Joint Collaborative Team on 3D Video Coding Extension Development of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11
4th Meeting: Incheon, KR, 20–26 Apr. 2013

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Title: **JCT-3V AHG report: 3D-HEVC Software Integration (AHG5)**

Status: AHG report input to JCT-3V

Purpose: AHG report

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Source: AHG

Abstract

This report summarizes the activities of the AhG on 3D-HEVC Software Integration that have taken place between the 3rd meeting in Geneva (17-23 January 2013) and the 4th JCT-3V meeting in Incheon (20–26 April 2013). Activities focused on the integration of tools adopted at the 3rd meeting into a common code base, the setup of a bug tracking system and the update of HTM software to HM 10.0.

1 Mandates

Title	Chairs	Mtg
3D-HEVC Software Integration (AHG5) • 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 6.0 software version and the reference configuration encodings according to JCT3V-C1100 based on common conditions suitable for use in most core experiments (expected within 4 weeks after the meeting). • Prepare and deliver HTM 6.1 software that include additional items not integrated into the 6.0 version (expected within 2 weeks after the 6.0 software release). • Prepare the migration of high-level syntax part corresponding to JCT3V-C1004 into HM10 (basic functionalities for multiview coding). • 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. • Set up a bug tracking system.	G. Tech L. Zhang (co-chairs) Y. Chang K. Wegner (vice chairs)	N

2 Tool integration to HTM

Development of the software was co-ordinated with the parties needing to integrate changes. Development of HTM-6.0 was conducted in three parallel tracks each performing sequential integration. Software of all three tracks was merged by the software coordinators. HTM-6.1 was developed using a single track.

Prior to each integration source code to be integrated has been reviewed by the software coordinator and suggestions for improvement have been made to the integrators when necessary.

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/

Anchor bitstreams have been created and uploaded to:

ftp.hhi.fraunhofer.de; login: mpeg3dv_guest; path: /MPEG-3DV/HTM-Anchors/

2.1 History of software tags

Multiple versions 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.

2.1.1 Version HTM-6.0

2.1.1.1 Integrated items

Track 1 (most tools related to Depth Intra):

JCT3V-C0034 CE6.h Modified deltaDC processing for DMM

JCT3V-C0160 CE6.h Modified depth coding in random access units

JCT3V-C0154 CE6.h Reference samples sub-sampling for SDC and DMM

JCT3V-C0044 CE6.h Simplification of Depth Modeling Mode 3 adopt JCT3V-C0044, solution 3

JCT3V-C0046 CE5.h related: Bug Fix and Extension of Illumination Compensation Adopt(SW): first and second fixes, enabling IC on depth

JCT3V-C0096 CE6.h Results on Improved Simple Depth, removal of DMM2

JCT3V-C0143 CE6.h Simplification of Simplified Depth Coding SW bug fix (identical to C0068 and C0155)

Track 2 (most tools related to Merge):

JCT3V-C0051 CE5.h Unification of inter-view candidate derivation for 3D-HEVC

JCT3V-C0047 CE5.h Improved temporal motion vector prediction for merge

JCT3V-C0138 CE4.h results on removal of parsing dependency for inter-view residual prediction Part that removes the parsing dependency. No action on removing interpolation of residual

JCT3V-C0137 3D-CE3.h results on removal of parsing dependency and picture buffers for motion parameter inheritance

JCT3V-C0115 Alignment of inter-view vector scaling. Flag in VPS

JCT3V-C0116 Inter-view vector scaling for AMVP

Track 3 (most tools related to Disparity Derivation):

JCT3V-C0152 CE1.h: Backward View Synthesis Prediction using Neighbouring Blocks

JCT3V-C0131 CE1.h: Depth-oriented neighbouring block disparity vector (DoNBDV) with virtual depth retrieval

JCT3V-C0097/JCT3V-C0141 CE2.h related results on disparity vector derivation. Part 1 Adopt (priority order, identical to C0141)

JCT3V-C0135 CE2.h related: Restriction on the temporal blocks for memory bandwidth reduction in DV derivation (All 3 Parts)

JCT3V-C0129 Constrained DV for inter-view Adopt remove the constraint from the decoder, but not as suggested in JCT3V-C0129, but unconditionally (without flag).

JCT3V-C0112 CE1.h related: Adaptive method for Depth Oriented Neighbouring Block Disparity Vector Method 4

JCT3V-C0055 Bug fix for disparity vector derivation in 3D-HEVC (SW)

2.1.1.2 Coding performance

HTM-6.0 vs. HTM-5.1 (CTC, three view configuration)

	video video rate	video total rate	synth total rate	enc time	dec time	ren time
Balloons	-0,7%	-0,5%	-1,8%	94,9%	107,2%	101,9%
Kendo	-1,2%	-0,9%	-1,8%	93,2%	101,2%	100,9%
Newspaper_CC	-0,5%	0,3%	-3,6%	98,9%	109,6%	102,1%
GT_Fly	-2,5%	-2,1%	-2,1%	95,6%	106,3%	98,9%
Poznan_Hall2	-0,7%	-0,8%	-1,8%	96,7%	104,2%	101,3%
Poznan_Street	-1,2%	-0,5%	-2,6%	99,7%	110,3%	100,7%
Undo_Dancer	-2,4%	-2,0%	-1,8%	96,3%	102,7%	100,5%
1024x768	-0,8%	-0,4%	-2,4%	95,7%	106,0%	101,6%
1920x1088	-1,7%	-1,3%	-2,1%	97,1%	105,9%	100,4%
average	**-1,3%**	**-0,9%**	**-2,2%**	**96,5%**	**105,9%**	**100,9%**

2.1.2 Version HTM-6.1

2.1.2.1 Integrated Items

JCT3V-C0170/JCT3V-C0132 CE2.h-related: Flexible Coding Order (FCO) and depth-first-based disparity derivation, DDV for FCO (non-ctc) (SW only)

JCT3V-C0223 Fixed to Weighted Prediction for 3D-HEVC

2.1.2.2 Coding performance

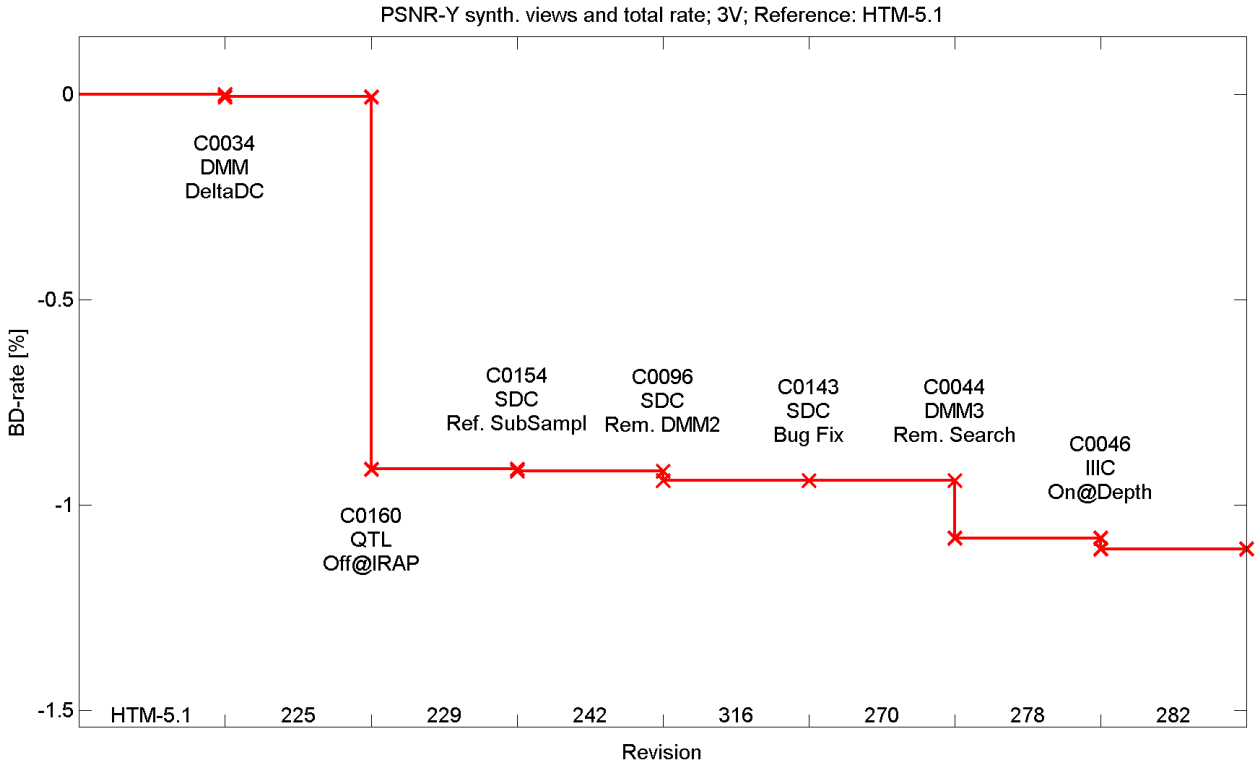
HTM-6.1 vs. HTM-6.0 (CTC, three view configuration)

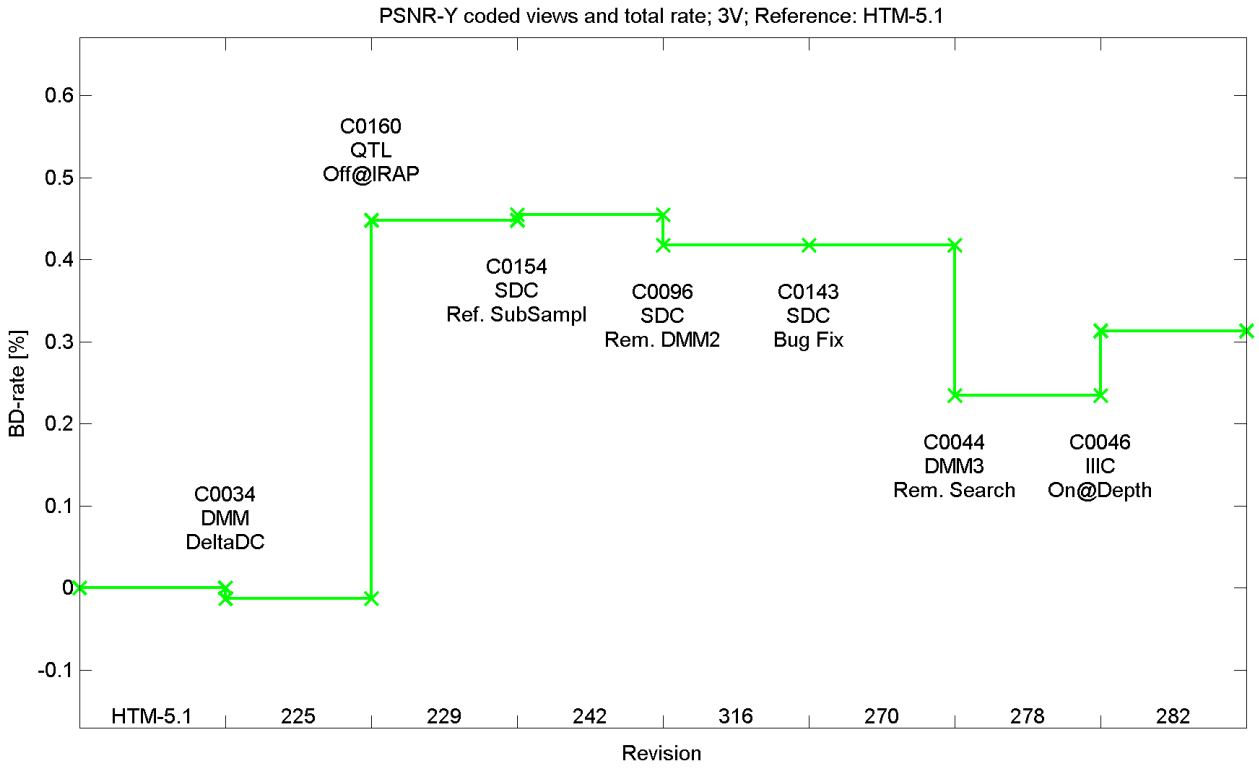
	video video rate	video total rate	synth total rate	enc time	dec time	ren time
Balloons	-0,3%	-0,2%	-0,3%	99,2%	97,3%	100,6%
Kendo	-0,1%	-0,1%	0,0%	100,3%	101,1%	100,0%
Newspaper_CC	-0,1%	0,0%	-0,1%	99,4%	95,2%	100,3%
GT_Fly	0,1%	0,1%	0,0%	100,2%	104,0%	103,1%
Poznan_Hall2	-0,1%	-0,1%	0,0%	99,7%	101,1%	100,3%
Poznan_Street	0,0%	0,0%	0,0%	99,8%	95,1%	104,9%
Undo_Dancer	0,0%	0,0%	0,0%	100,0%	102,8%	101,3%
1024x768	-0,1%	-0,1%	-0,1%	99,7%	97,8%	100,3%
1920x1088	0,0%	0,0%	0,0%	99,9%	100,8%	102,4%
average	**-0,1%**	**-0,1%**	**-0,1%**	**99,8%**	**99,5%**	**101,5%**

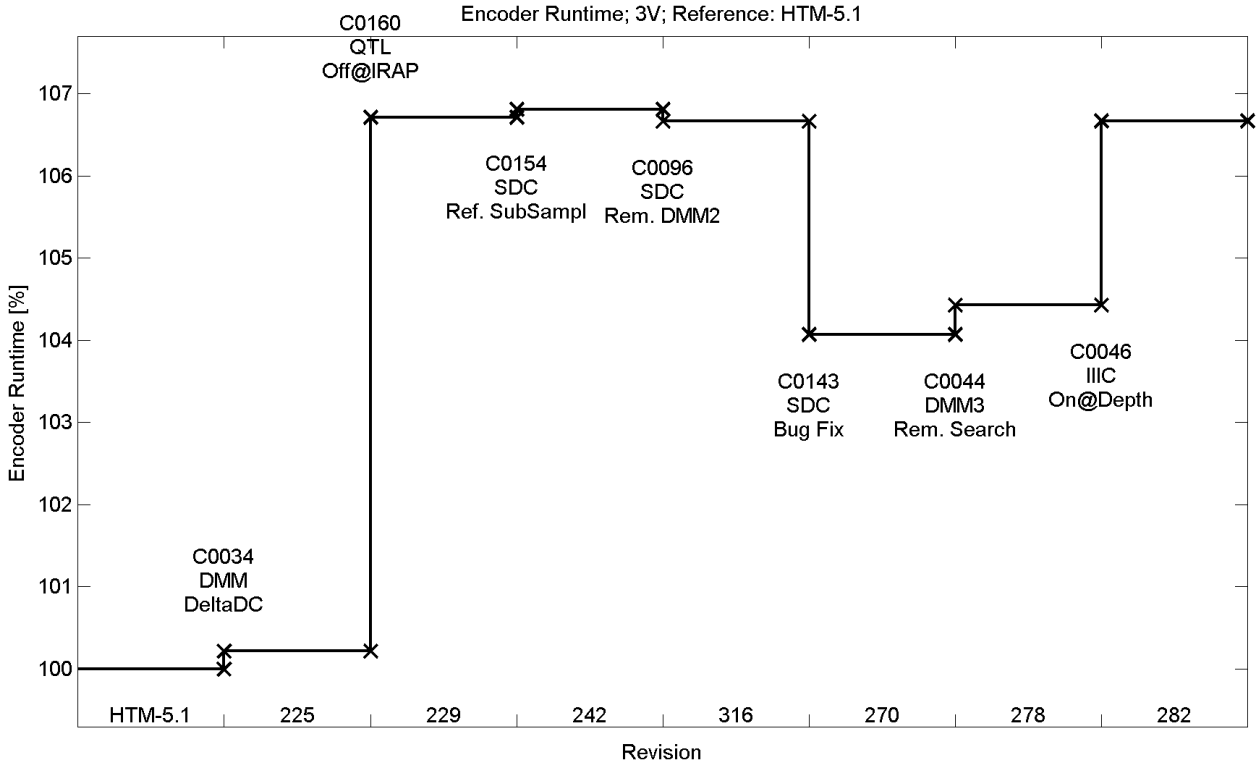
2.2 History of revisions

The following sections give a brief summary of average rate savings and runtimes of the different software revisions produced during the integration the period. Results are not cross verified.

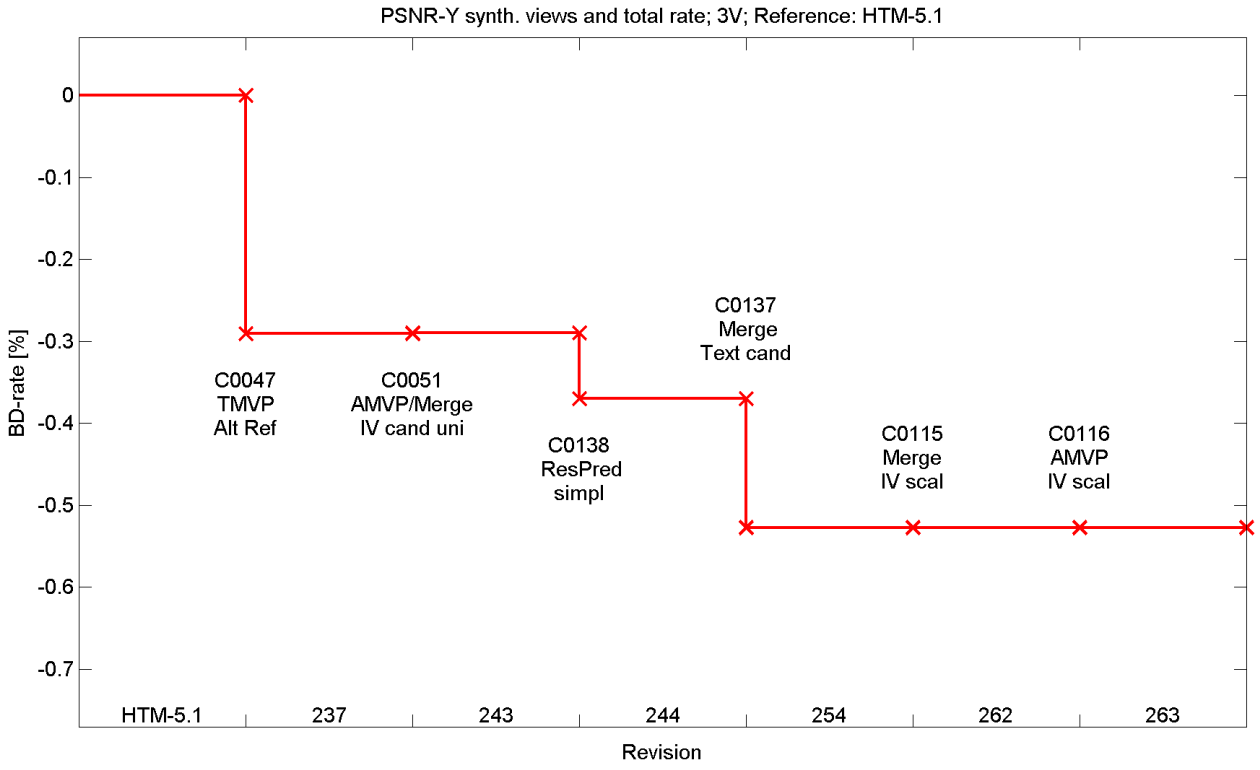
2.2.1 Track 1

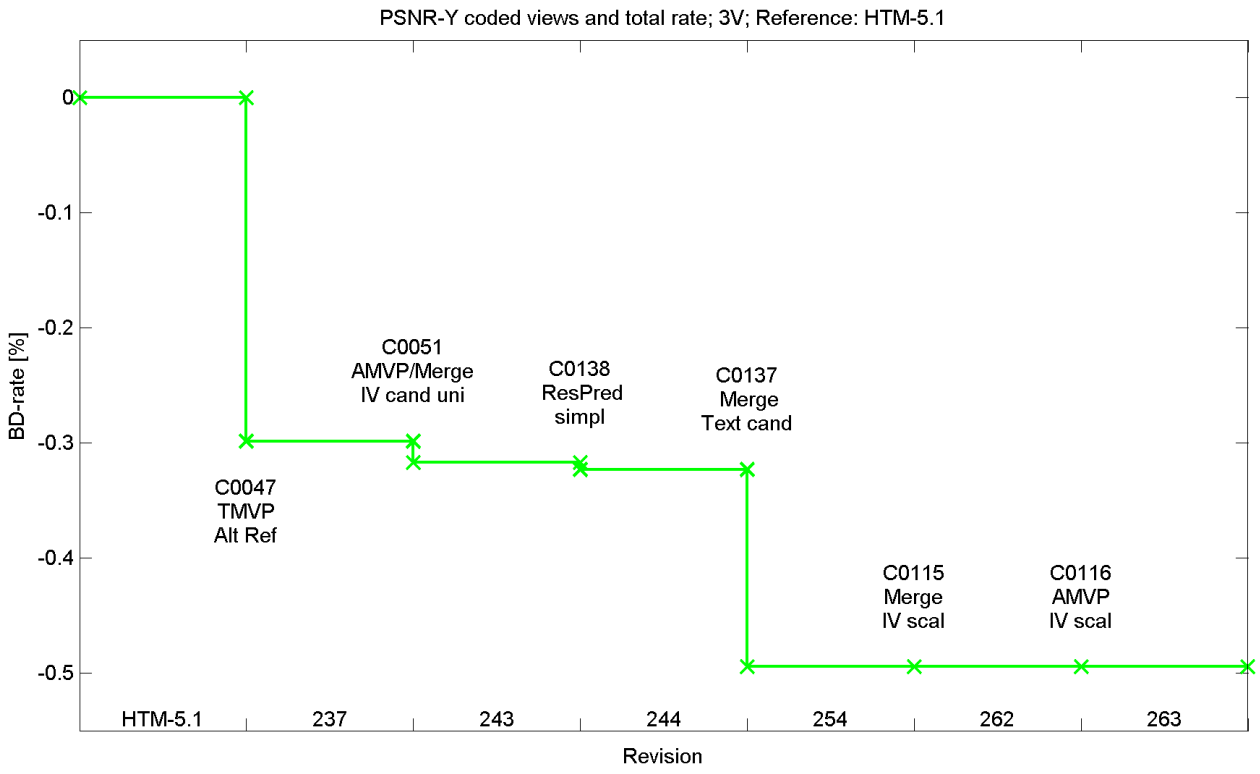

PSNR-Y synth. views and total rate; 3V; Reference: HTM-5.1
BD-rate [%]
0
-0.5
-1
-1.5
C0034
DMM
DeltaDC
C0160
QTL
Off@IRAP
C0154
SDC
Ref. SubSampl
C0096
SDC
Rem. DMM2
C0143
SDC
Bug Fix
C0044
DMM3
Rem. Search
C0046
IIIC
On@Depth
HTM-5.1
225
229
242
316
270
278
282
Revision

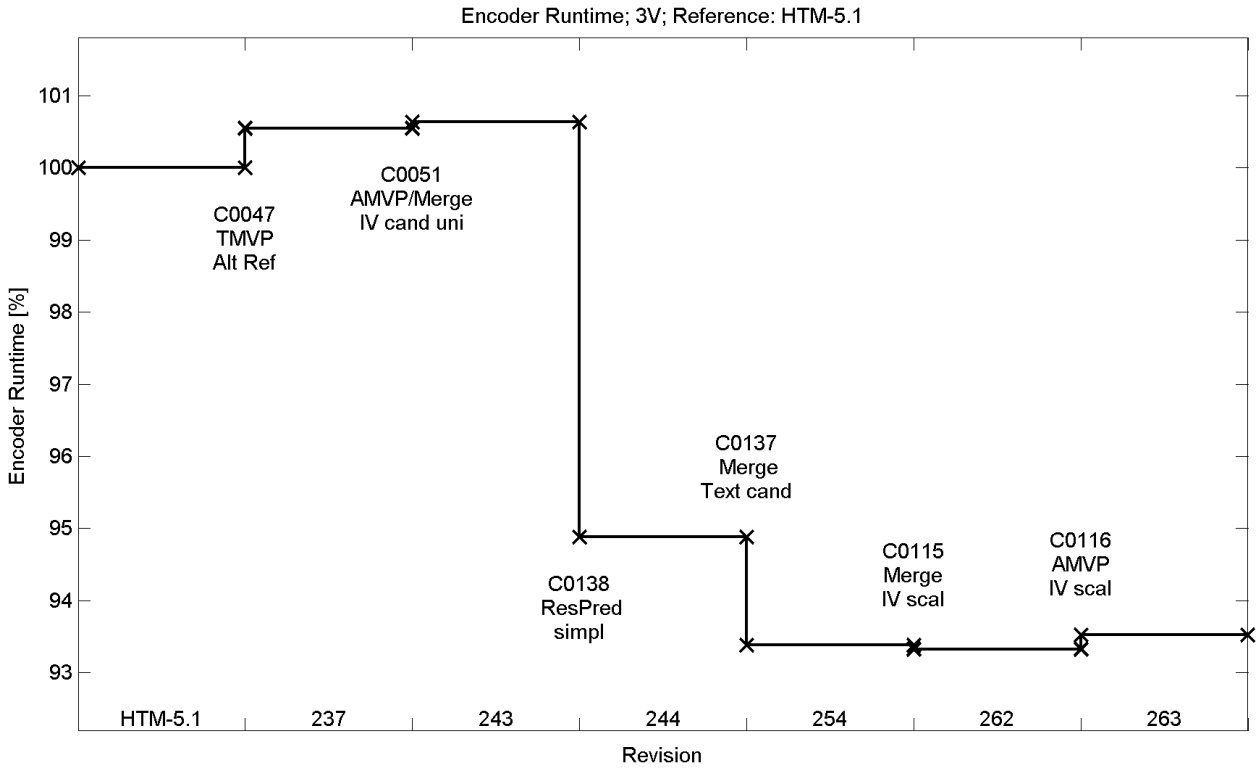

PSNR-Y coded views and total rate; 3V; Reference: HTM-5.1
BD-rate [%]
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
C0160
QTL
Off@IRAP
C0154
SDC
Ref. SubSampl
C0096
SDC
Rem. DMM2
C0143
SDC
Bug Fix
C0044
DMM3
Rem. Search
C0046
IIIC
On@Depth
C0034
DMM
DeltaDC
HTM-5.1
225
229
242
316
270
278
282
Revision


Encoder Runtime; 3V; Reference: HTM-5.1
Encoder Runtime [%]
107
106
105
104
103
102
101
100
C0160
QTL
Off@IRAP
C0154
SDC
Ref. SubSampl
C0096
SDC
Rem. DMM2
C0143
SDC
Bug Fix
C0044
DMM3
Rem. Search
C0046
IIIC
On@Depth
C0034
DMM
DeltaDC
HTM-5.1
225
229
242
316
270
278
282
Revision

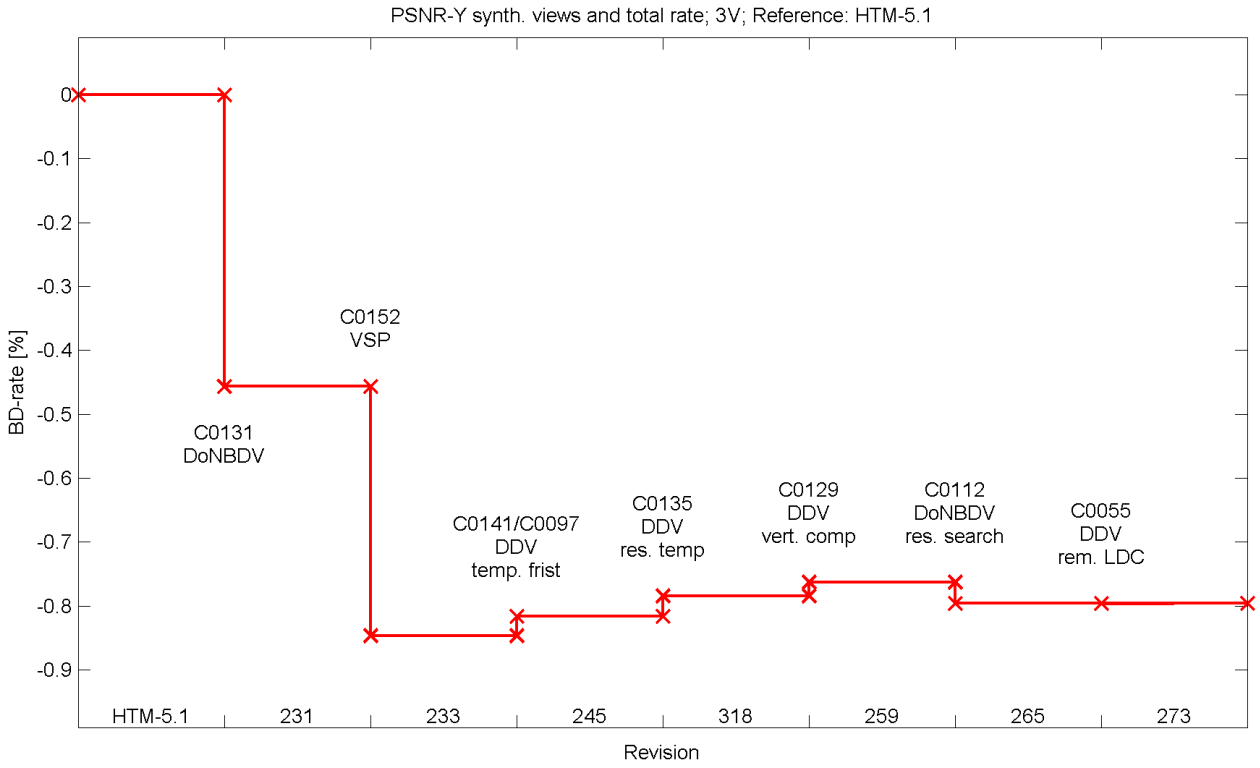
2.2.2 Track 2

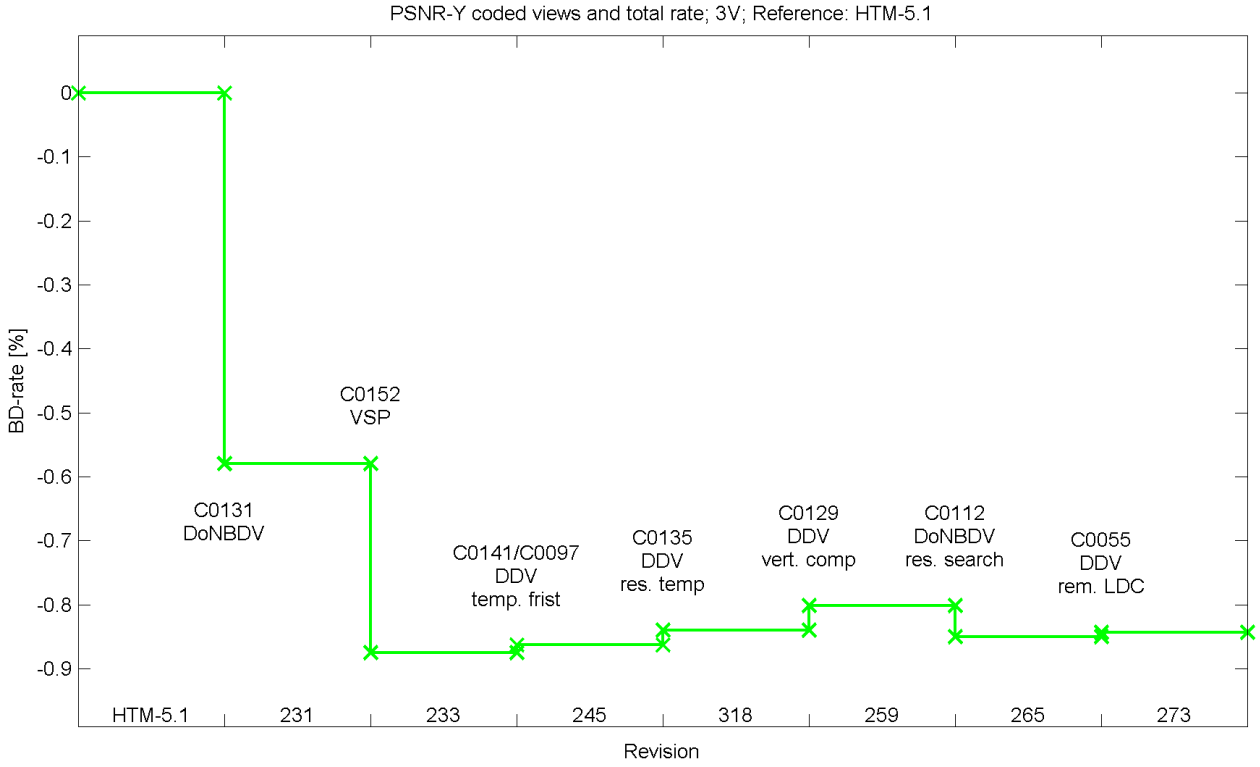

PSNR-Y synth. views and total rate; 3V; Reference: HTM-5.1
BD-rate [%]
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
C0047
TMVP
Alt Ref
C0051
AMVP/Merge
IV cand uni
C0138
ResPred
simpl
C0137
Merge
Text cand
C0115
Merge
IV scal
C0116
AMVP
IV scal
HTM-5.1
237
243
244
254
262
263
Revision

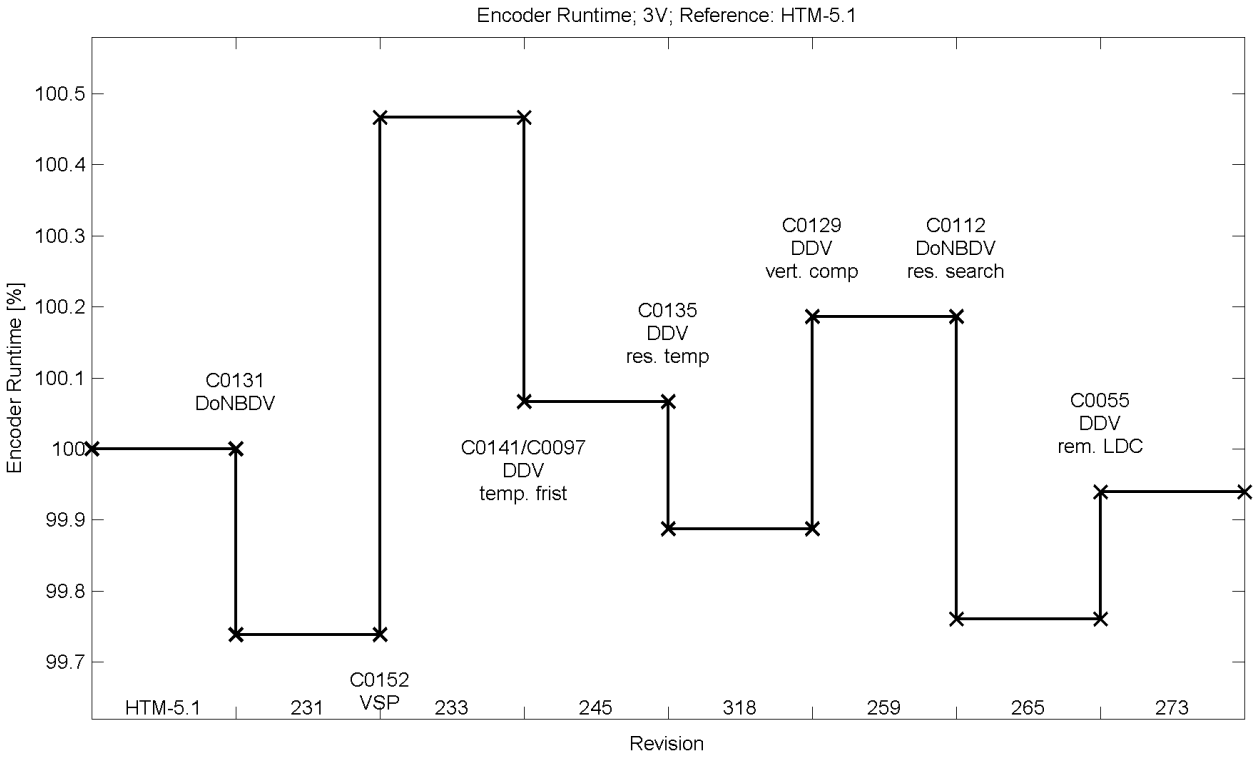

PSNR-Y coded views and total rate; 3V; Reference: HTM-5.1
BD-rate [%]
0
-0.1
-0.2
-0.3
-0.4
-0.5
C0047
TMVP
Alt Ref
C0051
AMVP/Merge
IV cand uni
C0138
ResPred
simpl
C0137
Merge
Text cand
C0115
Merge
IV scal
C0116
AMVP
IV scal
HTM-5.1
237
243
244
254
262
263
Revision


Encoder Runtime; 3V; Reference: HTM-5.1
Encoder Runtime [%]
101
100
99
98
97
96
95
94
93
C0047
TMVP
Alt Ref
C0051
AMVP/Merge
IV cand uni
C0138
ResPred
simpl
C0137
Merge
Text cand
C0115
Merge
IV scal
C0116
AMVP
IV scal
HTM-5.1
237
243
244
254
262
263
Revision

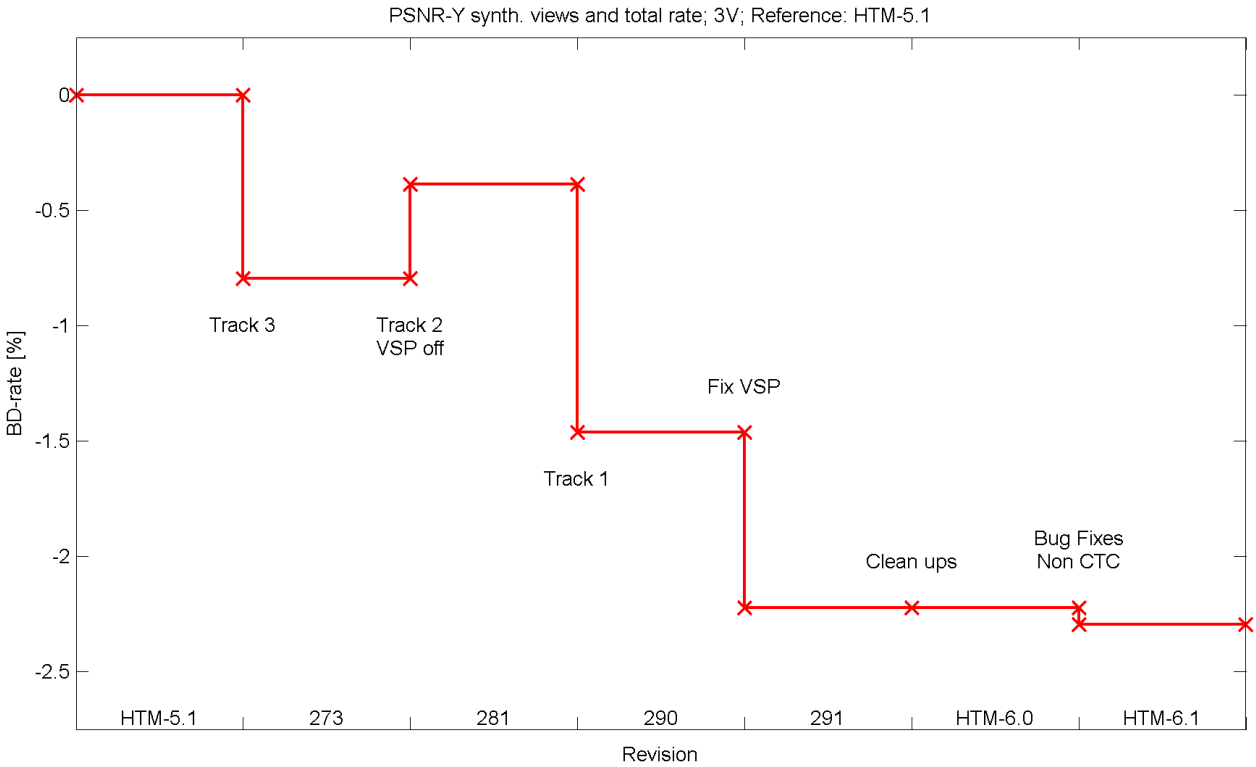
2.2.3 Track 3

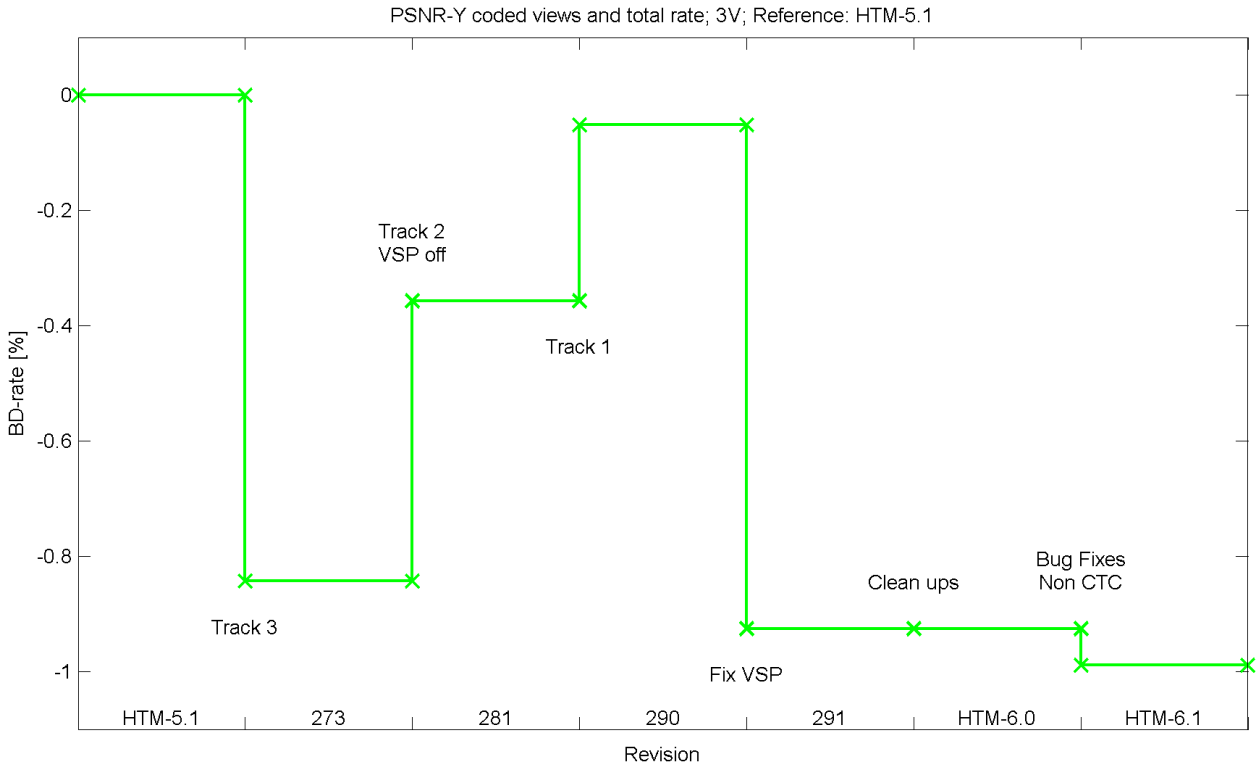

PSNR-Y synth. views and total rate; 3V; Reference: HTM-5.1
BD-rate [%]
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
C0152
VSP
C0131
DoNBDV
C0141/C0097
DDV
temp. frist
C0135
DDV
res. temp
C0129
DDV
vert. comp
C0112
DoNBDV
res. search
C0055
DDV
rem. LDC
HTM-5.1
231
233
245
318
259
265
273
Revision

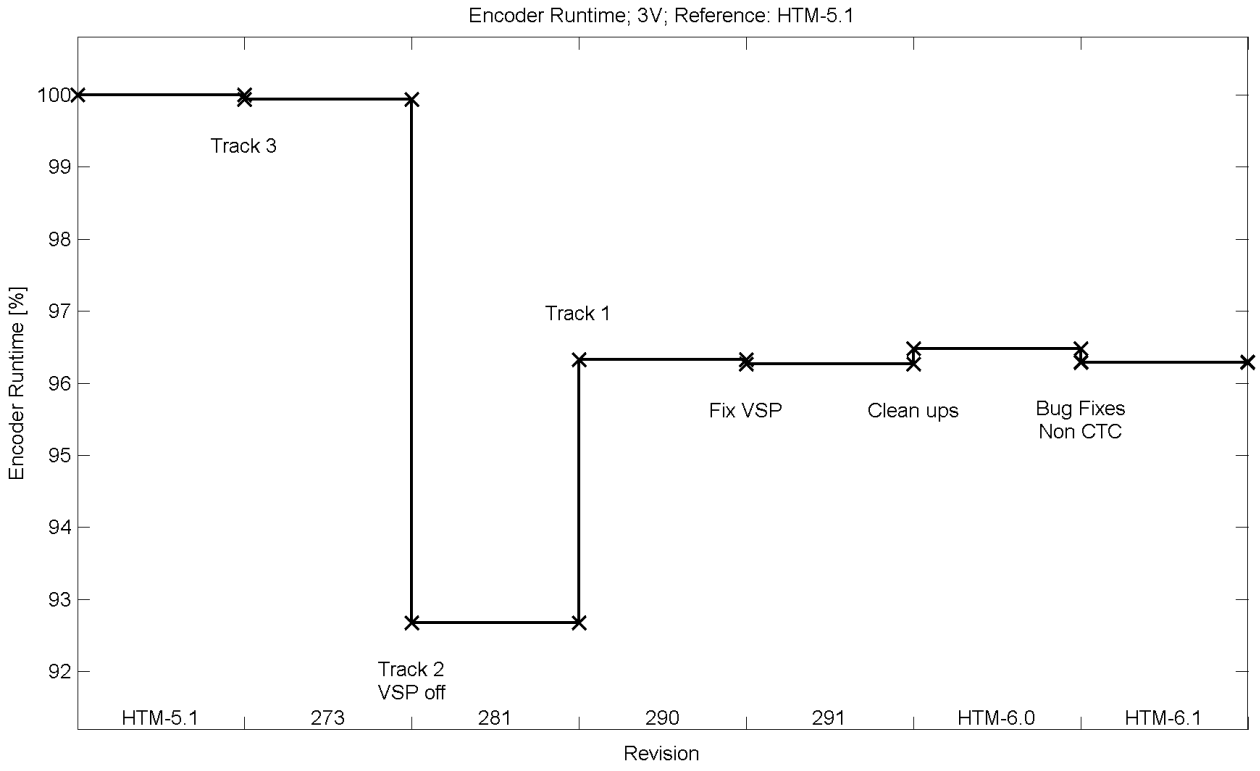

PSNR-Y coded views and total rate; 3V; Reference: HTM-5.1
BD-rate [%]
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
C0152
VSP
C0131
DoNBDV
C0141/C0097
DDV
temp. frist
C0135
DDV
res. temp
C0129
DDV
vert. comp
C0112
DoNBDV
res. search
C0055
DDV
rem. LDC
HTM-5.1
231
233
245
318
259
265
273
Revision



2.2.4 Merge on tracks and HTM-6.1




PSNR-Y coded views and total rate; 3V; Reference: HTM-5.1
BD-rate [%]
0
-0.2
-0.4
-0.6
-0.8
-1
Track 2
VSP off
Track 1
Track 3
Clean ups
Bug Fixes
Non CTC
Fix VSP
HTM-5.1
273
281
290
291
HTM-6.0
HTM-6.1
Revision


Encoder Runtime; 3V; Reference: HTM-5.1
Encoder Runtime [%]
100
99
98
97
96
95
94
93
92
Track 3
Track 1
Fix VSP
Clean ups
Bug Fixes
Non CTC
Track 2
VSP off
HTM-5.1
273
281
290
291
HTM-6.0
HTM-6.1
Revision

2.3 Open issues in HTM-6.1

- Since the 3D-HEVC Test Model [2] is based on HEVC text specification draft 8 [3] and HTM-6.1 is based on HM-6.1 there are mismatches between draft text and HTM-software.
- With the integration of tools related to inter-view motion prediction the issue arose that inter-view motion prediction only works properly under CTC. Moreover there are mismatches with the provided text.
- Some tools are not switchable by encoder configuration, although this would be desirable.
- Other minor issues are listed in the bug tracking system.

3 HTM Update

An initial version software version for HTM update has been released. The provided software package is conforming to the current MV-HEVC specification and can thus be used as reference software for MV-HEVC. For 3D-HEVC compliance the integration of 3D-HEVC tools is required.

Other features of the software are:

- clean software design from HM-10.0 as starting point
- strict separation of MV- and 3D-HEVC parts by macros
- multiple VPS features switchable by the encoder
- basic support of depth maps
- software architecture in sense of general extendibility, hence other scalability types can be added easily

Related input document:

JCT3V-D0287 AHG5 Report on update of HTM: MV-HEVC Software based on HM10.0, (H. Brust, G. Tech, K. Mueller (HHI), Y. Chen, L. Zhang (Qualcomm))

4 Setup of bug tracking system

The setup of the bug tracking has been carried out by Karsten Sühring and David Flynn. AHG5 wants to thank Karsten and David for their support. The bug tracking system has been announced on the reflector can be accessed at:

https://hevc.hhi.fraunhofer.de/trac/3d-hevc/

For HTM a component in the bug tracking system has been created:

Issues reported by the software coordinators often require additional inputs or clarification by the proponents. So it is recommended that proponents of adopted tools check the tracking system, whether there is an issue with their proposal and suggest to the editors how to fix it.

5 Recommendations

The recommendations of the 3D-HEVC Software integration group are:

- Continue to develop reference software based on HTM version 6.1 and improve its quality
- Remove bug fix related macros introduced in previous HTM versions before starting integration towards HTM 7.0.

- 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.
- Discuss how to continue the update of HTM to the most recent version of HM.
- Discuss on how to address open issues.
- Discuss AHG5 related input documents.

6 References

[1] JCT-3V, "MV-HEVC Draft 3", JCT3V-C1004, JCT-3V Meeting, Geneva, January 2013

[2] JCT-3V, "3D-HEVC Test Model 3", JCT3V-C1005, JCT-3V Meeting, Geneva, January 2013

[3] JCT-VC, "High Efficiency Video Coding (HEVC) text specification draft 8", JCTVC-J1003, JCT-VC Meeting, Stockholm, July 2012