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Title: **BoG report on PROF/BDOF harmonization contributions (CE4&CE9 related)**

Status: Input document to JVET

Purpose: Proposal

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Source: S. Esenlik, H. Yang

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Summary

The BoG met in 2 sessions in order to discuss CE9 (decoder motion vector derivation) related contributions. The sessions were held on 7 July 2019 from 11:30 to 13:45 and from 15:00 to 17:00.

BoG Recommendations

Recommended for adoption

JVET-O0594 CE4-related: Prediction sample padding unification for BDOF and PROF [X. Xiu, Y.-W. Chen, T.-C. Ma, H.-J. Jhu, X. Wang (Kwai Inc.)]

Aspect 1:

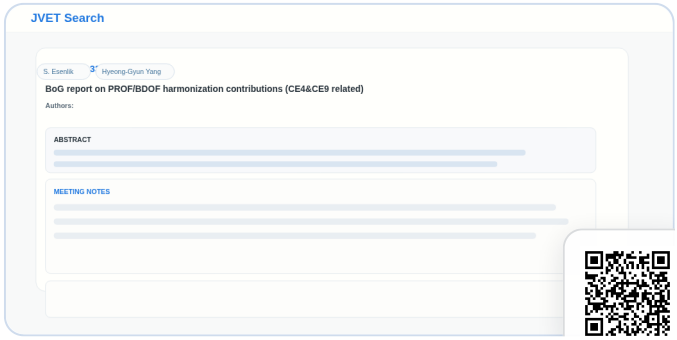
Built from JVET-O1133.docx

LINKS

CARD

JVET-O1133

http://vexpertise.stbit.ru/documents/JVET-O1133



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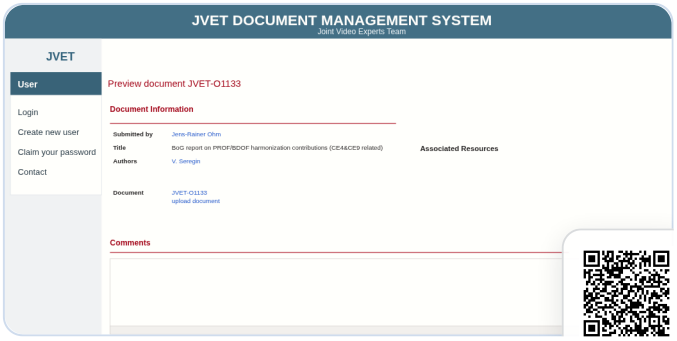


ARCHIVE

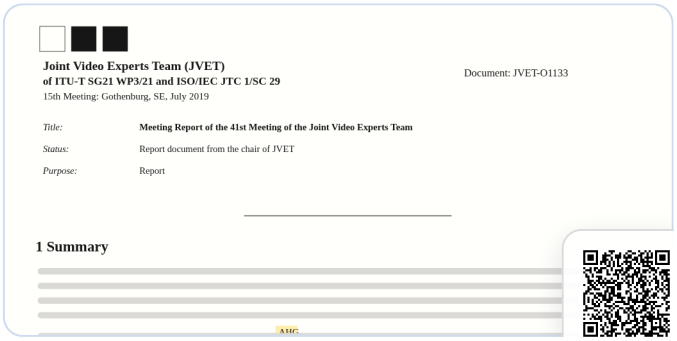
archive

https://jvet-experts.org/doc_end_user/documents/15_Gothenburg/wg11/JVET-O1133-v1.zip

MEETING NOTES

external meeting notes

https://www.itu.int/wftp3/av-arch/jvet-site/2019_07_O_Gothenburg/JVET-O_Notes_dF.docx



MEETING NOTES

JVET-O1133 BoG report on PROF/BDOF harmonization contributions (CE4 & CE9 related) [S. Esenlik, H. Yang]

The BoG met in two sessions in order to discuss CE9 (decoder motion vector derivation) related contributions. The sessions were held on 7 July 2019 from 11:30 to 13:45 and from 15:00 to 17:00.

Presented in track B Tuesday 1130-1330

Recommended for adoption:

JVET-O1133 BoG report on PROF/BDOF harmonization contributions (CE4 & CE9 related) [S. Esenlik, H. Yang]

See section 6.9.

List of actions taken affecting the draft text of VVC, the VTM, and 360Lib

The following is a summary, in the form of a brief list, of the actions taken at the meeting that affect the text of the VVC draft text, VTM or 360Lib description. Both technical and editorial issues are included. This list is provided only as a summary – details of specific actions are noted elsewhere in this report and the list provided here may not be complete and correct. The listing of a document number only indicates that the document is related, not that it was adopted in whole or in part. The description given in the “Tool” column is a best effort for the sake of understanding but may not precisely reflect the functionality of the tool. It is also noted that in cases where several contributions proposed the same method, usually only one of the is listed as adoption below; refer to the meeting notes about the adoption to see which other contributions are related.

Category	Sub-Category	Rationale	Tool	Document
In-loop Filter				
	Deblocking	Subjective quality	Sub-sample MV threshold	JVET-O0061
	Deblocking	Cleanup	Deblocking tC table defined for 10-bit video	JVET-O0159
	Deblocking	Bug fix	Chroma line selection for gradient computation	JVET-O0637

	Deblocking	Subjective quality	Deblocking at 4x4 block boundaries	JVET-O0060
	ALF	Coding efficiency (chroma)	Alternative chroma filters + CTU chroma filter selection	JVET-O0090
	ALF	Simplification	Modification of clipping value signalling	JVET-O0064
	ALF	Simplification	Modification of ALF coefficient signalling	JVET-O0216
	ALF	Cleanup	Save the signalling of the APS index in cases where the number is <= 2	JVET-O0247
	ALF	Bug fix	Apply VB when the bottom CTU boundary is a slice/tile/brick or “360 virtual” boundary	JVET-O0625
	ALF	Simplification	Modified ALF filtering for Slice, Brick and Virtual boundaries	JVET-O0662
	ALF	Simplification	Simplification of ALF Coefficient Signalling	JVET-O0669
	ALF	Cleanup	Syntax constraints of ALF APS	JVET-O0288
	LMCS	Cleanup/Bug fix	LMCS related clean-ups	JVET-O0428
	LMCS	Simplification	Unification of chroma residual scaling	JVET-O1109
	LMCS	Simplification	Simplified inverse luma mapping	JVET-O0272
Intra				
	IBC	Simplification	Single HMVP table inside shared merge list region for IBC	JVET-O0078
	IBC	Simplification	Disabling IBC for chroma in case of dual tree	JVET-O0258

	IBC	Bug fix	IBC mvp flag conditioned on MaxNumMergeCand>1	JVET-O0162
	IBC	Cleanup	Number of IBC merge candidates independent for P/B slices	JVET-O0455
	IBC	Simplification	Bitstream conformance with a virtual IBC buffer concept	JVET-O1170
	CCLM	Complexity reduction	CCLM restrictions for dualtree to reduce latency	JVET-O1124
	Palette	Coding efficiency (444/SCC)	Base palette mode for 4:4:4	JVET-O0119
	Block sizes	Complexity reduction	Small chroma block size restrictions for shared tree	JVET-O0050
	Block sizes	Bug fix	MinCbSize >= 8	JVET-O0640
	ISP	Complexity reduction	4xN prediction regions for 4xN and 8xN (N > 4) ISP-coded blocks	JVET-O0106
	BDPCM	Bug fix/cleanup	Unified TS and BDPCM signalling	JVET-O1136
	BDPCM	Simplification	Intra prediction mode alignment for BDPCM	JVET-O0315
	PCM	Simplification	Remove PCM	JVET-O0525
	Prediction	Simplification	Small blocks (4x4, 4x8, 8x4) are not smoothed for all angles	JVET-O0277
	Prediction	Simplification	Always apply ‘DCT-IF’ interpolation to ISP	JVET-O0341
	Prediction	Simplification	Intra prediction simplifications	JVET-O0364

	Prediction	Simplification	MRL reference samples for DC	JVET-O0426
	Prediction	Simplification	Signal all 67 intra modes for ISP (MPM, remaining modes); apply PDPC	JVET-O0502
	Prediction	Bug fix	Wide-angle in chroma intra angle mapping table for 4:2:2	JVET-O0655
	Mode coding	Bug fix	Chroma DM mode is planar in case of IBC	JVET-O0651
	Mode coding	Cleanup	Intra chroma mode coding cleanup	JVET-O1153
	MIP	Simplification	MIP 8-bit coefficient and simplifications	JVET-O0925
Transform				
	LFNST	Simplification	Simplification of 48x16 LFNST matrices	JVET-O0094
	LFNST	Simplification	LFNST index signalling depends on last position	JVET-O0472
	LFNST	Simplification	Disable LFNST for non-DCT2 MTS candidate	JVET-O0368
	LFNST	Cleanup	Disable LFNST and MIP for implicit MTS	JVET-O0529
	LFNST	Cleanup	LFNST transform set selection for a CCLM	JVET-O0219
	LFNST	Complexity reduction	Limit LFNST up to max TU size	JVET-O0213
	MTS	Cleanup	Context modelling for MTS index	JVET-O0294
	MTS	Cleanup	Context modelling for signalling MTS index	JVET-O0294

	MTS	Bug fix	Decouple intra transform selection from inter MTS related SPS flag	JVET-O0541
	MTS	Bug fix	MTS for IBC	JVET-O0474
	Block sizes	Cleanup	Configurable maximum transform size	JVET-O0545
	Block sizes	Cleanup	Maximum TU size for chroma format 4:2:2 and 4:4:4	JVET-O0357
Quantization				
	QP signalling	Bug fix	CU > 64x64, always send cu_qp_delta in first TU	JVET-O0046
	QP signalling	Functionality	Signalling of chroma QP tables	JVET-O0650
	QP signalling	Functionality	CU level chroma QP control	JVET-O1168
	Scaling matrices	Cleanup	Use inter matrices for IBC	JVET-O0267
	Scaling	Bug fix	QP clipping in scaling process for transform skip	JVET-O0919
CABAC				
	Coeff. coding	Troughput/worst case	TB-level constraints on context-coded bins	JVET-O0052
	Coeff. coding	Closing an open detail	Joint chroma residual coding with multiple modes	JVET-O0105
	Coeff. coding	Coding efficiency (SCC)	Sign context, level mapping, and bitplane coding for TS residual coding	JVET-O0122

	Coeff. coding	Complexity reduction	3-pass residual coding for transform skip	JVET-O0623
	Coeff. coding	Cleanup	Exclude coded_subblock_flag in TSRC max ctx coded bin count	JVET-O0409
	Coeff. coding	Cleanup	Ctx derivation of coded block flag	JVET-O0193
	Coeff. coding	Cleanup	Context model reduction for sig_coeff_flag	JVET-O0617
	Coeff. coding	Cleanup	Disallow joint chroma coding for non-I CUs	JVET-O0543
	Coeff. coding	Cleanup	High-level flag for joint chroma coding	JVET-O0376
	Engine	Simplification	CABAC init	JVET-O0065
Inter				
	AMVR	Coding efficiency	HPEL AMVR extension with alt. IF	JVET-O0057
	PROF	Coding efficiency	Affine prediction refinement with optical flow	JVET-O0070
	PROF/ BDOF	Cleanup	Prediction sample padding unification for BDOF and PROF	JVET-O0594
	PROF/ BDOF	SImplification	Unified gradient calculations	JVET-O0570
	BDOF	Simplification	BDOF 4x4 early termination threshold	JVET-O0055
	BDOF	Simplification	Reduction of number of multiplications	JVET-O0304

	DMVR/ BDOF	Simplification	disabling DMVR and BDOF for CIIP	JVET-O0108
	DMVR/ BDOF	Cleanup	Unify allowed DMVR and BDOF block sizes	JVET-O0634
	DMVR/ BDOF/ BCW	Simplification	Disabled DMVR, BDOF and BCW for CIIP	JVET-O0681
	DMVR	Simplification	modified SAD for the center coordinate	JVET-O0590
	DMVR	Simplification	Simplification for DMVR padding process	JVET-O0297
	Triangle merge	Simplification	MV storage in TPM	JVET-O0265
	Merge syntax	Cleanup	Change merge mode flags syntax tree	JVET-O0249
	SbTMVP	Bug fix	max. num. of subblock merge cand. Signalling	JVET-O0220
	SbTMVP	Cleanup	Remove switching between L0 and L1 for temporal MV	JVET-O0163
	AMVP	Simplification	remove spatial AMVP cand scaling	JVET-O0164
	Affine / AMVR	Cleanup	SPS affine AMVR control flag	JVET-O0438
	Affine / BCW	Simplification	copy BCW index from first spatial affine merge candidate	JVET-O0366
	SMVD	Cleanup	SMVD value range	JVET-O0567
	SMVD	Cleanup	condition sym_mvd_flag on mvd_l1_zero_flag	JVET-O0284

	SMVD	Simplification	SMVD only for STRPs	JVET-O0414
	SMVD	Bug fix	Add missing initialization	JVET-O0572
	MVD	Cleanup	Extent MVD range to [-2^17, 2^17-1]	Plenary
	BDOF	Simplification	Simplification of BDOF	JVET-O0304
	BDOF	Cleanup	Unified syntax for JVET-O0184/O0250/O0504 on DMVR and BDOF flag	JVET-O1140
Partitioning				
	Chroma formats	Cleanup	Do not signal SH chroma tool flags in case of 4:0:0	JVET-O0616
	Coding tree	Bug fix	Store CuPredMode[x][y], cqtDepth[x][y], CbWidth[x][y], CbHeight[x][y], CbPosX[x][y] and CbPosY[x][y] for separate trees	JVET-O0194
	CTU size	Simplification	Increase Min CTU size to 32x32	JVET-O0526
HLS				
	VUI	Bug fix	update BT.2100 references and ICTCP HLG coding equations	JVET-O0622
	RPR	Functionality	Integrated Specification Text for Reference Picture Resampling: including elements of the following documents: JVET-O0133, JVET-O0134, JVET-O0182, JVET-O0204, JVET-O0242, JVET-O0303, JVET-O0319, and JVET-O0395.	JVET-O1164
			High level syntax decision from BoG report JVET-O1076 review	notes on JVET-O1076

Software				
	Pre-filter	Coding efficiency	Encoder-only GOP-based temporal filter	JVET-O0549
	Triangle merge	Speedup	Modified mode decision process for triangle mode	JVET-O0379
	Triangle merge	Speedup	SIMD for triangle merge mode	JVET-O0280
	Subblock merge	Bug fix	Parse merge_subblock_flag conditioned on MaxNumSubblockMergeCand	JVET-O0220
	Subblock merge	Bug fix	Different ctx models (but same derivation) for inter affine flag and subblock merge flag	JVET-O0500
	Palette mode	Bug fix	4:4:4 low QP bug fix	JVET-O0282
	Motion search	Coding efficiency	Motion estimation improvements	JVET-O0592
	MVD	Bug fix	MVD clipping	JVET-O0567
	BCW	Bug fix	BCW index binarization	JVET-O0126
	LMCS	Bug fix	CRS luma lambda computation	JVET-O0429
	LMCS	Coding efficiency , simplification	LMCS encoder improvement	JVET-O0432
	MTS	Bug fix	SPS control of ISP and SBT transform selection	JVET-O0538
	PROF	Bug fix	Align bit-shift operation with BDOF	JVET-O0594

	Coeff. coding	Bug fix	Align SW to text regarding position of chroma CBFs for SBT TUs	JVET-O0596
	Dep. quant.	Speedup	Fast encoder with adjusted threshold	JVET-O0256
	QP signalling	Functionality	Chroma QP table signalling	JVET-O0186
	IBC		IBC virtual buffer in decoder SW	JVET-O1170

Project planning

Core experiment planning

Core experiment plans were established, and initial drafts of the plans were reviewed at the meeting.

Drafting of specification text, encoder algorithm descriptions, and software

The following agreement has been established: the editorial team has the discretion to not integrate recorded adoptions for which the available text is grossly inadequate (and cannot be fixed with a reasonable degree of effort), if such a situation hypothetically arises. In such an event, the text would record the intent expressed by the committee without including a full integration of the available inadequate text.

Plans for improved efficiency and contribution consideration

The group considered it important to have the full design of proposals documented to enable proper study.

> Adoptions need to be based on properly drafted working draft text (on normative elements) and HM encoder algorithm descriptions – relative to the existing drafts. Proposal contributions should also provide a software implementation (or at least such software should be made available for study and testing by other participants at the meeting, and software must be made available to cross-checkers in EEs).

Suggestions for future meetings included the following generally supported principles:

- No review of normative contributions without draft specification text
- VTM algorithm description text is 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 Tuesday 24 September 2019.

As general guidance, it was suggested to avoid usage of company names in document titles, software modules etc., and not to describe a technology by using a company name.

General issues for experiments

It was emphasized during the opening plenary on January 9 that those rules which had been set up or refined during the 12th meeting should be observed. In particular, for some CEs, results were available late, and some changes in the experimental setup (particularly in CE4) were not discussed on the JVET reflector.

Group coordinated experiments have been planned as follows:

- “Core experiments” (CEs) are the coordinated experiments on coding tools which are deemed to be interesting but require more investigation and could potentially become part of the draft standard by the next meeting.
- > A CE is a test of a specific fully described technology in a specific agreed way. It is not a forum for thinking of new ideas (like an AHG). The CE coordinators are responsible for making sure tha the CE description is complete and correct and has adequate detail. Reflector discussions about CE description clarity and other aspects of CE plans are encouraged.
- > A description of each experiment is to be approved at the meeting at which the experiment plan is established. This should include the issues that were raised by other experts when the tool was presented, e.g., interference with other tools, contribution of different elements that are part of a package, etc. The experiment description document should provide the names of individual people, not just company names.
- Software for tools investigated in a CE will be provided in one or more separate branches of the software repository. Each CE will have a “fork” of the software, and within the CE there may be multiple branches established by the CE coordinator. The software coordinator will help coordinate the creation of these forks and branches and their naming. All JVET members have read access to the CE software branches (using shared read-only credentials as described below).
- During the experiment, revisions of the experiment plans can be made, but not substantial changes to the proposed technology.
- The CE description must match the CE testing that is done. The CE description needs to be revised if there has been some change of plans.
- The CE summary report must describe any changes that were made in the process of finalizing the CE.
- By the next meeting it is expected that at least one independent cross-checker will report a detailed analysis of each proposed feature that has been tested and confirm that the implementation is correct. Commentary on the potential benefits and disadvantages of the proposed technology in cross-checking reports is highly encouraged. Having multiple cross-checking reports is also highly encouraged (especially if the cross-checking involves more than confirmation of correct test results). The reports of cross-checking activities may (and generally should) be integrated into the CE report rather than submitted as separate documents.

It is possible to define sub-experiments within particular CEs, for example designated as CEX.a, CEX.b, etc., where X is the basic CE number.

> As a general rule, it was agreed that each CE should be run under the same testing conditions using one software codebase, which should be based on the group test model software codebase. An experiment is not to be established as a CE unless there is access given to the participants in (any part of) the CE to the software used to perform the experiments.

> The general agreed common conditions for SDR single-layer coding efficiency experiments are described in the prior output document JVET-N1010.

> Experiment descriptions should be written in a way such that it is understood as a JVET output document (written from an objective “third party perspective”, not a proponent perspective – e.g. not referring to methods as “improved”, “optimized”, etc.). The experiment descriptions should generally not express opinions or suggest conclusions – rather, they should just describe what technology will be tested, how it will be tested, who will participate, etc. Responsibilities for contributions to CE work should identify individuals in addition to company names.

> CE descriptions contain a basic description of the technology under test, but should not contain excessively verbose descriptions of a technology (at least not unless the technology is not adequately documented elsewhere). Instead, the CE descriptions should refer to the relevant proposal contributions for any necessary further detail. However, the complete detail of what technology will be tested must be available – either in the CE description itself or in documents that are referenced in the CE description that are also available in the JVET document archive.

Any technology must have at least one cross-check partner to establish a CE – a single proponent is not enough. It is highly desirable have more than just one proponent and one cross-checker.

For each CE, a group is created in GitLab by the software coordinators, and CE coordinators are given owner rights to the group. This way they can clone VTM as required, create branches for different tests and assign user access to the group themselves.

The CE software development workflow is described at:

https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/wikis/Core-experiment-development-workflow

CE read access is available using shared accounts: One account exists for MPEG members, which uses the usual MPEG account data (as announced on the appropriate email lists). A second account exists for VCEG members. The account information for VCEG members is available in the TIES system:

https://www.itu.int/ifa/t/2017/sg16/exchange/wp3/q06/vceg_account.txt

Some agreements relating to CE activities were established as follows:

- Only qualified JVET members can participate in a CE.
- Participation in a CE is possible without a commitment of submitting an input document to the next meeting. Participation is requested by contacting the CE coordinator.

- All software, results, and documents produced in the CE should be announced and made available to JVET in a timely manner.
- A JVET CE reflector will be established and announced on the main JVET reflector. Discussion of logistics arrangements, exchange of data, minor refinement of the test plans, and preparation of documents shall be conducted on the JVET CE reflector, with subject lines prefixed by "[CEx:]", where "x" is the number of the CE. All substantial communications about a CE other than such details shall take place on main JVET reflector. In the case that large amounts of data are to be distributed, it is recommended to send a link to the data rather than the data itself, or upload the data as an input contribution to the next meeting.

General timeline for CEs

Reviewed Thursday 11 July 2019 at 1900 (chaired by Y. Ye).

T1= 3 weeks after the JVET meeting: To revise the CE description and refine questions to be answered. Questions should be discussed and agreed on JVET reflector. Any changes of planned tests after this time need to be announced and discussed on the JVET reflector. Initially assigned description numbers shall not be changed later. If a test is skipped, it is to marked as "withdrawn".

T2 = Test model software release + 2 weeks or X XX, whichever is earlier: Integration of all tools into a separate CE branch of the VTM is completed and announced to JVET reflector.

- Initial study by cross-checkers can begin.
- Proponents may continue to modify the software in this branch until T3
- 3rd parties are encouraged to study and make contributions to the next meeting with proposed changes

T3: 3 weeks before the next JVET meeting or T2 + 1 week, whichever is later: Any changes to the CE test branches of the software must be frozen, so the cross-checkers can know exactly what they are cross-checking. A software version tag should be created at this time. The name of the cross-checkers and list of specific tests for each tool under study in the CE plan description shall be documented in an updated CE description by this time.

T4: Regular document deadline – 1 week: CE contribution documents including specification text and complete test results shall be uploaded to the JVET document repository (particularly for proposals targeting to be promoted to the draft standard at the next meeting).

The CE summary reports shall be available by the regular deadline. This shall include documentation about crosscheck of software, matching of CE description and confirmation of the appropriateness of the text change, as well as sufficient crosscheck results to create evidence about correctness (crosscheckers must send this information to the CE coordinator at least 3 days ahead of the document deadline). Furthermore, any deviations from the timelines above shall be documented. The numbers used in the summary report shall not be changed relative to the description document.

CE reports may contain additional information about tests of straightforwared combinations of the identified technologies. Such supplemental testing needs to be clearly identified in the report if it was not part of the CE plan.

New branches may be created which combine two or more tools included in the CE document or the VTM (as applicable).

It is not necessary to formally name cross-checkers in the initial version of the CE description document. To adopt a proposed feature at the next meeting, we would like see comprehensive cross-checking done, with analysis that the description matches the software, and recommendation of value of the tool given tradeoffs.

The establishment of a CE does not indicate that a proposed technology is mature for adoption or that the testing conducted in the CE is fully adequate for assessing the merits of the technology, and a favourable outcome of CE does not indicate a need for adoption of the technology.

Availability of spec text is important to have a detailed understanding of the technology and also to judge what its impact on the complexity of the spec will be. There must also be sufficient time to study it in detail. CE contributions without sufficiently mature draft spec text in the CE input document should not be considered for adoption.

Plans for the CEs to be conducted were established Thursday 11 July (chaired by Y. Ye); CE plan documents were reviewed Thursday 11 July (chaired by Y. Ye).

Lists of participants in CE documents should be pruned to include only the active participants. Read access to CE software will be available to all members.

Software development and anchor generation

The planned timeline for software releases was established as follows:

- VTM6.0 was planned to be released by 2019-08-12, including all adoptions necessary for CTC and CE basis references. VTM6.1 with non-CTC adoptions were to be released later. Further versions of VTM may be released for additional bug fixing, as appropriate.
- Preparation of the VTM software will include immediate removal of macros that were added in the previous meeting cycle. The software coordinator has the discretion to retain some such macros.
- No change of of 360lib was noted in response to this meeting.
- See JVET-O0756 regarding a recent enhancement of HDRTools.

Establishment of ad hoc groups

The ad hoc groups established to progress work on particular subject areas until the next meeting are described in the table below. The discussion list for all of these ad hoc groups was agreed to be the main JVET reflector (jvet@lists.rwth-aachen.de).

Title and Email Reflector	Chairs	Mtg
Project Management (AHG1)	J.-R. Ohm, G. J. Sullivan (co-chairs)	N

(jvet@lists.rwth-aachen.de) • Coordinate overall JVET interim efforts. • Supervise CE and AHG studies. • Report on project status to JVET reflector. • Provide a report to next meeting on project coordination status.		
Draft text and test model algorithm description editing (AHG2) (jvet@lists.rwth-aachen.de) • Produce and finalize JVET-O2001 VVC text specification draft 6. • Produce and finalize JVET-O2002 VVC Test Model 6 (VTM 6) Algorithm and Encoder Description. • Gather and address comments for refinement of these documents. • Coordinate with test model software development AhG to address issues relating to mismatches between software and text.	B. Bross, J. Chen (co-chairs), J. Boyce, S. Kim, S. Liu, Y.-K. Wang, Y. Ye (vice-chairs)	N
Test model software development (AHG3) (jvet@lists.rwth-aachen.de) • Coordinate development of test model (VTM) software and associated configuration files. • Produce documentation of software usage for distribution with the software. • Discuss and make recommendations on the software development process. • Propose improvements to the guideline document for developments of the test model software. • Perform tests of VTM 6 behaviour relative to HEVC and VTM 5 using the VTM common test conditions. • Coordinate with AHG on Draft text and test model algorithm description editing (AHG2) to identify any mismatches between software and text, and	F. Bossen, X. Li, K. Sühring (co-chairs)	N

make further updates and cleanups to the software as appropriate. • Coordinate with AHG6 for integration with 360lib software.		
Test material and visual assessment (AHG4) (jvet@lists.rwth-aachen.de) • Maintain the video sequence test material database for development of the VVC standard. • Identify and recommend appropriate test materials for use in the development of the VVC standard. • Identify missing types of video material, solicit contributions, collect, and make available a variety of video sequence test material. • Evaluate new test sequences, particularly including the material recently submitted by the Blender Foundation / Blender Animation Studio and Twitch. • Propose a new structure for the test sequence repository. • Prepare availability of viewing equipment and facilities arrangements for the next meeting, and prepare testing upon consultation with CE coordinators. • Coordinate with AHG11 on test material for screen content coding	T. Suzuki, M. Wien (co-chairs), V. Baroncini, R. Chernyak, A. Norkin, J. Ye (vice-chairs)	N
Memory bandwidth consumption of coding tools (AHG5) (jvet@lists.rwth-aachen.de) • Develop improved software tools for measuring both average and worst case of memory bandwidth, and provide information for usage of these tools. • Study cache configurations for measuring decoder memory bandwidth consumption. • Identify coding tools in CEs and VTM with significant memory bandwidth impact.	R. Hashimoto (chair), T. Ikai, X. Li, D. Luo, H. Yang, M. Zhou (vice-chairs)	N

• Study the impact of memory bandwidth on specific application cases.		
360° video coding tools, software and test conditions (AHG6) (jvet@lists.rwth-aachen.de) • Study the effect on compression and subjective quality of different projections formats, resolutions, and packing layouts. • Discuss refinements of common test conditions, test sequences, and evaluation criteria. • Solicit additional test sequences, and evaluate suitability of test sequences on head-mounted displays and normal 2D displays. • Study coding tools dedicated to 360° video, their impact on compression, and implications to the core codec design. • Study the effect of viewport resolution, field of view, and viewport speed/direction on visual comfort. • Study complexity of GPU rendering of projection formats • Study syntax for signalling of projection formats, cubeface layouts, spherical rotations • Prepare and deliver the 360Lib-9.1 software version and common test condition configuration files according to JVET-M1012. • Generate CTC (PHEC) anchors and PERP results for VTM according to JVET-M1012, and finalize the reporting template for the common test conditions. • Produce documentation of software usage for distribution with the software.	J. Boyce and Y. He (co-chairs), K. Choi, J.-L. Lin, Y. Ye (vice-chairs)	N
Coding of HDR/WCG material (AHG7) (jvet@lists.rwth-aachen.de) • Study and evaluate available HDR/WCG test content.	A. Segall (chair), E. François, W. Husak, S. Iwamura, D. Rusanovskyy (vice-chairs)	N

• Study objective metrics for quality assessment of HDR/WCG material, including investigation of the correlation between subjective and objective results. • Compare the performance of the VTM and HM for HDR/WCG content. • Prepare for expert viewing of HDR content at the next JVET meeting if feasible. • Investigate the implications of chroma sampling location. • Coordinate implementation of HDR anchor aspects in the test model software with AHG3. • Study additional aspects of coding HDR/WCG content.		
Layered coding and resolution adaptivity (AHG8) (jvet@lists.rwth-aachen.de) • Study adaptive-resolution coding approaches for real-time communication, adaptive streaming, and 360-degree viewport-dependent streaming, including reference picture management and related scope and signalling • Study approaches for temporal scalability to avoid temporal judder when temporal scalability sub-bitstream extraction is used for achieving lower frame rate, and consider whether this should have a normative impact. • Develop a software framework which allows testing various layered coding and resolution adaptivity modalities in the context of the VTM software • Study approaches for support of layered coding scalability including spatial, temporal, quality, and view scalability; and analyse their coding efficiency and complexity characteristics • Coordinate with CE1 on resampling filters	S. Wenger and A. Segall (co-chairs), M. M. Hannuksela, Hendry, S. McCarthy, Y.-C. Sun, P. Topiwala, M. Zhou (vice-chairs)	N

Neural networks in video coding (AHG9) (jvet@lists.rwth-aachen.de) • Investigate the benefit of using neural networks in video compression such as CNN loop filter, intra prediction, resampling in adaptive resolution coding, and encoder-side partition mode decisions. • Investigate the complexity impact of using neural networks in video compression. • Investigate the complexity measurement of neural network coding tools. • Investigate benefit of universal versus selectable networks, both in terms of compression benefit and complexity. • Investigate how CNN parameters can be established for operation of the decoding process. • Investigate the impact of training materials on the performance of neural network coding tools. • Investigate the impact of the training process on performance and complexity.	S. Liu and Y. M. Li (co-chairs), B. Choi, K. Kawamura, Y. Li, L. Wang, P. Wu, H. Yang (vice-chairs)	N
Encoding algorithm optimization (AHG10) (jvet@lists.rwth-aachen.de) • Study the impact of using techniques such as GOP structures and perceptually optimized adaptive quantization for encoder optimization. • Study the impact of adaptive quantization on individual tools in the test model. • Study the quantization adaptation tool in the test model. • Investigate the feasibility of adding a CTC test category in which adaptive quantization is turned on. • Study quality metrics for measuring subjective quality using e.g. the CfP response MOS scores. • Investigate other methods of improving objective and/or subjective quality, including adaptive	A. Duenas, A. Tourapis (co-chairs), S. Ikonin, A. Norkin, R. Sjöberg, J. Le Tanou, J.-M. Thiesse (vice-chairs)	N

coding structures, adaptive quantization without signalling, and multi-pass encoding. • Study methods of rate control and their impact on performance, subjective and objective quality.		
Screen content coding (AHG11) (jvet@lists.rwth-aachen.de) • Investigate coding tools targeted at screen content in terms of compression benefit and implementation complexity. • Identify test materials, discuss testing conditions for screen content coding, and propose associated updated common test conditions. • Study the impact of loop filters on screen content coding.	S. Liu (chair), J. Boyce, A. Filippov, Y.-C. Sun, J. Xu, H. Yang (vice-chairs)	N
High-level parallelism and coded picture regions (AHG12) (jvet@lists.rwth-aachen.de) • Study wavefront processing including the relationship with tiles and low delay characteristics. • Study flexible loop filter control and tile size restriction, including identifying implications on coding tools and implementation. • Study flexible tile partitioning (e.g. more flexible than HEVC and tile boundaries not spanning a full picture). • Study support of independently coded picture regions, including easy rewriting of such regions into a conforming sub-bitstream. • Prepare software and configurations for the test model to facilitate parallel processing tests. • Study the coding efficiency impact of parallel processing and coded picture regions.	S. Deshpande (chair), M. M. Hannuksela, R. Sjöberg, R. Skupin, W. Wan, Y.-K. Wang S. Wenger (vice-chairs)	N
Tool reporting procedure (AHG13)	W.-J. Chien, J. Boyce (co-chairs), W. Chen, Y.-W. Chen, R. Chernyak,	N

(jvet@lists.rwth-aachen.de) • Prepare output document JVET-O2005, which describes the methodology of tool-off testing and a list of tools to be tested by identified testers. • Provide configurations files, bitstreams, and results of tool-on/tool-off testing. • Use the tool usage counts and memory bandwidth usage to study the decoder complexity of features in on/off testing. • Prepare a report with results of the tests.	K. Choi, R. Hashimoto, Y.-W. Huang, H. Jang, R.-L. Liao, S. Liu (vice-chairs)	
Operation modes for low latency support (AHG14) (jvet@lists.rwth-aachen.de) • Define relevant test conditions for the study of low latency modes • Study and propose low-latency performance assessment criteria/metrics • Update the implementation in the VTM model for supporting GRA. • Study a parallel framework for GRA assessment	J.-M. Thiesse (chair), S. Deshpande, A. Duenas, Hendry, K. Kazui, R. Sjöberg, A. Tourapis (vice-chairs)	N
Quantization control (AHG15) (jvet@lists.rwth-aachen.de) • Identify methods for quantization step size control for luma and chroma, including spatially and frequency-adaptive approaches • Develop methods for evaluating quantization step size control operation • Study the association between transforms and quantization matrices • Develop testing conditions for evaluating QP signalling improvements including rate control and perceptual optimization strategies as appropriate • Evaluate the performance of the current VVC QP design using the adaptive quantization control techniques currently available in the VTM	R. Chernyak (chair), E. François, C. Helmrich, S. McCarthy, A. Segall (vice-chairs)	N

Implementation studies (AHG16) (jvet@lists.rwth-aachen.de) • Study draft and proposed coding tools to identify implementation issues relating to decoder pipelines, decoder throughput, and other aspects of implementation difficulty. • Solicit hardware analysis of complex tools. • Provide feedback on potential solutions to address identified issues.	M. Zhou (chair), J. An, E. Chai, K. Choi, S. Sethuraman, T. Hsieh, X. Xiu (vice-chairs)	N
High-level syntax (AHG17) (jvet@lists.rwth-aachen.de) • Study NAL unit header, sequence parameter set, picture parameter set, adaptation parameter set, and tile group header syntax designs • Study reference picture buffering and list construction • Study random access signalling and random access approaches, including approaches with reference pictures provided by external means • Assist in software development and text drafting for the high-level syntax in the VVC design. • Study syntax approaches for interoperability point signalling • Study selection of constraint flags to be included in the VTM and their impact on syntax, semantics, and decoding process	R. Sjöberg, J. Boyce (co-chairs), S. Deshpande, M. M. Hannuksela, R. Skupin, A. Tourapis, Y.-K. Wang, W. Wan, S. Wenger (vice-chairs)	N
Lossless and near-lossless coding tools (AHG18) (jvet@lists.rwth-aachen.de) • Study coding tools for lossless and near-lossless coding, including transform skip, BDPCM, and other potential technologies • Consider the interaction between coding tools and other processing such as loop filtering and LMCS for lossless and near-lossless coding	T. Nguyen and T.-C. Ma (co-chairs), M. Ikeda, S. Iwamura, H. Jang, X. Zhao (vice-chairs)	N

• Develop proposals for lossless and near-lossless coding for chroma and non-YCbCr colour space content • Consider throughput bottlenecks for lossless and near-lossless coding at high resolutions and frame rates		

Output documents

The following documents were agreed to be produced or endorsed as outputs of the meeting. Names recorded below indicate the editors responsible for the document production. Where applicable, dates of planned finalization and corresponding parent-body document numbers are also noted.

It was reminded that in cases where the JVET document is also made available as MPEG output document, a separate version under the MPEG document header should be generated. This version should be sent to GJS and JRO for upload.

CITATION

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