

*Title:* **JCT-3V AHG report: MV-HEVC / 3D-HEVC Draft and Test Model editing (AHG3)**

*Status:* AHG report input to JCT-3V

*Purpose:* AHG report

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*Source:* AHG

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## Abstract

This document reports on the work of the JCT-3V ad hoc group on MV-HEVC / 3D-HEVC Draft and Test Model editing (AHG3) between the 6<sup>th</sup> meeting in Geneva and the 7<sup>th</sup> JCT-3V meeting in San José.

## 1 Mandates

Title and Email Reflector	Chairs	Mtg
<p><b>MV-HEVC / 3D-HEVC Draft and Test Model editing (AHG3)</b></p> <p>(jct-3v@lists.rwth-aachen.de)</p> <ul style="list-style-type: none"> <li>• Produce and finalize F1005 3D-HEVC Test Model 6.</li> <li>• Produce and finalize F1004 MV-HEVC Draft Text 6.</li> <li>• Produce and finalize F1001 3D-HEVC Draft Text 2.</li> <li>• Gather and address comments for refinement of these documents.</li> <li>• Coordinate with the 3D-HEVC Software Integration AhG to address issues relating to mismatches between software and text.</li> </ul>	<p>G. Tech, K. Wegner (co-chairs), J. Boyce, Y. Chen, M. Hannuksela, T. Suzuki, S. Yea, J.-R. Ohm, G. Sullivan (vice chairs)</p>	<p>N</p>

## 2 Introduction

The second 3D-HEVC draft, the sixth Test Model of 3D-HEVC and MV-HEVC and the sixth MV-HEVC draft were developed from the first 3D-HEVC draft, the fifth 3D-HEVC Test Model and the fifth MV-HEVC draft, respectively, following the decisions taken at the 6<sup>th</sup> JCT-3V meeting in Geneva.

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

- F1005 3D-HEVC Test Model 6
  - Li Zhang, Gerhard Tech, Krzysztof Wegner, Sehoon Yea
- F1001 3D-HEVC Draft Text 2
  - Gerhard Tech, Ying Chen, Krzysztof Wegner, Sehoon Yea
- F1004 MV-HEVC Draft Text 6
  - Gerhard Tech, Miska Hannuksela, Ying Chen, Jill Boyce, Krzysztof Wegner
  - Moreover Ye-Kui Wang supported editing.

## 3 Status

### 3.1 3D-HEVC Draft 2

Four versions of F1001 have been published by the editing AHG following the 6<sup>th</sup> JCT-3V meeting in Vienna. The 3D-HEVC draft text has been updated to be aligned with MV-HEVC draft 6.

#### 3.1.1 Incorporated changes

All adoptions of the last meeting have been incorporated. Moreover existing text has been revised and improved.

Changes (27) of F1005 relative to E1005 are:

View synthesis prediction (3)

- [F0102](#) CE1: VSP partitioning for AMP Decision
- [F0111](#) CE1: Simplified view synthesis prediction
- [F0109](#), [F0120](#) CE1: A simplified block partitioning method for view synthesis prediction

Disparity vector derivation (1)

- [F0115](#) CE2: Problem fix of the DV derivation

Merge, inter-view motion prediction (5)

- [F0093](#) CE3: Simple merge candidate list construction. Add the condition on numMergeCand from F0129.
- [F0110](#) CE3: Sub-PU level inter-view motion prediction
- [F0125](#) CE3: Inter-view motion vector prediction for depth coding
- [F0104](#) CE3: Removal of redundancy on VSP, ARP and IC Decision (without IC\_ARP\_DEPEND)
- [F0150](#) CE3: MPI candidate in depth merge mode list construction (option 1)

Residual prediction (3)

- [F0123](#), [F0108](#): Harmonize F0108/F0123 according to the above for inter-view ARP.
- [F0161](#) CE4: Coding of weighting factor of advanced residual prediction
- [F0105](#) CE4: ARP reference picture selection and its availability check

Depth intra: (5)

- [F0149](#) CE5: Simplified depth inter mode coding
- [F0147](#) CE5: DMM simplification and signalling (remove DMM3 and RBC).

- [F0159](#) CE5: Fast depth lookup table application method to intra modes for depth data, method 3. **Implement an enabling flag at (position t.b.d.).**
- [F0132](#) CE5: Unification of delta DC coding for depth intra modes.
- [F0171](#) CE5: Fix for DMM/RBC reference sample filtering.

Illumination compensation (1)

- [F0160](#) Illumination compensation flag coding

HLS (6)

- [F0151](#) HLS: Removal of IC in depth coding and IC flag signalling in 3D-HEVC
- [F0082](#) HLS: On slice-level camera parameter signaling ;Decision: Adopt the second solution: the cp\_in\_slice\_segment\_layer\_flag to be view specific and used as a condition of the presence of slice header level camera parameters.
- [F0131](#), [F0139](#), [F0138](#) DLT related: including F0131, F0139 and moving DLT from VPS to PPS.
- [F0044](#) HLS: HEVC compatible slice segment header in 3D-HEVC
- [F0045](#) HLS: Constraints on camera parameter signaling
- [F0136](#) Comments on camera parameters in 3D-HEVC

Others(3)

- Fix vps\_inter\_sdc\_flag.
- Clean up merge list generation.
- Fix ticket #49: Mismatch in VSP horSplitFlag derivation

### 3.1.2 Open issues

- On F0159 there was no decisions where to add the enabling flag.
- A list of other minor issues is listed in the bug tracking system.

## 3.2 3D-HEVC Test Model 6

One version of F1005 has been published by the editing AHG following the 6<sup>th</sup> JCT-3V meeting in Geneva.

### 3.2.1 Incorporated changes

All adoptions of the last meeting have been incorporated. Moreover existing text has been revised and improved and missing text from previous meeting has been added.

Changes (22) of F1005 relative to E1005 are:

- View synthesis prediction (3)
- [F0102](#) CE1: VSP partitioning for AMP Decision
- [F0111](#) CE1: Simplified view synthesis prediction Decision
- [F0109](#), [F0120](#) CE1: A simplified block partitioning method for view synthesis prediction

Disparity vector derivation (1)

- [F0115](#) CE2: Problem fix of the DV derivation in 3D-HEVC Decision: Adopt the suggested solution which aligns the text with the software bug fix.

Merge, inter-view motion prediction (6)

- [F0093](#) CE3: Results on simple merge candidate list construction for 3DV.
- [F0129](#) CE3 related: combined bi-predictive merging candidates for 3D-HEVC
- [F0110](#) CE3: Sub-PU level inter-view motion prediction
- [F0125](#) CE3: Inter-view motion vector prediction for depth coding
- [F0104](#) CE3: Removal of redundancy on VSP, ARP and IC Decision
- [F0150](#) CE3: MPI candidate in depth merge mode list construction Decision: Adopt (option 1

Residual prediction (3)

- [F0123,F0108](#) CE4: Results on improved advanced residual prediction
- [F0161](#) CE4: Coding of weighting factor of advanced residual prediction
- [F0105](#) CE4: ARP reference picture selection and its availability check

#### Depth intra: (5)

- [F0149](#) CE5: Simplified depth inter mode coding; Adoption (BF: Align the text with software as suggested in F0149)
- [F0147](#) CE5: DMM simplification and signalling Decision: Adopt (remove DMM3 and RBC.
- [F0159](#) CE5: Fast depth lookup table application method to intra modes for depth data (method 3)
- [F0132](#) CE5: Unification of delta DC coding for depth intra modes.
- [F0171](#) CE5: Fix for DMM/RBC reference sample filtering.

#### HLS(3)

- [F0151](#) HLS: Removal of IC in depth coding and IC flag signalling in 3D-HEVC; Decision: Remove IC for depth map coding, no change for texture coding.
- [F0138](#) HLS: Inter-view Updating Mechanism for Coding of DLT
- [F0131/F0139](#) Depth Lookup Table Coding for 3D-HEVC

#### Others (1)

- [F0122](#) HTM support of depth coding in MV-HEVC: software adoption

### 3.3 MV-HEVC Draft Text 6

Six versions of F1004 were published by the AHG following the 6<sup>th</sup> JCT-3V meeting in Geneva. The last version corresponds to the text submitted to MPEG secretariat.

#### 3.3.1 Incorporated changes

All adoptions of the last meeting have been incorporated. Moreover existing text has been revised and improved and missing text from previous meeting has been added.

Changes (47) of F1004 relative to E1004 are:

Generic HLS issues (2)

- (Gen/[00137,00200,00223](#),Layer id) #32 Add (editorial equivalent of) "The value of nuh\_layer\_id shall be in the range of 0 to 62. The value of 63 for nuh\_layer\_id is reserved for future use by ITU-T | ISO/IEC. Decoders shall ignore all data that follow the value 63 for nuh\_layer\_id in a NAL unit." and specify that vps\_max\_layers\_minus1 shall not be equal to 63, but decoders shall allow that value to appear in the bitstream. Specify that the value 63 is interpreted the same as the value 62 (e.g., MaxLayersMinus1 = Min( 62, vps\_max\_layers\_minus1) and subsequently refer to MaxLayersMinus1 instead of vps\_max\_layers\_minus1)
- (Gen/[00153](#)/output highest layer) #28 Add a flag in the VPS to indicate if startup process should output the highest available layer if the target output layer is not available.

POC alignment and derivation (3)

- (POC/[00140,00213](#)/Ed. Note) #39 Decision (Non-Normative): Add a note to explain what an encoder needs to do to avoid the problem – MMH to provide the wording.
- (POC/[00117](#)/Modify PicOrderCntVal of prevTid0Pic) #35 Modification of the PicOrderCntVal of prevTid0Pic and modification to the decoding process for reference picture set, to address problems found for cross-layer POC alignment.
- (POC/[00211](#)/Fix ambiguity) #38 Modify POC derivation to correct an ambiguity in the spec.

Random access and layer switching structures (8)

- (RALS/[00139](#)/Prop4) #8 layer initialization picture (LIP): A picture that is an IRAP picture with NoRaslOutputFlag equal to 1 or that is contained in an initial IRAP access unit, of which LayerInitializedFlag[ refLayerId ] is equal to 1 for all values of refLayerId equal to RefLayerId[ nuh\_layer\_id ][ j ], where j is in the range of 0 to NumDirectRefLayers[ nuh\_layer\_id ] - 1, inclusive. Decision (Ed.): Agreed in spirit. Editors to determine exact phrasing.
- (RALS/[00139](#)/Prop5) #9 Problem: It is asserted that if cross\_layer\_irap\_aligned\_flag is equal to 1 and two pictures having no dependency on each other in an access unit have different nal\_unit\_type values, the POC value alignment cannot be guaranteed. Decision (Ed): Agreed. The drafted intent was to enforce alignment by the flag only within each dependency tree. Editors to correct the text as necessary.
- (RALS/[00139](#)/Prop1) #6 Proposal: Invoke the layer-wise start-up process for a base-layer CRA picture with HandleCraAsBlaFlag equal to 1. Decision (Ed): Check/clarify text as necessary if not already addressed (intent agreed in spirit).
- (RALS/[00220](#)/Prop2) #5 Invoke the decoding process for generating unavailable reference pictures (subclause F.8.1.3) again when the current picture is the IRAP picture with NoRaslOutputFlag equal to 1. Decision (Ed BF): Check/clarify text as necessary if not already addressed (intent agreed in spirit).
- (RALS/[00220](#)/Prop1 Alt2) #4 NoRaslOutputFlag is set to equal to 1 when the current picture is an IRAP picture, LayerInitializedFlag[k] = 0, and LayerInitializedFlag[refLayerId]=1 for all values of refLayerId equal to RefLayerId[k][j], where j is in the range of 0 to NumDirectRefLayers[k]-1, inclusive. In this solution, LayerInitializedFlag[k] is set equal to 1 after setting NoRaslOutputFlag to 1. Decision (Ed. BF): Adopted

- (RALS/[O0149](#)/Prop1) #10 Proposal: A base-layer IRAP picture that initiates the layer-wise start-up process (i.e. has NoCIRasOutputFlag equal to 1) causes marking of all pictures in the DPB as “unused for reference”. Decision (Ed): Agreed.
- (RALS/[O0149](#)/Prop2): #11 Proposal: A new slice\_reserved\_flag is taken into use to indicate if a base-layer IDR picture initiates the layer-wise start-up process. Decision: Adopt (the bit should not be required to be present; if present should be the bit after the discardable\_flag, and discardable\_flag should be the first one of the three, and the poc reset flag is not required to be present).
- (RALS/[O0139](#)/Prop2/SPS activation) #7 Decision (Ed): Agreed in spirit that we should not allow activation of a new SPS by an enhancement layer non-IRAP picture that is not the first picture in the bitstream in that enhancement layer (that is not an LIP picture) and should not allow a "normal" CRA in an enhancement layer to activate a different SPS than what was already referred to by the preceding pictures in decoding order in that enhancement layer. (Editors to figure out how to phrase this in specification language.)

#### Parameter sets (13)

- (PS/[O0096](#)/rep format syntax element length ) #20 Modification of length to 8 bit as decided later in trac.
- (PS/[O0179](#)/Rep. Format) #18 Add flag in rep\_format() syntax structure to control sending of chroma and bit depth related parameters, as proposed in the v2 version of JCTVC-O0179.
- (PS/[O0109](#)/default\_one\_target\_output\_layer\_idc) #25 To change default\_one\_target\_output\_layer\_flag to a two-bit default\_one\_target\_output\_layer\_idc, and reserve the values 2 and 3
- (PS/[O0118](#)/visual signal info in vui per layer) #33 Add visual signal information (video\_format, video\_full\_range\_flag, colour\_primaries, transfer\_characteristics, matrix\_coeffs) per layer to the VPS VUI, from v2 version of JCTVC-O0118.
- (PS/[O0223](#)/Cross layer alignment type) #29 Add a flag in VPS VUI to indicate cross layer pic type alignment. Move cross\_layer\_irap\_aligned\_flag to VPS VUI and make presence condition on added flag
- (PS/[O0092](#)/Sharing SPS PPS) #17 Restrict sharing of SPS and PPS across layers to avoid creating problems during sub-bitstream extraction, based on modification of proposals in JCTVC-O0059 and JCTVC-O0092, reflected in the v2 version of O0092.
- (PS/FIX/N0092/Rep. Format) #19 Inferences.
- (PS/[O0096](#)/rep format) #20 Modify the SPS syntax for layers with nuh\_layer\_id > 0 to signal a reference to a rep\_format index in the VPS, rather than signalling explicit representation format data in the SPS, from the v2 version of JCTVC-O0096.
- (PS/[O0096](#)/direct\_dependency\_type gating flag) #21 Add a gating flag in VPS extension to condition the presence of direct dependency type, with a default type signalled, from JCTVC-O0096
- (PS/[O0109](#)/view\_id\_len) #22 Modify the VPS extension syntax and semantics to replace view\_id\_len\_minus1 with view\_id\_len, always signal that syntax element, add a constraint that  $(1 \ll \text{view\_id\_len}) \leq \text{NumViews}$ , and modify view\_id\_val semantics to infer value of 0 when not present, from discussion of JCTVC-O0109
- (PS/[O0109](#)/profile\_ref\_minus1 constraint) #23 Modify the semantics of profile\_ref\_minus1[i] to replace “shall be less than i” with “shall be less than or equal to i”, from discussion of JCTVC-O0109
- (PS/[O0109](#)/vps\_vui\_present\_flag move) #24 Move the vps\_vui\_present\_flag to precede vps\_vui\_offset, and make vps\_vui\_offset conditional on that flag, from JCTVC-O0109
- (PSEM/[O0142](#)/Conditional extension syntax) #3 Adopt JCTVC-O0142 (as a structure to be used to switch whatever extensions we define in SPS, not necessarily committing to having these extensions be separate for each extension, but the current plan unless decided otherwise is to use one flag for range extensions syntax presence and one flag for SHVC+MV-HEVC extension syntax presence)

#### Inter-layer dependency signalling and derivation (4)

- (ILDSD/[O0225](#)/signal max\_tid\_il\_ref\_pics per layer ) #30 2nd proposal of JCTVC-O0225 regarding signalling of max\_tid\_il\_ref\_pics per layer, based upon relation to SCE2 on single loop decoding. Decision: Adopted.

- (ILDSD/[O0225](#)/max\_tid\_il\_ref\_pics RPL const.) #27 Change derivation of NumActiveRefLayerPics to consider max\_tid\_il\_ref\_pics.
- (ILDSD/[O0120](#)/sub\_layers\_vps\_max\_minus1 RPL const) #34 Modify inter-layer reference picture list default construction to incorporate max temporal sub-layers per layer syntax elements in VPS extension, from r2 version of [JCTVC-O0120](#).
- (ILDSD/[O0120](#)/sub\_layers\_vps\_max\_minus1) #26 Add syntax elements to signal max temporal sub-layers for each layer in the VPS, with a gating flag, from JCTVC- option 2.

#### Hypothetical reference decoder (HRD) (3)

- (HRD/[O0164](#)/Multilayer HRD) #15 Decision: Adopt, modified as follows: It was suggested to constrain the stalling based on the relative cpb removal times, which must be in decoding order. The "du\_based\_bpb\_sync\_flag" is not needed, in view of this. SEI in the highest layer of the layer set or (inclusive "or") VPS VUI is used to carry the parameters (at encoder discretion). SEI in higher layer and SEI in VUI do not need to repeat information available in some lower layer. Shall be after APS SEI and buffering period SEI and before all other SEI of all layers except other HRD related SEI.
- (HRD/[O0217](#)/Sub-DPB based DPB operations) #13 Decision: Adopt – Specify a separate DPB capacity for each layer – no sharing of capacity across layers – each layer has its own parameters (max pictures, max latency, max reordering). This proposal would specify distinct parameters for each "output layer set" and to change the definition of an operation point to be specific to an output layer set instead of a 'layer set'. Decision: Adopted this aspect as well.
- (HRD/[O0266](#)/Flushing decoded picture) #14 Decision: Adopt (harmonize with O0149 proposal 3 and supply text in a revision of O0266).

#### Auxiliary pictures (3)

- (AUX/[O0358](#)/Reserved range) #16 Decision: Define a range of values of auxiliary picture types, the values 0x80-0x8F, for which the interpretation is specified externally or by other information in the bitstream (e.g., some SEI message to be defined later).
- (AUX/[O0135](#)/default\_one\_target\_output\_flag) #2 Carriage of auxiliary pictures. Decision: Relating to section 6, regarding auxiliary picture ID as part of the definition of the semantics of default\_one\_target\_output\_flag, adopt first variant.
- (AUX/[O0041](#)/HLS auxiliary picture layers) #1 Decision: Use nuh\_layer\_id to identify auxiliary pictures and map them to an interpretation (roughly per O0041, as clarified below). Do not make a blanket constraint that prohibits dependencies for auxiliary picture, but impose that constraint for the specific ones listed in O0041 Decision: Adopted the general structure and alpha and depth types. It was agreed that the terminology should be rephrased to not directly link the concepts auxiliary/primary to the concepts of normative/supplemental.

#### Others (6)

- (SEI/[F0169](#)/depth rep info SEI) #40 Depth representation information SEI message for auxiliary pictures.
- (VUI/[O0226](#)/Mod tile WPP) #37 Modifications to the VUI indicators of tile and WPP alignment related syntax elements, from the r1.
- (SHVC/[O0098](#)/Scaled ref layer offset) #36 Modify signalling of scaled reference layer offsets to allow signalling of any lower layer, rather than just a direct reference layer, in order to enable alignment of auxiliary pictures. In further JCT-VC and JCT-3V discussion, it was also agreed to use the same offset signalling for MV-HEVC as well as SHVC
- Unification of active layer SPS and active SPS.
- (Misc/[O0062](#)/POC LSB present condition) #31 Modification as decided later in trac.
- (Misc/[O0062](#)/POC LSB present) #31 The proposal's "option 3" is to add a flag in the VPS for each EL to control whether these LSBs are present or not (for IDR pictures), and when not present, the LSBs are inferred to be equal to 0. Decision: Adopted (as described herein).

#### Fixes (5)

- (Fix MV-HEVC trac [47](#)) Missing a close-bracket on slice\_pic\_order\_cnt\_lsb
- (Fix MV-HEVC trac [48](#)) Wrong element name of poc\_lsb\_present\_flag[] on slice\_segment\_header( ).
- (Fix misspelled LayerInitialisedFlag)

- (Fix MV-Trac Layers Present renaming) Incomplete renaming of “layers present” SEI.
- (Fix missing "!" before all\_ref\_layers\_active\_flag)

### **3.3.2 Open issues**

Open issues in F1004:

- Some text bugs reported in the bug tracking system or indicated by editor's comments.

## **4 Recommendations**

The recommendations of the MV-HEVC / 3D-HEVC Draft and Test Model editing AHG are to:

- Approve the edited documents F1001, F1004 and F1005 as JCT-3V outputs.
- Continue to edit documents to ensure that all agreed elements of 3D- and MV-HEVC are fully described.
- Compare the documents with the HTM-software and resolve any discrepancies that may exist, in collaboration with the Software AHG.
- Continue to improve the overall editorial quality of the documents.
- Ensure that properly drafted candidate text is available prior to making any decision to change the specifications.
- Discuss reported open issues.