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| **Joint Collaborative Team on 3D Video Coding Extension**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  10th Meeting: Strasbourg, FR, 18–24 Oct. 2014 | Document: JCT3V-J0004 |

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| *Title:* | **JCT-3V AHG Report: MV-HEVC and 3D-HEVC Software Integration (AHG4)** | | |
| *Status:* | AHG report input to JCT-3V | | |
| *Purpose:* | AHG report | | |
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| *Source:* | AHG | | |

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# Abstract

This report summarizes the activities of the AhG on MV-HEVC and 3D-HEVC Software Integration that have taken place between the 9th JCT-3V meeting in Sapporo and the 10th JCT-3V meeting in Strasbourg. Activities focused on the integration of proposals adopted at the 9th meeting into a common code base and the release of the MV-HEVC Software draft 1.

# Mandates

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| **Title** | **Chairs** | **Mtg** |
| **MV-HEVC / 3D-HEVC Software Integration (AHG4)**  ([jct-3v@lists.rwth-aachen.de](mailto:jct-3v@lists.rwth-aachen.de))   * Coordinate development of the HTM software and its distribution to JCT-3V members. * Produce documentation of software usage for distribution with the software. * Prepare and deliver HTM-12.0 software version and the reference configuration encodings according to JCT3V-G1100 based on common conditions suitable for in the core experiment (expected within four weeks after the meeting). * Prepare and deliver HTM-12.1 software that include additional items not integrated into the 12.0 version. * Prepare and deliver the WD text of MV-HEVC software JCT3V-I1009. * Perform analysis and reconfirmation checks of the behaviour of technical changes adopted into the draft design, and report the results of such analysis. * Suggest configuration files for additional testing of tools. * Coordinate with MV-HEVC Draft and 3D-HEVC Test Model editing AhG to identify any mismatches between software and text. | G. Tech  H. Liu (co-chairs)  Y. W. Chen  K. Wegner (vice chairs) | N |

# HTM tool integration

Development of the software was coordinated with the parties needing to integrate changes.

The distribution of the software was announced on the JCT-3V e-mail reflector and the software was made available through the SVN server:

[https://hevc.hhi.fraunhofer.de/svn/svn\_3DVCSoftware/tags/](https://hevc.hhi.fraunhofer.de/svn/svn_3DVCSoftware/tags/HTM-4.0)

Anchor bitstreams have been created and uploaded to:

[ftp.hhi.fraunhofer.de](ftp://ftp.hhi.fraunhofer.de); login: mpeg3dv\_guest; path: /MPEG-3DV/HTM-Anchors/

One version of the HTM software were produced and announced on the JCT-3V email reflector. The following sections give a brief summary of the integrated tools and achieved coding gains.

## Versions HTM-12.0

Starting point for development of HTM-12.0 was HTM-11.2. Development of HTM-12.0 was conducted in three parallel tracks each performing sequential integration. Development of each branch has been supervised by one software coordinator. Software of all three tracks was merged by the software coordinators.

### Integrated items

*Track 1: Merge, DBBP, others;* Coordinator: Hongbin Liu

* [JCT3V-I0086](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2169) Simplification of shift DV candidate
* [JCT3V-I0077](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2160) Partition Derivation for DBBP
* [JCT3V-I0078](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2161) Memory Complexity for DBBP and VSP
* [JCT3V-I0109](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2192) One dimensional DBBP boundary filtering
* [JCT3V-I0093](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2176) Depth coding compatible with arbitrary bit-depth in 3D-HEVC

*Track 2: ARP, HLS, IC, others;* Coordinator: Gerhard Tech

* [JCT3V-I0051](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2133) CE1: Simplification of advanced residual prediction
* [JCT3V-I0104](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2187) CE1: Results of ARP simplification
* [JCT3V-I0099](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2182) On the video parameter set extension 2 in 3D-HEVC
* [JCT3V-I0072](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2155) Problem fix for MV scaling in inter-view ARP
* [JCT3V-I0090](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2173) 3D HEVC HLS Cleanup
* [JCT3V-I0100](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2183) 3D-HEVC HLS: General comments on 3D-HEVC high level syntax
* [JCT3V-I0080](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2163) Parameter Derivation for Illumination Compensation

*Track 3: DMM, SDC, others;* Coordinator: Yi-Wen Chen

* [JCT3V-I0095](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2178) CE2: Single depth intra mode for 3D-HEVC
* [JCT3V-I0123](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2206) Fast Intra SDC coding for 3D-HEVC Intra Coding
* [JCT3V-I0120](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2203) CE2: Remove “depth\_dc\_flag” signalling in DMM cases
* [JCT3V-I0110](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2193) Lookup table size reduction in DMM1
* [JCT3V-I0057](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2140) Clipping Operation for DLT Indexes
* [JCT3V-I0076](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2159) Simplification of Threshold Derivation for DBBP and DMM4
* [JCT3V-I0084](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2167) CE2: Fast SDC DC offset decision
* [JCT3V-I0085](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2168) CE2: Separate enabling flag for intra coding tools
* [JCT3V-I0066](http://phenix.it-sudparis.eu/jct3v/doc_end_user/current_document.php?id=2149) CE2: Simplification of DMM4

### Coding performance

***MV-HEVC:*** The coding results for MV-HEVC are identical to results obtained from version HTM-11.2.

***3D-HEVC: HTM-12.0 vs. HTM-11.2 (CTC, three view configuration)***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | video  video rate | video  total rate | synth  total rate | enc time | dec time | ren time |
| Balloons | 0,3% | 0,3% | 0,2% | 98,7% | 100,9% | 99,4% |
| Kendo | 0,2% | 0,1% | -0,2% | 96,2% | 103,9% | 98,0% |
| Newspaper\_CC | 0,1% | 0,1% | -0,1% | 98,5% | 103,0% | 101,0% |
| GT\_Fly | 0,0% | -0,1% | -0,6% | 100,6% | 95,6% | 99,7% |
| Poznan\_Hall2 | 0,0% | 0,0% | -0,2% | 101,2% | 100,3% | 98,4% |
| Poznan\_Street | 0,0% | 0,0% | -0,1% | 99,7% | 101,6% | 99,5% |
| Undo\_Dancer | 0,0% | 0,1% | -0,1% | 100,4% | 96,0% | 98,7% |
| Shark | 0,0% | -0,1% | -0,5% | 100,3% | 102,0% | 98,9% |
| 1024x768 | 0,2% | 0,2% | 0,0% | 97,8% | 102,6% | 99,5% |
| 1920x1088 | 0,0% | 0,0% | -0,3% | 100,4% | 99,1% | 99,0% |
| **average** | **0,1%** | **0,0%** | **-0,2%** | **99,4%** | **100,4%** | **99,2%** |

## Version HTM-12.1

Starting point for development of HTM-12.1 was HTM-12.0. Development of HTM-12.1 was conducted in a single track. Most of MV-HEVC 9 HLS has been integrated. Moreover, auxiliary pictures and the correct indication of profiles, tiers, and levels, are now supported. Related to 3D-HEVC fixes for VSO and FCO have been integrated.

### Integrated items

* Fixes FCO, Fix VSO
* Clean up of configuration files
* DISCARDABLE\_PIC\_RPS G0131: Inter-layer RPS and temporal RPS should not contain picture with discardable\_flag equal to 1
* VPS\_MISC\_UPDATES Misc updates:JCT3V-0240,
* NON\_REF\_NAL\_TYPE\_DISCARDABLE If discardable picture is a non-IRAP, it must be a non-referenced sub-layer picture
* INFERENCE\_POC\_MSB\_VAL\_PRESENT poc\_msb\_val\_present\_flag shall be equal to 0 when slice\_header\_extension\_length is (inferred to be ) equal to 0
* INFERENCE\_POC\_RESET\_INFO\_PRESENT Infer the value of poc\_reset\_info\_present\_flag to be equal to 0 when no pps extension / pps extension for multilayer.
* I0044\_SLICE\_TMVP Regarding slice\_temporal\_mvp\_enabled\_flag
* I0045\_BR\_PR\_ADD\_LAYER\_SET Signalling of bit-rate and picture rate for additional layer set
* I0045\_VPS\_VUI\_VST\_PARAMS Related to signalling of VST parameters of the base layer.
* H\_MV\_HLS10\_AUX Auxiliary pictures
* H\_MV\_HLS10\_PTL\_FIX profile tier level fix
* H\_MV\_HLS10\_PTL\_INBL\_FIX profile tier level inbl fix
* H\_MV\_HLS10\_PTL\_INFER\_FIX fix inference ptl
* H\_MV\_FIX\_LOOP\_GOPSIZE
* H\_MV\_FIX\_SUB\_LAYERS\_MAX\_MINUS1
* H\_MV\_HLS10\_GEN\_VSP\_CONF\_WIN VPS conformance window
* H\_MV\_HLS10\_GEN\_VSP\_BASE\_LAYER\_AVAIL vps\_base\_layer\_available
* H\_MV\_HLS10\_REF\_PRED\_LAYERS reference and predicted layer derivation
* H\_MV\_HLS10\_NESSECARY\_LAYER necessary layers
* H\_MV\_HLS10\_ADD\_LAYERSETS additional layer sets
* H\_MV\_HLS10\_DBP\_SIZE dpb size syntax structure
* H\_MV\_HLS10\_MAXNUMPICS constraint on number of pictures in rps
* H\_MV\_HLS10\_PTL profile tier level
* H\_MV\_HLS10\_MULTILAYERSPS multilayer SPS extension
* H\_MV\_HLS10\_VPS\_VUI vsp vui
* H\_MV\_HLS10\_VPS\_VUI\_BSP vsp vui bsp
* H\_MV\_HLS10\_PPS PPS modifications

### Coding performance

***MV-HEVC:*** Insignificant changes compared to HTM-12.0, due to changed HLS.

***3D-HEVC:*** Very minor changes compared to HTM-12.0, due to VSO fix.

# MV-HEVC Software draft 1

The MV-HEVC Software draft 1 (JCT3V-I1009) has been released. The software has been generated by removing 3D-HEVC related source code and configuration files from HTM-12.1. The software can also be accessed using the svn:

https://hevc.hhi.fraunhofer.de/svn/svn\_3DVCSoftware/branches/HTM-12.1-MV-draft-1

For MV-HEVC non-CTC configuration parameters files have been included e.g. for generation of bitstreams using INBL decoding, auxiliary pictures, layer-wise startup, and IBP prediction.

# Open issues

* Some minor mismatches related to 3D-HEVC HLS.
* Most of MV-and 3D-HEVC SEI messages are not supported yet.
* Some items related to MV-HEVC decoding processes (e.g. hybrid scalability, correct bumping, POC reset) have not been integrated yet.
* Especially MV-HEVC related decoding processes and syntax need to be reviewed and tested.
* Other minor issues are listed in the bug tracking system.

# Recommendations

The recommendations of the MV-HEVC and 3D-HEVC Software Integration AHG are:

* Develop HTM-13 based on HTM-12 and improve its quality.
* When a proposal is adopted to discuss how to enable it in the HTM software (e.g. encoder parameter / parameter set flag, or always on).
* Continue to identify bugs and discrepancies with text, and address them.
* Fix open issues.
* Discuss alignment of HTM with HM versions including range extension.
* Discuss on how to address open issues.