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| **Joint Collaborative Team on 3D Video Coding Extensions**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  8th Meeting: Valencia, ES, 29 March – 4 April 2014 | Document: JCT3V-H0011 |

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| *Title:* | **CE1: Summary Report on Merge List Construction** | | |
| *Status:* | Input Document | | |
| *Purpose:* | Report | | |
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| *Source:* | CE coordinators | | |

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# Abstract

This document is the summary report of Core Experiment 1 (CE1) on merge list construction. This Core Experiment investigates methods on merge list construction. Tools under test will be evaluated according to their impact on compression efficiency and implementation complexity. There are 6 CE proposals and 5 CE related proposals.

# Participants

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1. **Tools under Test** 
   1. ***CE1***

There are totally two topics to be investigated in CE1. Three categories are listed in the following:

1. Merge candidate list simplification.
2. Coding efficiency improvement by removal of redundant merge list candidates.

## List of contributions

|  |  |  |  |
| --- | --- | --- | --- |
| **Participants** | **Doc No.** | **Title** | **Type** |
| **CE contributions** | | | |
| Sharp | [JCT3V-H0062](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=1932) | CE1: Simplification of 3D-HEVC merge candidate construction | Proposal |
| Zhejiang University | [JCT3V-H0172](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=2042) | Crosscheck on simplification of 3D-HEVC merge candidate construction (JCT3V-H0062) | Crosscheck |
| Samsung | [JCT3V-H0070](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=1940) | 3D-CE1: Results on Adaptive Disabling Inter-view Motion Vector Candidates | Proposal |
| Sharp | [JCT3V-H0179](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=2049) | 3D-CE1: Crosscheck of Results on Adaptive Disabling Inter-view Motion Vector Candidates (JCT3V-H0070) | Crosscheck |
| Samsung | [JCT3V-H0096](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=1966) | 3D-CE1: Simplification of a pruning process in 3D Merge list construction | Proposal |
| Sharp | [JCT3V-H0176](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=2046) | 3D-CE1: Crosscheck of Simplification of a pruning process in 3D Merge list construction (JCT3V-H0096) | Crosscheck |
| Samsung/ Zhejiang University | [JCT3V-H0097](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=1967) | 3D-CE1: Simplification of 3D Merge list construction | Proposal |
| Sharp | [JCT3V-H0177](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=2047) | 3D-CE1: Crosscheck of Simplification of 3D Merge list construction (JCT3V-H0097) | Crosscheck |
| Samsung | [JCT3V-H0098](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=1968) | 3D-CE1: Simplification of shift DV candidates | Proposal |
| MediaTek | [JCT3V-H0163](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=2033) | Crosschecking for Samsung's Simplification of shift DV candidates (JCT3V-H0098) | Crosscheck |
| Zhejiang University | [JCT3V-H0123](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=1993) | CE1: Results on simplification for VSP merging candidate construction | Proposal |
| Sharp | [JCT3V-H0178](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=2048) | CE1: Crosscheck of Results on simplification for VSP merging candidate construction (JCT3V-H0123) | Crosscheck |
| **CE-related contributions (including related other CE-related contributions)** | | | |
| Samsung | [JCT3V-H0066](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=1936) | 3D-CE1 related: Sub-PU Size for MPI | Proposal |
|  |  |  | Crosscheck |
| Samsung | [JCT3V-H0067](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=1937) | 3D-CE1 related: CU-level VSP and DV Candidates | Proposal |
| NTT | [JCT3V-H0142](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=2012) | 3D-CE1 related: Crosscheck on CU-level VSP and DV Candidates (JCT3V-H0067) | Crosscheck |
| MediaTek | [JCT3V-H0074](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=1944) | 3D-CE1 related: Simplification of merging candidate list in depth coding | Proposal |
| Samsung | [JCT3V-H0153](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=2023) | 3D-CE1 related: Cross check of simplification of merging candidate list in depth coding (JCT3V-H0074) | Crosscheck |
| MediaTek | [JCT3V-H0075](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=1945) | 3D-CE1 related: Simplification of merging candidate list in texture coding | Proposal |
| Samsung | [JCT3V-H0154](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=2024) | 3D-CE1 related: Cross check of simplification of merging candidate list in texture coding (JCT3V-H0075) | Crosscheck |
| ETRI/KHU | [JCT3V-H0083](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=1953) | CE1 related: Bug-fix and clean up on merge list construction | Proposal |
| Samsung | [JCT3V-H0151](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=2021) | CE1 related: Cross check of Bug-fix and clean up on merge list construction (JCT3V-H0083) | Crosscheck |
| Samsung | [JCT3V-H0099](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=1969) | 3D-CE1 related: Default motion parameter for sub-PU MPI | Proposal |
| Zhejiang University | [JCT3V-H0170](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=2040) | Crosscheck on default motion parameter for sub-PU MPI (JCT3V-H0099) | Crosscheck |
| LGE | [JCT3V-H0111](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=1981) | CE1 related : The unification of sub-PU process for MPI blocks | Proposal |
| Samsung | [JCT3V-H0152](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=2022) | 3D-CE1 related: Cross check of the unification of sub-PU process for MPI blocks (JCT3V-H0111) | Crosscheck |
| LGE | [JCT3V-H0117](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=1987) | 3D-CE1 related: Simplification on merge list for depth video coding | Proposal |
| Samsung | [JCT3V-H0169](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=2039) | 3D-CE1 related: Cross check of Simplification on merge list for depth video coding (JCT3V-H0117) | Crosscheck |

# Summary of proposals & results

## Coding efficiency improvement by removal of redundant merge list candidates

### Test1: Adaptive Disabling Inter-view Motion Vector Candidates

* + JCT3V-H0070:
    - * It is proposed to disable the IVMV candidates when IC is enabled.
      * In the simplified solution, the motion information of the IVMV candidates is not used for the pruning process.

#### Coding results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | *Video 1* | *Video 2* | *Video/video BR* | *Video/total BR* | *Synthesized/total BR* | *Enc time* | *Dec time* |
| H0070 (CE Test) | -0.06% | -0.04% | -0.03% | -0.04% | -0.01% | 98.7% | 97.0% |
| H0070 (with simplification) | -0.06% | -0.05% | -0.02% | -0.02% | -0.03% | 99.7% | 97.5% |

## Merge candidate list simplification

### Test1: Simplification on pruning process

* + JCT3V-H0096: Proposed pruning process

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Texture | Depth | Option 1 | Option 2 | Option 3 |
| N/A | MPI-IVMV | Removed | Removed | Removed |
| IVMV-A1 | MPI-A1 | Allowed | Allowed | Allowed only for texture |
| IVMV-B1 | MPI-B1 | Allowed | Removed | Removed |
| A1-DV | N/A | Removed | Removed | Removed |
| B1-DV | N/A | Removed | Removed | Removed |
| IVMV-Shift IVMV | N/A | Removed | Removed | Removed |

* + JCT3V-H0123: The VSP flag storage and checking process are removed by disabling VSP inheritance and only one default VSP candidate is inserted to a fixed position in the merge candidate list.



* + JCT3V-H0097:

Table 1. Proposed pruning process

|  |
| --- |
| Texture(or Depth) |
| IVMV(or MPI)- First candidate in the HEVC list |

Table 2. Proposed 3D Merge list construction (Texture)

|  |  |
| --- | --- |
| Current | Proposed |
| IVMV | IVMV |
| A1 | First candidate in the HEVC list |
| B1 | Second candidate in the HEVC list |
| B0 | DV |
| DV | Third candidate in the HEVC list |
| VSP | Shift IVMV |
| A0 | Shift DV |
| B2 | Forth candidate in the HEVC list |
| Shift IVMV | Fifth candidate in the HEVC list |
| Shift DV |  |
| Temporal |  |

Table 3. Proposed 3D Merge list construction (Depth)

|  |  |
| --- | --- |
| Current | Proposed |
| MPI | MPI |
| DDD | DDD |
| IVMV | IVMV |
| A1 | First candidate in the HEVC list |
| B1 | Second candidate in the HEVC list |
| B0 | Third candidate in the HEVC list |
| A0 | Forth candidate in the HEVC list |
| B2 | Fifth candidate in the HEVC list |
| Temporal |  |



Fig. 1. Proposed VSP position

#### Coding results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | *Video 1* | *Video 2* | *Video/video BR* | *Video/total BR* | *Synthesized/total BR* | *Enc time* | *Dec time* |
| H0096 (Option 1) | 0.01% | -0.07% | 0.00% | 0.00% | 0.01% | 99.5% | 99.4% |
| H0096 (Option 2) | 0.04% | -0.01% | 0.03% | 0.01% | 0.02% | 99.8% | 99.8% |
| H0096 (Option 3) | 0.04% | -0.05% | 0.02% | 0.01% | 0.04% | 99.1% | 99.9% |
| H0123 | 0.20% | 0.06% | 0.01% | 0.00% | 0.00% | 101.6% | 100.3% |
| H0097 | 0.29% | 0.13% | 0.06% | 0.04% | 0.09% | 99.8% | 99.3% |

### Test2: Simplification on shift DV candidates

* + JCT3V-H0098:
    - Option1: propose to move the shift DV candidates
    - Option2: propose to replace the shift DV candidates by the depth-based minimum DV

#### Coding results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | *Video 1* | *Video 2* | *Video/video BR* | *Video/total BR* | *Synthesized/total BR* | *Enc time* | *Dec time* |
| H0098 (Option 1) | 0.19% | 0.10% | 0.06% | 0.05% | 0.05% | 102.4% | 99.6% |
| H0098 (Option 2) | 0.03% | 0.00% | 0.02% | 0.02% | 0.00% | 99.7% | 99.5% |

### Test3: Simplification of 3D-HEVC merge candidate construction

* + JCT3V-H0062 (CE): proposes to remove 3D-HEVC merge candidates for 8x4 / 4x8 PU
  + JCT3V-H0074 (related)
    - Option 2: propose to remove 3D-HEVC merge candidates in depth coding for all non-2Nx2N PU
  + JCT3V-H0075 (related)
    - Option 2: propose to remove 3D-HEVC merge candidate in texture coding for all non-2Nx2N PU.
    - Option 3: propose to remove 3D-HEVC merge candidate in both depth and texture coding for all non-2Nx2N PU

#### Coding results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | *Video 1* | *Video 2* | *Video/video BR* | *Video/total BR* | *Synthesized/total BR* | *Enc time* | *Dec time* |
| H0062 (CE) | 0.04% | -0.07% | 0.00% | 0.00% | -0.01% | 99.8% | 99.9% |
| H0074-related (Option2) | 0.01% | -0.03% | 0.00% | -0.01% | 0.00% | 100.6% | 104.3% |
| H0075-related (Option2) | 0.24% | 0.20% | 0.08% | 0.08% | 0.04% | 99.9% | 102.0% |
| H0075-related (Option3) | 0.27% | 0.24% | 0.09% | 0.08% | 0.07% | 99.8% | 102.3% |

### CE Related: Simplification of sub-PU candidates

* + - JCT3V-H0066 (related) / JCT3V-H0074 – Option 1 (related) / JCT3V-H0133 – Option2 (related):
      * Propose to disallow sub-PU MPI candidate for all non-2Nx2N PU in order to avoid irregular 8x12/12x8 MCP block sizes.



Current Sub-PU partition for AMP mode (CU size: 16x16)

* + - JCT3V-H0075 – Option 1 (related) / JCT3V-H0067 – Option1 (related)
      * Propose to remove VSP candidate for all non-2Nx2N PU
    - JCT3V-H0067 – Option2 (related)
      * Propose to remove DV candidates for all non-2Nx2N PU

#### Coding results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | *Video 1* | *Video 2* | *Video/video BR* | *Video/total BR* | *Synthesized/total BR* | *Enc time* | *Dec time* |
| H0066-related/ H0074-related (Option1)/ H0133-related (Option2) | 0.01% | -0.01% | 0.00% | -0.01% | -0.04% | 99.1% | 99.2% |
| H0075-related (Option 1)/ H0067-related (Option1) | 0.11% | 0.06% | 0.01% | 0.01% | 0.00% | 99.6% | 97.4% |
| H0067-related (Option2) | -0.02% | 0.03% | -0.02% | -0.02% | 0.00% | 99.9% | 98.6% |
| H0067-related (Option1+2) | 0.15% | 0.15% | 0.02% | 0.01% | 0.01% | 100.1% | 99.1% |

## Other CE1 related contributions

The CE1-related contributions are roughly classified into four categories according to their purpose:

* Motion hole filling for sub-PU MPI
* Removal of DDD candidate
* Bug-fix and clean ups on merge list construction

### Motion hole filling for sub-PU MPI

* + JCT3V-H0077/JCT3V-H0099/JCT3V-H0111/JCT3V-H0133 (Option 1)
    - * Proposes to use a default motion parameter to fill the sub-PU MPI motion hole, where the default motion parameter is derived from the center sub-PU.
      * In order to align with the motion hole filling in sub-PU IVMP and make sub-PU MPI friendly to parallel processing.

#### Coding results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | *Video 1* | *Video 2* | *Video/video BR* | *Video/total BR* | *Synthesized/total BR* | *Enc time* | *Dec time* |
| H0077/  H0099/  H0133(Option 1) | 0.02% | -0.10% | -0.01% | -0.02% | -0.02% | 101.9% | 97.8% |
| H0111 | 0.02% | -0.09% | -0.01% | -0.02% | 0.00% | 99.8% | 97.4% |

### Removal of DDD candidate

* + JCT3V-H0117: proposes to remove the DDD candidate from the depth merge candidate list.

#### Coding results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | *Video 1* | *Video 2* | *Video/video BR* | *Video/total BR* | *Synthesized/total BR* | *Enc time* | *Dec time* |
| H0117 | 0.0% | 0.0% | 0.0% | 0.0% | 0.12% | 99.6% | 101.4% |

### Bug-fix and clean ups on merge list construction

* + JCT3V-H0083: proposes a bug-fix and clean ups on merging candidate list construction.

#### Coding results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | *Video 1* | *Video 2* | *Video/video BR* | *Video/total BR* | *Synthesized/total BR* | *Enc time* | *Dec time* |
| H0083 | -0.06% | -0.16% | -0.03% | -0.03% | -0.03% | #NUM! | #NUM! |

# Closing Remarks

It is recommended the CE be continued and investigate proposed designs in further details.