	2011-07-01 22:05:28			Considered as withdrawn	
JCTVC-F546	m20979	2011-07-01 22:16:00	2011-07-01 22:19:05	2011-07-01 22:19:05	Sliding Window Improvement for Temporal Scalability	Y. Chen, P. Chen, M. Karczewicz (Qualcomm)
JCTVC-F547	m20980	2011-07-01 22:56:10	2011-07-08 23:07:42	2011-07-08 23:07:42	Cross-check of Tiles (JCTVC-F335), experiment #1	R. Sjöberg, P. Wennersten (Ericsson)

JCTVC-F548	m20981	2011-07-01 23:25:59	2011-07-07 03:38:34	2011-07-14 09:45:32	Cross-verification report of JCTVC-F075	G. Li, N. Ling (Santa Clara University), L. Liu, J. Zheng, P. Zhang (Hisilicon)
JCTVC-F549	m20982	2011-07-01 23:32:17	2011-07-02 01:06:02	2011-07-16 11:23:54	Coding with a single, unified reference picture list	D. Flynn, N. Šprljan, M. Mrak (BBC)
JCTVC-F550	m20983	2011-07-01 23:38:21	2011-07-02 10:32:50	2011-07-17 13:45:03	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-F551	m20984	2011-07-01 23:49:32	2011-07-05 12:34:04	2011-07-05 12:34:04	Cross-check report for JCTVC-F158 on resolution switching	A. Gabriellini, M. Mrak (BBC)
JCTVC-F552	m20985	2011-07-02 00:11:23	2011-07-02 10:59:49	2011-07-16 13:52:46	Parallel processing of residual data in HE	J. Sole, R. Joshi, M. Karczewicz (Qualcomm)
JCTVC-F553	m20986	2011-07-02 00:26:46	2011-07-02 10:44:51	2011-07-17 14:39:00	Mode-Dependent DCT/DST for 4x4 Chroma Blocks	A. Saxena, F. Fernandes, E. Alshina, J. Chen (Samsung)
JCTVC-F554	m20987	2011-07-02 00:29:00	2011-07-02 13:53:21	2011-07-18 16:26:10	On secondary transforms for intra prediction residual	A. Saxena, F. Fernandes (Samsung)
JCTVC-F555	m20988	2011-07-02 00:32:38	2011-07-12 00:35:14	2011-07-12 00:35:14	Cross-Check Report of Evaluation of SDIP (JCTVC-E343)	A. Saxena, F. Fernandes (Samsung)
JCTVC-F556	m20989	2011-07-02 00:41:28	2011-07-02 06:07:58	2011-07-17 18:06:59	CE6.b: SDIP Harmonization with Deblocking, MDIS and HE Residual Coding	G. Van der Auwera, J. Sole, Y. Zheng, X. Wang, I. S. Chong, R. Joshi, M. Karczewicz (Qualcomm)
JCTVC-F557	m20990	2011-07-02 00:52:01	2011-07-02 01:44:55	2011-07-08 18:52:04	CE6.b SDIP Harmonization: Cross Check Results for Test 5 on MDIS and Test 7 on Deblocking (JCTVC-F532)	G. Van der Auwera (Qualcomm)
JCTVC-F558	m20991	2011-07-02 00:54:41	2011-07-02 05:28:00	2011-07-04 01:34:04	CE7: Crosscheck of tool 3 – Panasonic's mode dependent secondary transform (JCTVC-F224)	R. Joshi (Qualcomm)
JCTVC-F559	m20992	2011-07-02 01:01:09	2011-07-02 05:29:41	2011-07-15 02:04:00	CE7: Crossscheck of tool 4 - Samsung's rotational transform (JCTVC-F294)	R. Joshi (Qualcomm)

JCTVC-F560	m20993	2011-07-02 01:03:28	2011-07-02 10:55:01	2011-07-02 10:55:01	CE10: Crosscheck of Samsung/FastVDO's contribution on core transform - high/low QP range (JCTVC-F251)	R. Joshi (Qualcomm)
JCTVC-F561	m20994	2011-07-02 01:08:27	2011-07-07 08:32:39	2011-07-07 08:32:39	Crosscheck of Sharp's proposal on guaranteeing 16 bit dynamic range in inverse transforms (JCTVC-F595)	R. Joshi (Qualcomm)
JCTVC-F562	m20995	2011-07-02 01:18:05	2011-07-02 01:30:42	2011-07-16 11:06:59	Updated Video Test Material Submission for	G. Cook, W. Gao, J. Zhou, H. Yu (Huawei Technologies)
JCTVC-F563	m20996	2011-07-02 01:19:38	2011-07-02 09:33:53	2011-07-16 20:59:49	Non-Square Transform for 2NxN and Nx2N Motion Partitions	L. Guo, J. Sole, R. Joshi, P. Chen, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-F564	m20997	2011-07-02 01:32:54	2011-07-02 01:34:45	2011-07-19 00:15:14	Near Lossless Coding for Screen Content	W. Gao, G. Cook, M. Yang, H. Yu (Huawei)
JCTVC-F565	m20999	2011-07-02 02:37:50	2011-07-02 02:41:40	2011-07-09 01:56:06	CE6.a: Cross Check of Tests 9 and 10 for BUDI Mode (JCTVC-F509)	G. Van der Auwera (Qualcomm)
JCTVC-F566	m21000	2011-07-02 02:44:19	2011-07-02 03:20:59	2011-07-16 08:34:54	CE6.c: Differential Coding of Intra Modes	E. Maani (Sony), T. Yamamoto (Sharp), A. Tanizawa, T. Shiodera (Toshiba), V. Drugeon (Panasonic)
JCTVC-F567	m21001	2011-07-02 02:56:53	2011-07-02 10:11:40	2011-07-12 01:31:23	Adaptive resolution on motion vector difference	W.-J. Chien, P. Chen, X. Wang, M. Karczewicz (Qualcomm)
JCTVC-F568	m21002	2011-07-02 03:05:56	2011-07-02 03:45:05	2011-07-02 03:45:05	CE3: Cross-check report for Samsung's test JCTVC-F247 by Motorola Mobility	J. Lou, K. Minoo, L. Wang (Motorola Mobility)
JCTVC-F569	m21003	2011-07-02 03:07:08	2011-07-02 04:08:06	2011-07-16 09:17:51	Adaptive Scan for Large Blocks for HEVC	Y. Yu, K. Panusopone, J. Lou, L. Wang (Motorola Mobility)
JCTVC-F570	m21004	2011-07-02 03:07:36	2011-07-02 03:49:05	2011-07-19 08:00:35	CE3: Cross-check report for eBrisk's test JCTVC-F216 by Motorola Mobility	J. Lou, L. Wang (Motorola Mobility)
JCTVC-F571	m21005	2011-07-02 03:08:19	2011-07-02 04:37:58	2011-07-05 20:53:32	CE10: Cross-check report for FastVDO/Samsung's test JCTVC-F363 by Motorola Mobility	J. Lou, L. Wang (Motorola Mobility)
JCTVC-F572	m21006	2011-07-02	2011-07-02	2011-07-03	Cross-check report for HKUST's test JCTVC-F190 by	J. Lou, L. Wang (Motorola

		03:08:50	04:39:15	08:38:04	Motorola Mobility	Mobility)
JCTVC-F573	m21007	2011-07-02 03:09:48	2011-07-02 04:08:40	2011-07-16 09:05:20	The Construction of Combined List for HEVC	S. Fang, Y. Yu, L. Wang (Motorola Mobility)
JCTVC-F574	m21008	2011-07-02 03:10:11	2011-07-02 04:43:23	2011-07-03 04:10:59	CE3: Fixed interpolation filter tests by Motorola Mobility	J. Lou, K. Minoo, D. Baylon, K. Panusopone, L. Wang, A. Luthra (Motorola Mobility)
JCTVC-F575	m21009	2011-07-02 03:11:01	2011-07-02 04:09:10	2011-07-19 05:56:03	Simplification of MVP Design for HEVC	Y. Yu, K. Panusopone, L. Wang (Motorola Mobility)
JCTVC-F576	m21010	2011-07-02 03:12:08	2011-07-02 04:45:26	2011-07-07 20:44:36	CE3: Slice-type based adaptive interpolation filter tests by Motorola Mobility	J. Lou, K. Minoo, D. Baylon, K. Panusopone, L. Wang, A. Luthra (Motorola Mobility)
JCTVC-F577	m21011	2011-07-02 03:12:15	2011-07-02 04:09:33	2011-07-15 17:57:22	QP adaptation at sub_CU level	K. Panusopone, A. Luthra, X. Fang, L. Wang (Motorola Mobility)
JCTVC-F578	m21012	2011-07-02 03:14:22	2011-07-02 04:09:57	2011-07-19 05:57:09	RQT with rectangular transform unit support	K. Panusopone, X. Fang, V. Kung, L. Wang(Motorola Mobility)
JCTVC-F579	m21013	2011-07-02 03:15:55	2011-07-12 19:14:22	2011-07-12 19:14:22	Cross-check report for Huawei's proposal on inter non-square TU technique by Motorola Mobility	K. Panusopone, X. Fang, V. Kung, L. Wang (Motorola Mobility)
JCTVC-F580	m21014	2011-07-02 03:16:48	2011-07-02 03:24:20	2011-07-08 18:57:06	CE12: Cross Check of Panasonic's Deblocking Decisions (JCTVC-F191)	G. Van der Auwera, I. S. Chong (Qualcomm)
JCTVC-F581	m21015	2011-07-02 03:17:18	2011-07-14 09:29:30	2011-07-14 09:29:30	Cross-check report for BBC's proposal on Transform skip mode (JCTVC-F077) by Motorola Mobility	K. Panusopone, X. Fang, V. Kung, L. Wang (Motorola Mobility)
JCTVC-F582	m21016	2011-07-02 03:20:33	2011-07-02 10:03:53	2011-07-16 23:35:08	CE2: Asymmetric Motion Partition, Non-Square Quadtree Transform and Overlapped Block Motion Compensation	L. Guo, M. Karczewicz, X. Wang (Qualcomm), Y. Yuan, Y. He (Tsinghua), X. Zheng, H. Yu (Huawei)

JCTVC-F583	m21017	2011-07-02 04:11:43	2011-07-02 04:15:20	2011-07-08 19:01:55	CE6.d: Cross Check Result for Sharp's Parallel Intra Coding (JCTVC-F605)	G. Van der Auwera (Qualcomm)
JCTVC-F584	m21018	2011-07-02 04:25:10	2011-07-02 05:25:03	2011-07-02 05:25:03	Modification to DC prediction in SDIP	Y. Lin, C. Lai (HiSilicon)
JCTVC-F585	m21019	2011-07-02 04:29:33	2011-07-02 04:37:01	2011-07-15 09:47:51	Luma/chroma interpolation precision	M. Coban, P. Chen, M. Karczewicz (Qualcomm)
JCTVC-F586	m21020	2011-07-02 05:00:08	2011-07-02 05:07:56	2011-07-17 00:06:14	Adaptive sampling for Intra coding	J.H. Kim, J. Lou, X. Fang, L. Wang (Motorola Mobility Inc.)
JCTVC-F587	m21021	2011-07-02 05:11:12	2011-07-04 06:39:57	2011-07-16 06:07:50	Reduction of reference picture list checking for temporal motion vector prediction	I.-K Kim, W.-J Han, JH Park (Samsung)
JCTVC-F588	m21022	2011-07-02 05:12:41	2011-07-14 12:20:28	2011-07-14 12:20:28	Cross check report of JCTVC-F274 Wavefront Parallel Processing	M. Coban (Qualcomm)
JCTVC-F589	m21023	2011-07-02 05:15:59	2011-07-06 06:39:18	2011-07-12 06:24:34	Cross check report of JCTVC-F335 Tiles	M. Coban (Qualcomm)
JCTVC-F590	m21024	2011-07-02 05:18:09	2011-07-09 16:29:03	2011-07-13 19:30:36	Cross check report of JCTVC-F495	M. Coban (Qualcomm)
JCTVC-F591	m21025	2011-07-02 05:20:01	2011-07-02 06:02:08	2011-07-18 08:33:59	Modified Selection of 4x4 Mode-Dependent Transforms	R. Cohen, A. Vetro, H. Sun (MERL)
JCTVC-F592	m21026	2011-07-02 05:35:35	2011-07-02 09:40:56	2011-07-18 14:36:32	Recursive factorization for 16 and 32-point transforms using 4 and 8-point HM 3.0 core transforms	R. Joshi, Y. Reznik, J. Sole, M. Karczewicz (Qualcomm)
JCTVC-F593	m21027	2011-07-02 05:47:55	2011-07-02 06:04:34	2011-07-16 10:48:59	Improved CABAC Context Initialization	K. Misra, A. Segall (Sharp)
JCTVC-F594	m21028	2011-07-02 05:53:17	2011-07-02 06:07:37	2011-07-17 10:25:44	New results for parallel decoding for Tiles	K. Misra, A. Segall (Sharp)
JCTVC-F595	m21029	2011-07-02 05:55:56	2011-07-02 06:09:27	2011-07-15 18:01:41	New results for guaranteeing 16-bit transform dynamic range	K. Misra, A. Segall, L. Kerofsky (Sharp)
JCTVC-F596	m21030	2011-07-02	2011-07-02	2011-07-16	The effect of LCU size on coding efficiency in the context of	M. Horowitz, S. Xu (eBrisk Video), E. S. Ryu, Y. Ye

		06:02:30	06:07:39	09:46:18	MTU size matching	(InterDigital Communications)
JCTVC-F597	m21031	2011-07-02 06:13:22	2011-07-02 06:23:05	2011-07-15 07:10:01	CE11: Hardware complexity of large zig-zag scan for level-coding of transform coefficients	C. Auyeung, T. Suzuki (Sony)
JCTVC-F598	m21032	2011-07-02 06:32:44	2011-07-02 06:34:31	2011-07-16 14:57:41	Adaptive significance map coding for large transform	J. Min, Y. Piao, J. Chen (Samsung)
JCTVC-F599	m21033	2011-07-02 06:33:04	2011-07-02 08:44:07	2011-07-07 23:40:34	On Chroma interpolation filters	K. Minoo, J. Lou, A. Luthra (Motorola Mobility)
JCTVC-F600	m21034	2011-07-02 06:34:28	2011-07-02 09:04:55	2011-07-06 01:29:26	CE7: Cross check of JCTVC-F229, Performance analysis of adaptive DCT/DST selection	R. Cohen, A. Vetro, H. Sun (MERL)
JCTVC-F601	m21035	2011-07-02 06:39:09	2011-07-02 06:42:47	2011-07-15 19:05:06	Joint Sub-pixel Interpolation for bi-predicted Motion Compensation	K. Minoo, J. Lou (Motorola Mobility)
JCTVC-F602	m21036	2011-07-02 06:52:28	2011-07-12 07:34:50	2011-07-19 13:03:57	Cross-check for combined interpolation filter design (JCTVC-F468) by Samsung	E. Alshina (Samsung)
JCTVC-F603	m21037	2011-07-02 07:03:25	2011-07-02 07:04:59	2011-07-06 01:59:32	Cross-check of Sony's proposed JCTVC-F091 on Unifying binarizations of Intra modes in HE and LC	W.-J. Chien, M. Karczewicz (Qualcomm)
JCTVC-F604	m21038	2011-07-02 07:04:00	2011-07-02 08:14:40	2011-07-09 07:23:04	Detection of CDR decoding status	Y. Park, K. P. Choi, C. Kim (Samsung)
JCTVC-F605	m21039	2011-07-02 09:11:21	2011-07-02 09:15:40	2011-07-02 09:16:40	CE6.d Parallel Intra Coding	J. Zhao, A. Segall (Sharp)
JCTVC-F606	m21040	2011-07-02 09:30:53	2011-07-02 09:35:12	2011-07-20 11:26:58	Memory and Parsing Friendly CABAC Context	W.-J. Chien, M. Karczewicz, X. Wang (Qualcomm)
JCTVC-F607	m21041	2011-07-02 09:36:52	2011-07-04 11:56:24	2011-07-04 11:56:24	CE11:Cross-check report for Qualcomm's proposal JCTVC-F288 part1	J. Chen, V. Seregin (Samsung)
JCTVC-F608	m21042	2011-07-02 09:37:39	2011-07-02 09:39:24	2011-07-15 09:56:07	Removing Chroma Zonal Coding in CAVLC	M. Karczewicz, X. Wang, W.-J. Chien, L. Guo (Qualcomm)
JCTVC-F609	m21043	2011-07-02 09:42:02	2011-07-02 09:43:22	2011-07-06 08:37:49	CE12: Cross-verification of the Deblocking Filter Proposed by MediaTek and Ericsson (JCTVC-F118)	V. Seregin, J. Chen (Samsung)

JCTVC-F610	m21044	2011-07-02 09:42:37	2011-07-02 09:43:54	2011-07-14 15:36:54	Fine granularity QP offset	X. Wang, R. Joshi, G. Van Der Auwera, M. Karczewicz (Qualcomm)
JCTVC-F611	m21045	2011-07-02 09:45:53	2011-07-02 09:47:24	2011-07-06 08:36:38	CE12: Cross-verification of SK Telecom/SKKU Harmonized Deblocking Filter with Additional Chroma Processing (JCTVC-F262)	V. Seregin, J. Chen (Samsung)
JCTVC-F612	m21046	2011-07-02 09:49:24	2011-07-02 10:05:26	2011-07-15 10:01:02	Modifications to intra blocks coefficient coding with VLC	M. Karczewicz, Y. Zheng, L. Guo, X. Wang (Qualcomm)
JCTVC-F613	m21047	2011-07-02 09:54:32			Withdrawn	
JCTVC-F614	m21048	2011-07-02 09:56:00	2011-07-02 14:39:34	2011-07-10 15:20:26	Cross-check report for Motorola Mobility's JCTVC-F569 by HKUST	F. Zou, O. C. Au (HKUST)
JCTVC-F615	m21049	2011-07-02 10:05:32	2011-07-05 13:50:02	2011-07-05 13:50:02	Cross-verification of Microsoft's JCTVC-F199 by Samsung	T. Lee, J. Chen (Samsung)
JCTVC-F616	m21050	2011-07-02 10:44:24	2011-07-12 01:04:10	2011-07-12 17:52:42	Cross-check of MediaTek's proposed JCTVC-F125 on Progressive MV resolution	W.-J. Chien (Qualcomm)
JCTVC-F617	m21053	2011-07-02 11:25:21	2011-07-02 11:32:12	2011-07-15 16:58:41	Intra prediction based on repetitive pixel replenishment	S. Mochizuki, R. Hashimoto, K. Iwata (Renesas)
JCTVC-F618	m21055	2011-07-02 14:59:49	2011-07-03 03:54:47	2011-07-18 13:17:02	Resampling Filters For Scalability And Screen Content Applications	W. Dai, M. Krishnan, P. Topiwala (FastVDO)
JCTVC-F619	m21056	2011-07-02 18:55:31	2011-07-09 00:57:31	2011-07-09 00:57:31	CE4 Subtest 2.3.c: QP prediction from spatially neighboring CUs per JCTVC-E391 method 2	D. Hoang (Zenverge)
JCTVC-F620	m21057	2011-07-02 20:58:09	2011-07-06 20:55:52	2011-07-07 18:50:38	Crosscheck of JCTVC-F319 Toshiba Adaptive Scaling with Offset RFC	D. Hoang (Zenverge)
JCTVC-F621	m21058	2011-07-03 02:01:05	2011-07-14 15:18:05	2011-07-15 00:01:14	Crosscheck report for Samsung's JCTVC-F458 on CAVLC run coding	X. Wang, L. Guo (Qualcomm)
JCTVC-F622	m21059	2011-07-03 02:07:23	2011-07-14 15:19:54	2011-07-14 15:19:54	Crosscheck report for Samsung's JCTVC-F466 on CAVLC long codeword handling	X. Wang, L. Guo (Qualcomm)

JCTVC-F623	m21060	2011-07-03 02:10:28	2011-07-14 15:20:24	2011-07-14 15:20:24	Crosscheck report for Samsung's JCTVC-F467 on CAVLC table adaptation	X. Wang, L. Guo (Qualcomm)
JCTVC-F624	m21062	2011-07-03 04:13:24	2011-07-09 11:10:05	2011-07-09 11:10:05	Crosscheck for Qualcomm's Transform in JCTVC-F563	Y.-W. Chen, Y.-W. Huang (MediaTek)
JCTVC-F625	m21063	2011-07-03 08:20:32	2011-07-05 08:08:23	2011-07-05 08:08:23	CE12: Cross-verification of SKT/SKKU Deblocking Filter (JCTVC-F258) by ETRI	S. Lee, S. Cho, N. Eum (ETRI)
JCTVC-F626	m21064	2011-07-04 02:09:29	2011-07-04 12:45:55	2011-07-04 12:45:55	Cross-verification result of JCTVC-F427 proposed by Sony	K. Kazui (Fujitsu)
JCTVC-F627	m21065	2011-07-04 02:56:01	2011-07-04 15:16:41	2011-07-04 15:16:41	Cross-check of Motorola Mobility's proposal on combined reference list construction (JCTVC-F573)	C. Yeo (I2R)
JCTVC-F628	m21066	2011-07-04 06:22:35	2011-07-04 09:52:33	2011-07-14 12:05:11	CE6.d: Cross Check Result for Sharp's Parallel Intra Coding (JCTVC-F605) by ETRI	S. Cho, S. Lee, N. Eum (ETRI)
JCTVC-F629	m21067	2011-07-04 11:52:14	2011-07-04 11:55:50	2011-07-04 11:55:50	Cross-verification of Huawei's JCTVC-F505 on chroma coding scheme for SDIP mode	J. Chen (Samsung)
JCTVC-F630	m21068	2011-07-04 12:09:51	2011-07-04 18:09:07	2011-07-04 18:09:07	CE6.b4:Cross-check results (JCTVC-F026)	A. Gabriellini, M. Mrak (BBC)
JCTVC-F631	m21069	2011-07-04 12:21:58	2011-07-04 12:59:34	2011-07-04 12:59:34	CE9: Cross-check of Temporal vector restriction for small PUs JCTVC-F169 (SP12)	B. Bross (Fraunhofer HHI)
JCTVC-F632	m21071	2011-07-04 15:32:38	2011-07-04 16:23:18	2011-07-04 16:23:18	Cross-check of Huawei's proposal (JCTVC-F584): Modification to DC prediction in SDIP	J. Jung, J. Le Tanou (Orange Labs)
JCTVC-F633	m21072	2011-07-04 15:41:07	2011-07-04 15:43:14	2011-07-04 15:43:14	CE12: Cross-check of deblocking for large size blocks (JCTVC-F198 by Microsoft)	J. Lainema, K. Ugur (Nokia)
JCTVC-F634	m21073	2011-07-04 22:21:46	2011-07-18 18:46:26	2011-08-16 11:34:45	HEVC Reference Software Manual	F. Bossen, D. Flynn, K. Sühring (AHG chairs)
JCTVC-F635	m21074	2011-07-04 22:32:31	2011-07-14 15:20:59	2011-07-14 15:20:59	Crosscheck report for JCTVC-F407 on CAVLC run-mode coding from Yonsei Univ. and Samsung	X. Wang, L. Guo (Qualcomm)
JCTVC-F636	m21075	2011-07-04	2011-07-14	2011-07-14	Cross-check of JCTVC-F254: Multi-Parameter Probability	J. Zan, G. Martin-Cocher, D. He

		23:50:46	17:03:42	17:03:42	Update for CABAC	(RIM)
JCTVC-F637	m21076	2011-07-05 02:47:23	2011-07-05 10:25:53	2011-07-05 10:25:53	Cross-check report for JCTVC-F318: on the precision in MC process	K. Kondo, T. Suzuki (Sony)
JCTVC-F638	m21077	2011-07-05 04:00:00	2011-07-06 08:34:13	2011-07-06 08:34:13	CE6.b: Cross-verification of Qualcomm's JCTVC-F556 section 4 on SDIP Harmonization for HE Residual Coding	V. Seregin, J. Chen (Samsung)
JCTVC-F639	m21078	2011-07-05 04:09:18	2011-07-07 12:37:54	2011-07-07 12:37:54	Cross-verification of TI's JCTVC-F233 on Luma-based chroma intra prediction simplification	J. Chen, V. Seregin (Samsung)
JCTVC-F640	m21079	2011-07-05 04:15:23	2011-07-06 06:53:03	2011-07-06 06:53:03	CE4 Subtest 2: Cross-check report for JCTVC-F400 (test 2.3.g and 2.3.f combined)	H. Aoki, K. Chono, Y. Senda (NEC)
JCTVC-F641	m21080	2011-07-05 04:16:15	2011-07-05 10:59:52	2011-07-05 10:59:52	Cross-verification of MediaTek's JCTVC-F121 on Intra Chroma LM Mode with Reduced Line Buffer	J. Chen, V. Seregin
JCTVC-F642	m21081	2011-07-05 04:21:19	2011-07-06 09:29:26	2011-07-06 09:29:26	CE2: Cross-check report for a combination of AMP, NSQT and OBMC (JCTVC-F582)	I.-K Kim (Samsung)
JCTVC-F643	m21082	2011-07-05 04:22:11	2011-07-06 09:05:18	2011-07-06 09:05:18	CE10: Cross-check report on scaled orthogonal integer transforms supporting recursive factorization structure (JCTVC-F352)	I.-K Kim (Samsung)
JCTVC-F644	m21083	2011-07-05 04:22:27	2011-07-07 11:13:19	2011-07-07 11:13:19	CE4 Subtest 2: Cross-check report for JCTVC-F648 (test 2.3.g and 2.3.e.r1 combined)	H. Aoki, K. Chono, Y. Senda (NEC)
JCTVC-F645	m21084	2011-07-05 04:23:12	2011-07-06 10:33:48	2011-07-06 10:33:48	Cross-check report for coding with a single, unified reference picture list (JCTVC-F549)	I.-K Kim (Samsung)
JCTVC-F646	m21085	2011-07-05 04:27:04	2011-07-07 12:38:36	2011-07-07 12:38:36	Cross-verification of MediaTek's JCTVC-F124 on Extended Mode-Dependent Coefficient Scanning	J. Chen, V. Seregin (Samsung)
JCTVC-F647	m21086	2011-07-05 04:44:33	2011-07-05 13:10:58	2011-07-05 13:10:58	Cross-verification of Mitsubishi's JCTVC-F173 on chroma intra prediction from luma improvement	J. Chen, V. Seregin (Samsung)
JCTVC-F648	m21087	2011-07-05 06:09:08	2011-07-11 09:40:19	2011-07-11 09:40:19	CE4: Result of Combination 2.3.g + 2.3.e	K. Sato (Sony)
JCTVC-F649	m21088	2011-07-05 07:53:42	2011-07-11 15:24:12	2011-07-11 15:24:12	Cross-check of ETRI's proposal (JCTVC-F358) on mode dependent filtering for intra predicted samples	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)

JCTVC-F650	m21089	2011-07-05 08:33:48	2011-07-10 16:05:01	2011-07-10 16:05:01	Crosscheck for Samsung's Context Model Selection in JCTVC-F497	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-F651	m21090	2011-07-05 11:54:38	2011-07-07 05:36:57	2011-07-07 05:36:57	Cross-check report on ETRI's proposal JCTVC-F359	V. Wahadaniah, C. S. Lim (Panasonic)
JCTVC-F652	m21091	2011-07-05 12:48:48	2011-07-06 13:05:08	2011-07-06 13:05:08	Cross-check report on Mitsubishi's proposal: Signaling of max and min QP in slice (JCTVC-F174)	K. Chono, H. Aoki (NEC)
JCTVC-F653	m21092	2011-07-05 12:51:00	2011-07-06 07:10:10	2011-07-06 07:10:10	Cross-check report on Unification of Availability Checking Method for Intra Prediction (JCTVC-F477)	K. Chono, H. Aoki (NEC)
JCTVC-F654	m21095	2011-07-05 13:40:57	2011-07-12 06:26:39	2011-07-12 06:26:39	Cross verification for Qualcomm's proposal JCTVC-F552 on Parallel Processing of Residual Data in HE	H. Sasai, T. Nishi (Panasonic)
JCTVC-F655	m21097	2011-07-05 16:26:33	2011-07-11 14:27:54	2011-07-14 12:31:43	Cross-check report on unified reference picture list (JCTVC-F549)	J. Jung, J. Le Tanou (Orange Labs)
JCTVC-F656	m21099	2011-07-05 20:05:40	2011-07-12 01:19:01	2011-07-12 01:19:01	Cross Check Report for Consideration of reference pixel availability for mode-dependent DCT/DST decision (JCTVC-F225)	A. Saxena, F. Fernandes (Samsung)
JCTVC-F657	m21101	2011-07-05 20:56:46	2011-07-07 01:00:14	2011-07-09 19:35:38	Cross verification of Samsung's proposal JCTVC-F587 on Reduction of reference picture list checking for temporal motion vector prediction	M. Zhou (TI)
JCTVC-F658	m21102	2011-07-06 01:58:50	2011-07-10 16:05:59	2011-07-10 16:05:59	Crosscheck for TI's MVD Context in JCTVC-F133	T.-D. Chuang, Y.-W. Huang (MediaTek)
JCTVC-F659	m21104	2011-07-06 02:11:55	2011-07-06 02:16:14	2011-07-08 01:26:43	Cross Check of BBC's proposal JCTVC-F184 on PU-level Intra Prediction	J. Zhao, A. Segall (Sharp)
JCTVC-F660	m21105	2011-07-06 02:30:43	2011-07-06 02:32:33	2011-07-08 01:28:46	Cross Check of LGE's proposal (JCTVC-F111) on Intra prediction mode coding with LCEC on SDIP	J. Zhao, A. Segall (Sharp)
JCTVC-F661	m21106	2011-07-06 04:04:38	2011-07-08 02:23:52	2011-07-08 02:23:52	CE4 Subtest 2: Spatial QP prediction: combination of test 2.3.g, 2.3.f and 2.3.e	H. Aoki, K. Chono (NEC), M. Kobayashi, M. Shima (Canon), K. Sato (Sony)
JCTVC-F662	m21113	2011-07-06	2011-07-07	2011-07-08	CE1: Crosscheck for test A.4	M. Mrak, A. Gabriellini (BBC)

		10:03:24	10:45:46	09:03:51		
JCTVC-F663	m21116	2011-07-06 12:38:02	2011-07-09 09:21:16	2011-07-15 14:18:58	On cu_qp_delta range constraint	K. Chono, H. Aoki (NEC)
JCTVC-F664	m21117	2011-07-06 12:38:04			Withdrawn	
JCTVC-F665	m21118	2011-07-06 14:51:59	2011-07-11 12:12:49	2011-07-11 12:12:49	Verification results of MediaTek's ALF with zero pixel line buffers JCTVC-F054	T. Yamakage, T. Watanabe (Toshiba)
JCTVC-F666	m21119	2011-07-06 14:58:36	2011-07-09 01:47:49	2011-07-11 21:42:51	CE8.5: Verification results of TI's Proposal JCTVC-E287	F. Kossentini, H. Guermazi (eBrisk)
JCTVC-F667	m21120	2011-07-06 17:51:06	2011-07-11 22:09:29	2011-07-16 09:15:45	Cross-check of JCTVC-F612 on CAVLC Intra coding.	T. Davies (Cisco)
JCTVC-F668	m21122	2011-07-06 20:33:15	2011-07-07 17:49:09	2011-07-07 17:49:09	Cross-check results of Canon’s Predicted neighbour for context selection of significant_coeff_flag for parallel processing (JCTVC-F186)	V. Sze (TI)
JCTVC-F669	m21123	2011-07-06 20:35:08	2011-07-07 23:07:54	2011-07-07 23:07:54	Cross-check of Mitsubishi's Fast bypass mode for CABAC (JCTVC-F177)	V. Sze (TI)
JCTVC-F670	m21124	2011-07-06 20:35:40	2011-07-14 09:27:55	2011-07-14 09:27:55	Cross-check of Mediatek's Reducing Line Buffers for Motion Data and CABAC (JCTVC-F060)	V. Sze (TI)
JCTVC-F671	m21125	2011-07-06 20:36:45	2011-07-07 17:17:18	2011-07-07 17:17:18	Cross-check of Sony's proposal on semantic, syntax, and implementation (JCTVC-F134)	V. Sze (TI)
JCTVC-F672	m21126	2011-07-06 23:35:24	2011-07-10 01:36:21	2011-07-10 01:36:21	Cross-check of Panasonic’s proposal on modified context derivation for neighboring dependency reduction (JCTVC-F429)	J. Sole (Qualcomm)
JCTVC-F673	m21127	2011-07-07 00:22:52	2011-07-07 00:45:02	2011-07-08 01:30:28	Cross Check of Qualcomm’s Proposal (JCTVC-F126) on Mode-Dependent Intra Smoothing Modifications	J. Zhao, A. Segall (Sharp)
JCTVC-F674	m21128	2011-07-07 00:39:22	2011-07-07 00:44:37	2011-07-08 01:31:34	Cross Check of CE6.b Test 5 (JCTVC-F556) on SDIP Harmonization with MDIS	J. Zhao, A. Segall (Sharp)
JCTVC-F675	m21129	2011-07-07	2011-07-07	2011-07-08	Cross Check of LGE’s proposal (JCTVC-F109) on Remaining	J. Zhao, A. Segall (Sharp)

		00:54:46	01:07:48	01:32:53	mode redundancy removal	
JCTVC-F676	m21130	2011-07-07 01:37:58	2011-07-07 02:38:55	2011-07-07 02:38:55	Cross-check for Sony’s Proposal (JCTVC-F286) on Redundancy removal for Run-mode in CAVLC	Z. Zhou, S. Liu (MediaTek)
JCTVC-F677	m21131	2011-07-07 01:40:31	2011-07-07 02:40:48	2011-07-07 02:40:48	Cross-check for Sony’s Proposal (JCTVC-F287) on Improvements on last nonzero position coding of 4x4 TU in CAVLC	Z. Zhou, S. Liu (MediaTek)
JCTVC-F678	m21132	2011-07-07 04:20:50	2011-07-11 09:04:28	2011-07-11 09:04:28	Cross-verification results of Panasonic’s intra mode coding (JCTVC-F426) by LG	J. Park, B. Jeon (LGE)
JCTVC-F679	m21133	2011-07-07 06:32:45	2011-07-07 07:43:12	2011-07-07 07:43:12	Cross Check Report for Samsung's Proposal 'Mode-Dependent DCT/DST for 4x4 Chroma Blocks' (JCTVC-F553) by Panasonic	Y. Shibahara, T. Nishi (Panasonic)
JCTVC-F680	m21134	2011-07-07 06:32:55	2011-07-07 08:50:00	2011-07-18 09:56:33	Cross Check Report for Samsung's Proposal 'On secondary transforms for intra prediction residual' (JCTVC-F554) by Panasonic	Y. Shibahara, T. Nishi (Panasonic)
JCTVC-F681	m21135	2011-07-07 08:22:08	2011-07-12 10:19:44	2011-07-15 09:00:54	Cross-Check of JCTVC-F493 by Ericsson	Y. Morigami, K. Sato (Sony)
JCTVC-F682	m21137	2011-07-07 09:57:44	2011-07-07 10:02:19	2011-07-07 10:02:19	Cross check for Picture Adaptive 1/8-pel Motion Compensation Method (JCTVC-471) by Samsung	E.Alshina (Samsung)
JCTVC-F683	m21142	2011-07-07 10:30:15	2011-07-08 01:55:08	2011-07-08 01:55:08	Cross-verification of Panasonic's proposal JCTVC-F271	M. Ikeda, T. Suzuki (Sony)
JCTVC-F684	m21143	2011-07-07 13:33:28	2011-07-07 13:37:41	2011-07-08 06:49:15	CE6.b: Additional simulation results of RQT and SDIP harmonization	K. Chono (NEC), K. Panusopone (Motorola Mobility)
JCTVC-F685	m21146	2011-07-07 18:11:50	2011-07-15 16:32:34	2011-07-15 16:32:34	Cross-check of JCTVC-F599: Chroma interpolation filters	J. Zan, D. He (RIM)
JCTVC-F686	m21152	2011-07-08 07:04:22	2011-07-11 10:17:20	2011-07-11 10:17:20	Cross-check report on JCTVC-F479: Chroma DC offset for intra coding	Keiichi Chono, Hirofumi Aoki (NEC)
JCTVC-F687	m21154	2011-07-08 08:48:55	2011-07-09 23:08:22	2011-07-13 19:38:16	CE2: Report on the Combination of OBMC with Motion Merging and Non-Square Quadtree Transform	C.-C. Chen, Y.-Y. Chen, C.-L. Lee, W.-H. Peng, H.-M. Hang

						(NCTU/ITRI)
JCTVC-F688	m21157	2011-07-08 10:08:50	2011-07-11 15:20:57	2011-07-11 15:20:57	Revised HEVC Software Guidelines	K. Suehring, D. Flynn, F. Bossen, (AHG chairs)
JCTVC-F689	m21166	2011-07-08 14:49:58	2011-07-13 10:27:13	2011-07-13 10:27:13	Cross-check of CE4 Subtest 2, Combination of 2.3.g, 2.3.f and 2.3.e (JCTVC-F661)	R. Sjöberg (Ericsson)
JCTVC-F690	m21169	2011-07-08 16:07:13	2011-07-11 17:18:21	2011-07-11 17:18:21	Cross check by Canon on Merge Candidate Selection in 2NxN, Nx2N, and NxN Mode from Qualcomm (F302)	G. Laroche (Canon)
JCTVC-F691	m21174	2011-07-08 23:43:35	2011-07-13 10:26:41	2011-07-13 10:26:41	Verification of JCTVC-F132: reduction of the number of CABAC contexts	F. Bossen (DOCOMO USA Labs)
JCTVC-F692	m21175	2011-07-09 03:37:37	2011-07-21 10:00:38	2011-07-21 10:00:38	Crosscheck for Qualcomm's Proposal JCTVC-F567	J. An, X. Guo (MediaTek)
JCTVC-F693	m21176	2011-07-09 10:59:02	2011-07-14 13:07:49	2011-07-15 11:34:16	Crosscheck for Sharp's SAO in JCTVC-F396	C.-Y. Tsai, Y.-W. Huang (MediaTek)
JCTVC-F694	m21177	2011-07-09 17:12:58	2011-07-10 02:09:01	2011-07-10 02:09:01	HM3.2 fine granularity slice implementation issues to be clarified	A. Osamoto (TI)
JCTVC-F695	m21179	2011-07-09 23:24:28	2011-07-09 23:30:02	2011-07-10 01:56:09	Cross-verification of Samsung's proposal JCTVC-F402 on MVP index parsing with fixed number of candidates (combined study with JCTVC-F470 part)	M. Zhou (TI)
JCTVC-F696	m21182	2011-07-10 12:58:00	2011-07-13 11:21:42	2011-07-13 11:21:42	Suggested SCC Test Conditions	X. Zhang, O. Au, C. Pang, X. Wen (HKUST)
JCTVC-F697	m21183	2011-07-10 14:47:10	2011-07-10 16:51:26	2011-07-10 16:51:26	CE6.b Crosscheck for additional simulation results of RQT and SDIP harmonization from NEC and Motorola Mobility(JCTVC-F684)	C. Lai, L. Liu, J. Zheng (HiSilicon)
JCTVC-F698	m21186	2011-07-11 02:23:39	2011-07-12 06:39:32	2011-07-12 06:39:32	Cross verification for Qualcomm's proposal JCTVC-F606	H. Sasai, T. Nishi (Panasonic)
JCTVC-F699	m21190	2011-07-11 03:19:16	2011-07-11 09:59:16	2011-07-11 09:59:16	Cross-check report of TI's proposal JCTVC-F068 on HEVC parsing throughput issue (combined study with JCTVC-F470 part)	T. Sugio, T. Nishi (Panasonic)

JCTVC-F700	m21192	2011-07-11 03:20:21	2011-07-14 03:15:22	2011-07-14 03:15:22	Cross-check of MediaTek's Sample Adaptive Offset (JCTVC-F058)	T. Yamazaki, T. Ikai, Y. Yasugi, T. Yamamoto (SHARP)
JCTVC-F701	m21195	2011-07-11 04:24:41	2011-07-12 15:36:02	2011-07-12 15:36:02	Encoding optimization to improve coding efficiency for low delay cases	B. Li (USTC), J. Xu (Microsoft), F. Wu (Microsoft), H. Li (USTC)
JCTVC-F702	m21197	2011-07-11 04:32:49	2011-07-14 17:06:07	2011-07-14 17:06:07	CE4-subtest3.3.2: Cross-check of Adaptive Reconstruction Levels (JCTVC-F276)	B. Li (USTC), J. Xu, G. J. Sullivan (Microsoft)
JCTVC-F703	m21198	2011-07-11 04:33:40			Withdrawn	
JCTVC-F704	m21200	2011-07-11 04:51:01	2011-07-11 12:01:27	2011-07-11 12:01:27	CE2: Cross verification of JCTVC-F687	Y.-J. Chiu, L. Xu, W. Zhang, Y. Han (Intel)
JCTVC-F705	m21203	2011-07-11 06:17:16	2011-07-11 06:19:43	2011-07-11 06:19:43	CE4 Subtest 2: Spatial QP prediction: combination of test 2.3.g with 2.3.b/2.3.c	M. Coban, M. Karczewicz (Qualcomm)
JCTVC-F706	m21208	2011-07-11 07:10:43	2011-07-14 14:57:13	2011-07-14 14:57:13	Crosscheck for Intel's Proposal JCTVC-F502	M. Guo, X. Guo (MediaTek)
JCTVC-F707	m21209	2011-07-11 07:32:27	2011-07-12 06:18:58	2011-07-12 06:18:58	CE4 Subtest 2: Cross check report of JCTVC-F661 for MinCUDQPSize = 32x32	M. Coban (Qualcomm)
JCTVC-F708	m21212	2011-07-11 08:33:51	2011-07-14 22:39:13	2011-07-14 22:39:13	Crosscheck of JCTVC-F528 Simplified Bilateral Intra Smoothing Filter	D. Hoang (Zenverge)
JCTVC-F709	m21214	2011-07-11 09:23:38	2011-07-13 07:54:56	2011-07-13 07:54:56	Crosscheck of Samsung's proposal JCTVC-F598 by Huawei	Q. Shen, H. Yang, H. Yu (Huawei)
JCTVC-F710	m21215	2011-07-11 09:26:46	2011-07-13 14:01:48	2011-07-13 14:01:48	The result of SIMD implementation for Core Transforms	C. Kim, J.-Y. Choi, M. Choi, K. Pachauri, R. Nagpal, B. Raut (Samsung)
JCTVC-F711	m21227	2011-07-11 12:16:42	2011-07-12 06:28:56	2011-07-12 06:28:56	Cross-check of Nokia’s proposal (JCTVC-F456) on directional intra prediction smoothing	A. Minezawa, K. Sugimoto, S. Sekiguchi (Mitsubishi)
JCTVC-F712	m21243	2011-07-11 16:23:45	2011-07-13 05:58:01	2011-07-21 17:48:23	Additional results on JCTVC-F356 (MC complexity reduction)	H. Y. Kim (ETRI), K. Y. Kim, G. H. Park (KHU), S.-C. Lim, J. Lee, J. S. Choi (ETRI)

JCTVC-F713	m21256	2011-07-11 18:14:37	2011-07-13 17:53:06	2011-07-19 10:12:31	CE9: Result about the combination of experiments ROB02 and ROB04	G. Laroche, P. Onno, T. Poirier, C. Gisquet (Canon), , J.-L. Lin, Y.-W. Chen, Y.-W. Huang, S. Lei (MediaTek)
JCTVC-F714	m21269	2011-07-11 19:15:10	2011-07-11 22:42:10	2011-07-18 18:12:07	High-level syntax mismatches between WD and HM	Q. Shen, Y.-K. Wang (Huawei), K. Sühring (Fraunhofer HHI)
JCTVC-F715	m21285	2011-07-12 01:35:51	2011-07-12 06:58:50	2011-07-12 06:58:50	CE1: Cross-check report for A.12(JCTVC-F337), C.1 and C.2 (JCTVC-F021)	J. Zhao, S. H. Kim, A. Segall (Sharp)
JCTVC-F716	m21293	2011-07-12 05:18:57	2011-07-14 03:15:53	2011-07-14 20:10:18	Cross-check of Samsung's proposal F554	J. Xu, A. Tabatabai (Sony)
JCTVC-F717	m21294	2011-07-12 05:33:59	2011-07-12 05:55:25	2011-07-12 05:55:25	Cross-verification of Sony's proposal JCTVC-F431 by Panasonic	C. S. Lim, S. M. T. Naing (Panasonic)
JCTVC-F718	m21304	2011-07-12 07:33:58			Withdrawn	
JCTVC-F719	m21305	2011-07-12 07:34:56	2011-07-12 07:36:52	2011-07-14 00:40:11	Cross-check report for Qualcomm's JCTVC-F585 on Luma/chroma interpolation precision	J. Chen (Samsung)
JCTVC-F720	m21306	2011-07-12 07:45:03	2011-07-14 07:36:02	2011-07-14 07:36:02	Cross-check of Qualcomm's fine granularity QP offset (JCTVC-F610) by Institute for Infocomm Research	Y. H. Tan, C. Yeo (I2R)
JCTVC-F721	m21308	2011-07-12 08:37:38	2011-07-12 08:39:26	2011-07-12 08:39:26	Cross-verification of Qualcomm's JCTVC-F459 on parsing friendly intra mode coding	V. Seregin, J. Chen (Samsung)
JCTVC-F722	m21309	2011-07-12 08:42:21	2011-07-12 08:54:33	2011-07-12 08:54:33	Cross-verification of TI's JCTVC-F484 on improving worst case performance of deblock-filter	V. Seregin, J. Chen (Samsung)
JCTVC-F723	m21314	2011-07-12 13:04:48	2011-07-15 14:39:57	2011-07-15 14:39:57	Cross-verification of F608 and F296 by Nokia	K. Ugur, O. Bici (Nokia)
JCTVC-F724	m21315	2011-07-12 13:10:13	2011-07-14 17:05:32	2011-07-14 17:05:32	Cross-check for JCTVC-F500	M. Yang (Huawei)
JCTVC-F725	m21316	2011-07-12 13:41:33	2011-07-15 16:13:07	2011-07-15 16:13:07	Cross-verification of F356 by Nokia	K. Ugur, O. Bici (Nokia)

JCTVC-F726	m21323	2011-07-12 21:21:11	2011-07-13 11:10:55	2011-07-13 11:10:55	Video Test Material Submission for Screen Content Coding	X. Zhang, O. Au, C. Pang, X. Wen (HKUST)
JCTVC-F727	m21324	2011-07-12 22:17:46	2011-07-13 19:42:33	2011-07-13 19:42:33	CE10: A Cross-check report for core transform proposal JCTVC-F363 High QP configuration	K. Misra, L. Kerofsky, A. Segall (Sharp)
JCTVC-F728	m21325	2011-07-12 22:19:13	2011-07-12 22:34:04	2011-07-12 22:34:04	A Cross-check report for JCTVC-F550 proposal removing parsing dependency of residual coding on intra mode	K. Misra, A. Segall (Sharp)
JCTVC-F729	m21326	2011-07-12 22:20:22	2011-07-12 22:36:50	2011-07-12 22:36:50	Cross-check report for JCTVC-F325 proposal on modifying temporal MV derivation process for merge/skip mode	K. Misra, A. Segall (Sharp)
JCTVC-F730	m21330	2011-07-13 03:40:36	2011-07-16 00:32:34	2011-07-16 00:32:34	Cross-check for Motorola's Proposal (F601) on Sub-pixel Interpolation	Z. Zhou, S. Liu (MediaTek)
JCTVC-F731	m21337	2011-07-13 15:50:12	2011-07-13 22:14:21	2011-07-14 17:32:18	CE10: Crosscheck of Samsung/FastVDO's contribution on core transform - low QP range (JCTVC-F251)	D. Hoang (Zenverge)
JCTVC-F732	m21343	2011-07-13 22:41:35	2011-07-16 15:21:07	2011-07-16 15:21:07	CE4 Subtest2: Verification result of Qualcomm's Spatial QP prediction (JCTVC-F705)	M. Shima (Canon)
JCTVC-F733	m21344	2011-07-13 22:47:23	2011-07-13 22:49:27	2011-07-16 14:48:36	Modification to JCTVC-F537: 16-bit bi-prediction interpolation process	M. Coban, P. Chen, M. Karczewicz (Qualcomm),
JCTVC-F734	m21345	2011-07-13 23:02:45	2011-07-14 09:42:55	2011-07-17 14:48:56	CE 7: Cross-Check for Mode-Dependent 2-step transform for Intra Coding (F224)	A. Saxena, Y. Piao, E. Alshina, F. Fernandes (Samsung)
JCTVC-F735	m21347	2011-07-14 00:12:41	2011-07-16 05:57:00	2011-07-16 05:57:00	Cross-check of Intel's proposal (JCTVC-F500) on self derivation of motion estimation at decoder side	K. Sugimoto, A. Minezawa, S. Sekiguchi (Mitsubishi)
JCTVC-F736	m21353	2011-07-14 10:34:29	2011-07-14 10:40:28	2011-07-14 10:40:28	On Performance Drawbacks of Intra Luma Prediction	S. Riabtsev (Zoran)
JCTVC-F737	m21356	2011-07-14 12:42:58	2011-07-15 10:43:38	2011-07-15 10:43:38	CE9: Cross-check of experiment ROB6 (JCTVC-F713)	J. Jung, J. Le Tanou (Orange Labs)
JCTVC-F738	m21368	2011-07-15 10:16:53	2011-07-20 11:58:41	2011-07-20 11:58:41	Cross-check of Qualcomm's contribution on 16-bit bi-prediction interpolation process (JCTVC-F733)	A. Fuldseth (Cisco)
JCTVC-F739	m21369	2011-07-15	2011-07-15	2011-07-15	Cross Check of Sharp's JCTVC-F593 on CABAC Context	G. Van der Auwera (Qualcomm)

		11:59:33	18:25:27	18:25:27	Initialization	
JCTVC-F740	m21373	2011-07-15 14:34:45	2011-07-15 15:04:36	2011-07-15 15:04:36	Crosscheck results for Samsung's JCTVC-F252 (Block-size and pixel position independent boundary smoothing for non-directional Intra prediction)	J. Lainema, K. Ugur (Nokia)
JCTVC-F741	m21376	2011-07-15 18:12:38	2011-07-16 00:09:56	2011-07-16 00:09:56	Test material update for screen content	W. Ding, Y. Shi, B. Yin (Beijing Univ. Tech.)
JCTVC-F742	m21377	2011-07-15 23:43:24			Considered as withdrawn	
JCTVC-F743	m21378	2011-07-16 01:35:20	2011-07-17 10:27:03	2011-07-17 10:27:03	A Cross-check report for JCTVC-F586 proposal on adaptive sampling for intra coding	K. Misra, A. Segall (Sharp)
JCTVC-F744	m21382	2011-07-16 09:52:25	2011-07-21 15:58:45	2011-08-05 10:20:42	BoG Report on MV Coding and Parsing Throughput/Robustness	B. Bross (BoG coordinator)
JCTVC-F745	m21383	2011-07-16 10:49:43	2011-07-16 11:34:32	2011-07-17 09:19:50	BoG report on efficient binary representation of cu_qp_delta syntax for CABAC	K. Chono, H. Aoki, Y. Senda, K. Kondo, K. Sato, J. Xu (BoG coordinators)
JCTVC-F746	m21384	2011-07-16 14:22:31	2011-07-21 06:48:13	2011-07-21 12:34:48	BoG report on context reduction for CABAC	V. Sze (BoG coordinator)
JCTVC-F747	m21385	2011-07-16 18:52:34	2011-07-17 12:00:32	2011-07-21 18:26:42	Adaptation Parameter Set (APS)	S. Wenger, J. Boyce, Y.-W. Huang, C.-Y. Tsai, P. Wu, M. Li (BoG coordinators)
JCTVC-F748	m21386	2011-07-16 19:02:11	2011-07-17 21:08:23	2011-07-17 21:08:23	Cross-check report on a variant of JCTVC-F410	K. Chono (NEC),
JCTVC-F749	m21387	2011-07-16 20:08:38	2011-07-16 20:34:17	2011-07-16 20:34:17	Cross-check of new results for parallel decoding for tiles (JCTVC-F594)	M. Horowitz, S. Xu (eBrisk)
JCTVC-F750	m21388	2011-07-16 23:57:44	2011-07-17 10:10:50	2011-07-17 10:10:50	Cross-check of Nokia's proposal on Tableless run-length coding for transform coefficients in CAVLC (JCTVC-F543)	V. Sze, M. Budagavi (TI)
JCTVC-F751	m21391	2011-07-17 09:48:33	2011-07-17 14:39:02	2011-07-17 14:39:02	BoG report on CE2: Motion partitioning and OBMC	J. Boyce (BoG coordinator)

JCTVC-F752	m21393	2011-07-17 10:52:56	2011-07-18 15:13:26	2011-07-18 15:13:26	BoG report on quantization offset, adaptive reconstruction level	G. Martin-Cocher (BoG coordinator)
JCTVC-F753	m21394	2011-07-17 12:53:56	2011-07-17 15:59:41	2011-07-17 15:59:41	BoG report on unified scans for the significance map and coefficient level coding in high efficiency (JCTVC-F288)	R. Joshi (BoG coordinator)
JCTVC-F754	m21396	2011-07-17 16:52:24	2011-07-17 16:56:54	2011-07-21 00:12:39	BoG report on CAVLC run-level coding	T. Davies (BoG coordinator)
JCTVC-F755	m21401	2011-07-18 08:57:00	2011-07-18 09:04:07	2011-07-19 00:13:33	BoG report on SDIP throughput	W. Gao (BoG coordinator)
JCTVC-F756	m21404	2011-07-18 11:44:16	2011-07-18 17:42:23	2011-07-18 18:41:28	BoG report on CExx: Quantization (Subtest yy: QP coding)	K. Chono, H. Aoki, K. Sugomoto, M. Shima, K. Panusopone, X. Zhang, S. Liu, C. Yeo, M. Coban, G. Martin-Cocher, K. Sato (BoG coordinators)
JCTVC-F757	m21405	2011-07-18 12:19:23	2011-07-18 14:10:10	2011-07-18 14:10:10	Request to revisit CE4 Subtest2 results	M. Shima (Canon), K. Sugimoto (Mitsubishi Electric), K. Panusopone (Motorola Mobility), H. Aoki, K. Chono (NEC), M. Coban (Qualcomm), K. Sato, K. Kondo (Sony)
JCTVC-F758	m21406	2011-07-18 14:18:08	2011-07-18 14:25:58	2011-07-18 14:25:58	BoG report on CE10	P. Topiwala, M. Budagavi, R. Joshi, A. Fuldseth, I. Kim (BoG coordinators)
JCTVC-F759	m21409	2011-07-18 18:20:35	2011-07-19 19:09:39	2011-07-21 14:17:18	BoG report on clean random access (CRA) picture	Y.-K. Wang (BoG coordinator)
JCTVC-F760	m21412	2011-07-19 01:28:37	2011-07-19 01:30:55	2011-07-19 17:45:41	BoG report on simplification of intra_chromaFromLuma mode prediction	J. Chen (BoG coordinator)
JCTVC-F761	m21414	2011-07-19 09:04:12	2011-07-19 12:16:28	2011-07-19 12:16:28	Cross verification for HHI's proposal JCTVC-F455 (part3)	H. Sasai, T. Nishi (Panasonic)
JCTVC-F762	m21417	2011-07-19 10:33:18	2011-07-19 10:40:40	2011-07-20 00:02:32	Entropy Coders: How many do we need in HEVC?	K. McCann (Samsung/ZetaCast)

JCTVC-F763	m21418	2011-07-19 13:02:20	2011-07-21 08:00:36	2011-07-21 19:39:22	BoG report on review of deblocking filter related contributions	M. Zhou, A. Norkin (BoG coordinators)
JCTVC-F764	m21419	2011-07-19 18:38:46	2011-07-20 16:44:08	2011-07-21 08:20:12	BoG report of CE3 MC interpolation filter	T. Suzuki (BoG coordinator)
JCTVC-F765	m21420	2011-07-20 11:28:35	2011-07-20 11:30:16	2011-08-04 04:40:59	BoG report on intra mode coding with fixed number of MPM candidates	J. Chen (BoG coordinator)
JCTVC-F766	m21421	2011-07-20 11:54:06	2011-07-20 11:55:17	2011-07-20 18:00:34	Additional results on Intra Mode Coding	E. Francois, N. Ouedraogo (Canon), J. Park (LGE), E. Maani, A. Tabatabai, C. Auyeung (Sony)
JCTVC-F767	m21422	2011-07-20 12:40:43	2011-07-21 09:04:22	2011-07-21 11:50:27	BoG report on subjective viewing test for deblocking filter proposals	V. Baroncini, A. Norkin, M. Narroschke, B. Jeon (BoG coordinators)
JCTVC-F768	m21423	2011-07-20 13:27:55	2011-07-20 15:47:25	2011-07-21 10:17:04	An observation of the subjective viewing test results for deblocking filter proposals	X. Guo, S. Lei (MediaTek)
JCTVC-F769	m21424	2011-07-20 13:32:00	2011-07-20 13:36:00	2011-07-20 13:36:00	Cross Check of JCTVC-F712	D. Flynn (BBC)
JCTVC-F770	m21425	2011-07-20 15:00:43	2011-07-20 15:04:14	2011-07-20 15:04:14	Results for SCC with Transform Skip Mode (JCTVC-F077)	M. Mrak, A. Gabriellini, D. Flynn (BBC)
JCTVC-F771	m21426	2011-07-20 17:01:59	2011-07-21 10:04:20	2011-07-22 00:26:13	BoG Report on Screen Content Coding	O. C. Au, J. Xu, H. Yu (BoG coordinators)
JCTVC-F772	m21427	2011-07-20 17:06:38	2011-07-21 08:01:33	2011-07-26 23:41:16	Report on subjective viewing test for configurations in JCTVC-F320	V. Sze (TI)
JCTVC-F773	m21428	2011-07-21 00:58:46	2011-07-21 01:01:31	2011-07-21 19:50:11	Additional Performance Metric for Screen Content Coding	W. Gao (Huawei)
JCTVC-F774	m21429	2011-07-21 10:17:00	2011-07-21 11:49:39	2011-07-21 11:49:39	Cross check of JCTVC-F405	G. Van der Auwera (Qualcomm)
JCTVC-F800	m21451	2011-08-02 10:45:19			Meeting report of the sixth meeting of the Joint Collaborative Team on Video Coding (JCT-VC), Torino, IT, 14-22 July 2011	G. J. Sullivan, J.-R. Ohm (JCT-VC chairs)

JCTVC-F802	m21450	2011-07-29 20:57:51	2011-10-04 20:32:17	2011-10-04 20:32:17	HM4: HEVC Test Model 4 Encoder Description	K. McCann, S. Sekiguci, B. Bross, W.-J. Han (Editors)
JCTVC-F803	m21449	2011-07-28 11:38:31	2011-08-09 10:14:29	2011-10-28 11:51:18	WD4: Working Draft 4 of High-Efficiency Video Coding	B. Bross, W.-J. Han, J.-R. Ohm, G. J. Sullivan, T. Wiegand (Editors)
JCTVC-F900	m21452	2011-08-09 00:18:51	2011-09-12 17:29:47	2011-09-12 17:29:47	Common test conditions and software reference configurations	F. Bossen (software & test condition coordinator)
JCTVC-F901	m21444	2011-07-22 08:33:25	2011-07-22 08:36:31	2011-09-06 03:03:51	Description of Core Experiment 1: Entropy Coding	R. Joshi, E. Alshina, H. Sasai, H. Kirchhoffer, J. Lainema (CE coordinators)
JCTVC-F902	m21441	2011-07-22 08:13:59	2011-07-22 08:42:53	2011-08-21 17:08:44	Description of Core Experiment 2: Motion Partitioning and OBMC	X. Zheng, I. S. Chong, Il-Koo Kim (CE coordinators)
JCTVC-F903	m21445	2011-07-22 09:02:55	2011-07-22 15:41:16	2011-08-22 00:59:25	CE3: Motion Compensation	T. Chujoh, E. Alshina (CE coordinators)
JCTVC-F904	m21434	2011-07-21 15:24:41	2011-07-22 08:36:19	2011-08-31 08:38:00	Description of Core Experiment 4: Quantization	K. Sato, M. Budagavi, M. Coban, H. Aoki, X. Li (CE coordinators)
JCTVC-F905	m21440	2011-07-22 07:04:39	2011-07-22 14:13:14	2011-08-21 16:27:59	Description of Core Experiment 5: CAVLC Entropy Coding Improvements	X. Wang, P. Wu, C.Y. Kim (CE coordinator)
JCTVC-F906	m21442	2011-07-22 08:26:46	2011-07-22 11:35:59	2011-08-24 23:01:22	CE6: Intra Coding Improvements	A. Tabatabai, E. Francois, K. Chono, H. Yu, R. Joshi, J. Lainema (CE coordinators)
JCTVC-F907	m21439	2011-07-22 00:57:50	2011-07-22 20:04:27	2011-08-27 00:07:31	Description of Core Experiment 7 (CE7): Additional Transforms	R. Cohen, C. Yeo, R. Joshi, F. Fernandes (CE coordinators)
JCTVC-F908	m21446	2011-07-22 09:05:50	2011-07-22 09:08:12	2011-08-29 15:13:18	Description of Core Experiment 8 (CE8): Non-deblocking loop filtering	T. Yamakage, I. S. Chong, M. Narroschke (CE coordinators)
JCTVC-F909	m21436	2011-07-21 19:20:53	2011-07-22 12:46:35	2011-08-24 10:41:56	Description of Core Experiment 9: MV Coding and Skip/Merge Operations	B. Bross, J. Jung, W.-J. Chien, I.-K. Kim, M. Zhou (CE coordinators)

JCTVC-F910	m21433	2011-07-21 14:26:54	2011-07-21 14:28:44	2011-07-21 20:16:01	CE10: Core Transform Design	P. Topiwala, M. Budagavi, R. Joshi, A. Fuldseth, I. Kim (CE coordinators)
JCTVC-F911	m21443	2011-07-22 08:30:08	2011-07-23 06:51:33	2011-09-08 23:27:48	Description of Core Experiment (CE11): Coefficient scanning and coding	V. Sze, J. Chen, T. Nguyen, K. Panusopone, J. Sole (CE coordinators)
JCTVC-F912	m21438	2011-07-21 20:53:48	2011-07-22 18:21:32	2011-09-08 23:42:24	Description of Core Experiment 12: Deblocking filtering	A. Norkin, X. Guo, B. Jeon, M. Narroschke (CE coordinators)
JCTVC-F913	m21437	2011-07-21 20:12:59	2011-07-22 10:48:40	2011-09-19 10:03:24	Description of Core Experiment CE13: Motion data parsing robustness and throughput	J. Jung, B. Bross (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 254 in total), were as follows:

1. Daniele Alfonso (STMicroelectronics)
2. Elena Alshina (Samsung)
3. Peter Amon (Siemens AG)
4. Kenneth Andersson (LM Ericsson)
5. Teo Anselimo (STMicroelectronics)
6. Hirofumi Aoki (NEC)
7. Kohtaro Asai (Mitsubishi Electric)
8. Oscar Au (Hong Kong Univ. Sci. & Tech.)
9. Cheung Auyeung (Sony Electronics Inc)
10. Tae Meon Bae (SK Telecom)
11. Yukihiro Bandoh (NTT)
12. Gun Bang (ETRI)
13. Osnat Bar-Nir (Harmonic)
14. Rémi Bertin (Allegro DVT)
15. Oguz Bici (Nokia)
16. Lazar Bivolarsky (Skype)
17. Gisle Bjontegaard (Cisco Systems Norway)
18. Ronan Boitard (INRIA)
19. Philippe Bordes (Technicolor)
20. Frank Bossen (DoCoMo USA Labs)
21. Jill Boyce (Vidyo)
22. Benjamin Bross (Fraunhofer HHI)
23. Madhukar Budagavi (Texas Instruments Inc)
24. Xiaoran Cao (Tsinghua Univ.)
25. Jianle Chen (Samsung Electronics Co., Ltd.)
26. Weizhong Chen (Huawei technologies CO.,LTD)
27. Ying Chen (Qualcomm)
28. Wei-Jung Chien (Qualcomm)
29. Yi-Jen Chiu (Intel Corp.)
30. Jaehee Cho (Sejong Univ.)
31. Seunghyun Cho (ETRI)
32. Haechul Choi (Hanbat Univ.)
33. Hyomin Choi (Kwangwoon Univ.)
34. Kiho Choi (Hanyang Univ.)
35. Sung Jun Choi (Feelingk)
36. In Suk Chong (Qualcomm)
37. Keiichi Chono (NEC)
38. Tzu-Der Chuang (MediaTek)
39. Takeshi Chujoh (Toshiba)
40. Sorin Cismas (Maxim Integrated Products)
41. Muhammed Coban (Qualcomm)
42. Robert Cohen (Mitsubishi Electric)
43. Nicholas Culver (Altera)
44. Thomas Davies (Cisco Systems)
45. Jan De Cock (Ghent Univ. - IBBT)
46. Wenping Ding (Beijing Univ. Tech.)
47. Jie Dong (Chinese Univ. Hong Kong)
48. Virginie Drugeon (Panasonic R&D DE)
49. MyungJin Eom (Samsung)
50. Semih Esenlik (Panasonic)
51. Nak Woong Eum (ETRI)
52. Pascal Eymery (Allegro DVT)
53. Eyal Farkash (NDS)
54. Felix Fernandes (Samsung)
55. David Flynn (BBC R&D)
56. Chad Fogg (Harmonic)
57. Edouard François (Technicolor)
58. Deliang Fu (Zhejiang Univ.)
59. Akira Fujibayashi (NTT DoCoMo)
60. Shigeru Fukushima (JVC Kenwood)
61. Arild Fuldseth (Cisco Systems)
62. Wen Gao (Huawei Technologies (USA))
63. Hsan Guermozi (eBrisk Video)
64. Laurent Guillo (INRIA)

65. Xun Guo (MediaTek)
66. Ryeong Hee Gweon (Sejong Univ.)
67. Antti Hallapuro (Nokia)
68. Jong-Ki Han (Sejong Univ.)
69. Ki Hun Han (Feelingk)
70. Woo-Jin Han (Samsung Electronics)
71. Miska Hannuksela (Nokia)
72. Munsi Haque (Sony USA)
73. Ryoji Hashimoto (Renesas Electronics)
74. Dake He (Research In Motion)
75. Tim Hellman (Broadcom Corporation)
76. Hendry (LG Electronics)
77. Felix Henry (Orange Labs FT)
78. Dzung Hoang (Zenverge, Inc.)
79. Danny Hong (Vidyo, Inc.)
80. Sung-Wook Hong (Sejong Univ.)
81. Yingjie Hong (ZTE)
82. Michael Horowitz (eBrisk Video, Inc.)
83. Yu-Wen Huang (MediaTek)
84. Atsuro Ichigaya (NHK)
85. Masaru Ikeda (Sony Corporation)
86. Byeong Moon Jeon (LG)
87. Byeungwoo Jeon (Sungkyunkwan Univ.)
88. Yong-Joon Jeon (LG Electronics)
89. Ali Jerbi (Cisco)
90. Jie Jia (LG Electronics China R&D Center)
91. Xin Jin (Waseda Univ.)
92. Rajan Joshi (Qualcomm)
93. Joël Jung (Orange Labs)
94. Jewon Kang (Nokia)
95. Jung Won Kang (ETRI)
96. Marta Karczewicz (Qualcomm)
97. Kei Kawamura (KDDI)
98. Kimihiko Kazui (Fujitsu)
99. Abdellatif Khindouf (Allegro DVT)
100. Chanyul Kim (Samsung)
101. Hae Kwang Kim (Sejong Univ.)
102. Hui Yong Kim (ETRI)
103. Hyun-Dong Kim (Sejong Univ.)
104. Il-Koo Kim (Samsung Electronics Co., Ltd.)
105. Jae Hoon Kim (Motorola Mobility)
106. Jae-Gon Kim (Korea Aerosp. Univ.)
107. Jaeil Kim (KAIST)
108. Kyungyong Kim (Kyunghee Univ.)
109. Munchurl Kim (KAIST)
110. Seongwan Kim (Yonsei Univ.)
111. Yong-Hwan Kim (KETI)
112. Kenji Kondo (Sony)
113. Jumpei Koyama (Fujitsu)
114. Cheonhak Ku (LG Electronics)
115. Thomas Kunlin (STMicroelectronics)
116. JaeCheol Kwon (KT)
117. Changcai Lai (Huawei)
118. PoLin (Wang) Lai (Samsung)
119. Jani Lainema (Nokia)
120. Guillaume Laroche (Canon)
121. Hansoo Lee (Kyunghee Univ.)
122. Jaeho Lee (Yonsei Univ.)
123. Jae-Young Lee (Sejong Univ.)
124. Jinho Lee (ETRI)
125. Ju Ock Lee (Sejong Univ.)
126. Sang-Yong Lee (Korea Aerosp. Univ.)
127. Sangyoun Lee (Yonsei Univ.)
128. Sinwook Lee (Hanyang Univ.)
129. Sukho Lee (ETRI)
130. Sunil Lee (Samsung Electronics)
131. Yung-Lyul Lee (Sejong Univ.)
132. Shawmin Lei (MediaTek)
133. Guichun Li (Huawei Technologies)
134. Jin Li (Panasonic)
135. Ming Li (ZTE Corp.)
136. Xiang Li (MediaTek (Beijing) Inc.)
137. Chongsoon Lim (Panasonic Singapore Labs)
138. Jaehyun Lim (LG Electronics)
139. Jiunn BinLim (Panasonic)
140. Sung-Chang Lim (ETRI)

141. Younghun Lim (Chips & Media)
142. Yongbing Lin (Huawei)
143. Lingzhi Liu (Huawei / Hisilicon)
144. Shan Liu (MediaTek)
145. Yu Liu (ASTRI)
146. Ajay Luthra (Motorola Mobility)
147. Sadufule Manyesh (TI)
148. Detlev Marpe (Fraunhofer HHI)
149. Gaëlle Martin-Cocher (Research in Motion)
150. Masaake Matsumura (NTT)
151. Shohei Matsuo (NTT)
152. Ken McCann (Zetacast / Samsung)
153. Holger Meuel (Leibniz Universität Hannover)
154. Akira Minezawa (Mitsubishi Electric Corporation)
155. Koohyar Minoo (Motorola Mobility)
156. Mikhail Mishurovskiy (Samsung Res. RU)
157. Marta Mrak (BBC)
158. Tokumichi Murakami (Mitsubishi Electric)
159. Hiroya Nakamura (JVC Kenwood)
160. Matthias Narroschke (Panasonic R&D DE)
161. Tung Nguyen (Fraunhofer HHI)
162. Takahiro Nishi (Panasonic)
163. Andrey Norkin (Ericsson AB)
164. Jens-Rainer Ohm (RWTH Aachen Univ.)
165. Patrice Onno (Canon)
166. Krit Panusopone (Motorola Mobility)
167. Jeonghoon Park (Samsung)
168. Joonyoung Park (LG)
169. Seongmo Park (ETRI)
170. Seungwook Park (LG)
171. Youngil Park (Samsung)
172. Youngo Park (Samsung)
173. Wen-Hsiao Peng (NCTU/ITRI)
174. Isabelle Perroux (Allegro DVT)
175. Matthias Preiß (Fraunhofer HHI)
176. Mohamad Raad (RaadTech Consulting)
177. Majid Rabbani (Kodak)
178. Justin Ridge (Nokia)
179. Arturo Rodriguez (Cisco Systems)
180. Christopher Rosewarne (Canon)
181. Shinichi Sakaida (NHK)
182. Jesus Sampedro (Polycom)
183. Hisao Sasai (Panasonic)
184. Kazushi Sato (Sony Corp.)
185. Nicholas Saunders (Sony Europe)
186. Andrew Segall (Sharp Corporatoin)
187. Shun-ichi Sekiguchi (Mitsubishi Electric Corp.)
188. Stian Selnes (Cisco Systems)
189. Chan-Won Seo (Sejong Univ.)
190. Karl Sharman (Sony Europe)
191. Bazhong ("BZ") Shen (Broadcom)
192. Youji Shibahara (Panasonic Corp.)
193. Masato Shima (Canon)
194. Satoshi Shimada (Fujitsu)
195. Shinya Shimizu (NTT)
196. Donggyu Sim (Kwangwoon Univ.)
197. Didier Siron (STMicroelectronics)
198. Rickard Sjöberg (Ericsson)
199. Joel Sole (Qualcomm)
200. Karsten Sühring (Fraunhofer HHI)
201. Kazuo Sugimoto (Mitsubishi Electric)
202. Toshiyasu Sugio (Panasonic Corp.)
203. Gary Sullivan (Microsoft Corp.)
204. Huifang Sun (Mitsubishi Electric)
205. Teruhiko Suzuki (Sony Corp.)
206. Yoshinori Suzuki (NTT DoCoMo)
207. Vivienne Sze (Texas Instruments)
208. Ali Tabatabai (Sony Electronics)
209. Seishi Takamura (NTT)
210. Thiow Keng Tan (NTT DoCoMo)
211. Yih Han Tan (I2R)
212. Akiyuki Tanizawa (Toshiba)
213. Kian Seng They (Panasonic)
214. Pankaj Topiwala (FastVDO LLC)
215. Chia-Yang Tsai (MediaTek)
216. Yi-Shin Tung (MStar Semiconductor)

217. Kemal Ugur (Nokia)
218. Geert Van der Auwera (Qualcomm)
219. Sebastiaan Van Leuven (Ghent Univ. - IBBT)
220. Glenn Van Wallendael (Ghent Univ. - IBBT)
221. Viktor Wahadaniah (Panasonic Singapore Labs)
222. Wade Wan (Broadcom Corporation)
223. Jing Wang (Research in Motion)
224. Xianglin Wang (Qualcomm)
225. Ye-Kui Wang (Huawei Technologies)
226. Thomas Wedi (Panasonic)
227. Krzysztof Wegner (Poznań Univ. Tech.)
228. Xing Wen (Hong Kong Univ. Sci. & Tech.)
229. Stephan Wenger (Vidyo, Inc.)
230. Thomas Wiegand (Fraunhofer HHI)
231. Adrian Wise (Aspex)
232. Kwanghyun Won (Sungkyunkwan Univ.)
233. Ping Wu (ZTE)
234. Jizheng Xu (Microsoft Corp.)
235. Lidong Xu (Intel)
236. Tomoo Yamakage (Toshiba)
237. Tomoyuki Yamamoto (Sharp)
238. Haitao Yang (Huawei)
239. Jungyoup Yang (Sungkyunkwan Univ.)
240. Yukinobu Yasugi (Sharp)
241. Yan Ye (InterDigital Comm.)
242. Chuohao Yeo (I2R)
243. Binbin Yu (Zhejiang Univ.)
244. Haoping Yu (Huawei Technologies (USA))
245. Lu Yu (Zhejiang Univ.)
246. Xiang Yu (Research in Motion)
247. Yong Yu (Broadcom)
248. Yuan Yuan (Tsinghua Univ.)
249. Wen Zhang (ZTE)
250. Jianhua Zheng (Huawei)
251. Xiaozhen Zheng (Huawei Technologies)
252. Yunfei Zheng (Qualcomm)
253. Minhua Zhou (Texas Instruments Inc)
254. Xiaosong Zhou (Apple Inc.)