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# Abstract

This report summarizes the activities of Ad Hoc Group 8 on screen content extensions software (SCM) development that have taken place between the JCT-VC 20th meeting in Geneva, Switzerland, and the 21th meeting in Warsaw, Poland.

# Mandates

The ad hoc group was mandated to:

* Coordinate development of the HM SCM software and its distribution.
* Prepare and deliver HM 16.x-SCM-4.0 software version and the reference configuration encodings according to JCTVC-T1015.
* Prepare and deliver additional "dot" version software releases and software branches as appropriate.
* Perform analysis and reconfirmation checks of the behavior of the draft design, and report the results of such analysis.
* Suggest configuration files for additional testing of tools.
* Coordinate with AHG7 to address any identified issues regarding text and software relationship.

# Software revisions

Multiple versions of the HM SCM software were produced and SCM4.0 was announced on the JCT-VC email reflector. The integration details and performance summary of these revisions are provided in the next subsections. The performance results of software revisions were observed to be consistent with the adopted techniques.

## HM-16.4\_SCM-4.0

HM-16.4\_SCM-4.0 was tagged on the SVN HHI repository on March 18th 2014. This release includes following adoptions:

* JCTVC-T0048 : Palette\_predictor\_initializer at PPS-level
* JCTVC-T0058 : Disallow palette mode for 64x64 CUs
* JCTVC-T0063 : EG0 signaling for palette\_num\_signalled\_entries
* JCTVC-T0064 : Remove the palette sharing flag and its context
* JCTVC-T0065 : Grouping Palette Indices
* JCTVC-T0069 : AMVR high-level syntax cleanup
* JCTVC-T0072/T0109/T0120 : Palette Coding for non-4:4:4 format content
* JCTVC-T0078 : Remove context in palette run mode
* JCTVC-T0087 : Palette Table Generation
* JCTVC-T0116 : Encoder improvements on IBC search
* JCTVC-T0118/T0112 : On Escape color coding
* JCTVC-T0121 : Encoder operation to infer split\_transform\_flag
* JCTVC-T0132 : ACT dynamic range control
* JCTVC-T0134 : Use delta to signal palette predictor size
* JCTVC-T0140 : QP offset for different color spaces
* JCTVC-S0180/S0150/Meeting notes : Grouping escape at the end
* JCTVC-T0183 : Add inference rule when  palette\_escape\_val\_present\_flag  is not present
* JCTVC-T0227 : Intra block copy and inter signaling unification
* SW Bug fix :  For high bit-Depth test configuration
* Meeting notes :  Double the palette and palette predictor size
* Ticket#1376 : Incorrect search range for Nx2N
* Migration to HM-16.3, HM-16.4.

The main changes to the configuration files are:

* Addition of 420 configuration files as in JCTVC-T1015
* Temporal scalability is supported in the RA test conditions.

Following adoptions have not been integrated to SCM 4.0 (These do not impact CTC)

* JCTVC-T0048/T0055/T0056: IntraBC constraint for multiple slices/tiles SW fix. These aspects are integrated to SCC branch targeting SCM 4.1
* JCTVC-S0043 - palette delta QP coding

During integration, it was observed that original software palette design (from SCM 2.0) does not properly handle changing QP’s across CU’s (a functionality that is available in HM using –d options). This issue was brought to attention of palette experts and investigation is ongoing.

The release was announced on the email reflector. The software can be downloaded at   
<https://hevc.hhi.fraunhofer.de/svn/svn_HEVCSoftware/tags/HM-16.4+SCM-4.0/>

The performance of this version against HM-16.2+SCM-3.0 was described according to the common test conditions in JCTVC-S1015. For the lossy 444 configuration, it is reported that this version provides BD-rate reduction of 1.7%, 3.4% and 2.9% for RGB 1080p & 720p text and graphics category in AI/RA/LB configurations respectively and BD-rate reduction of 1.0%, 3.2% and 2.8% for YUV 1080p & 720p text and graphics category in AI/RA/LB configuration, respectively. For the lossless 444configuration, it is reported that this version provides BD-rate reduction of 1.0%, -0.4% and -0.2% for RGB 1080p & 720p text and graphics category in AI/RA/LB configurations respectively and BD-rate reduction of 0.7%, -0.6% and -0.3% for YUV 1080p & 720p text and graphics category in AI/RA/LB configuration, respectively.

Table 1 and Table 2 summarize BD-rate change for lossy and lossless 444 configurations respectively.

Table 1. BD-Rate change in Lossy 444 configuration

|  |  |  |  |
| --- | --- | --- | --- |
|  | **All Intra** | | |
|  | G/Y | B/U | R/V |
| RGB, text & graphics with motion, 1080p & 720p | -1.7% | -3.0% | -2.9% |
| RGB, mixed content, 1440p & 1080p | -1.1% | -2.4% | -2.4% |
| RGB, Animation, 720p | 0.0% | 0.0% | 0.0% |
| RGB, camera captured, 1080p | 0.1% | 0.1% | 0.1% |
| YUV, text & graphics with motion, 1080p & 720p | -1.0% | -2.4% | -2.4% |
| YUV, mixed content, 1440p & 1080p | -1.2% | -2.5% | -2.2% |
| YUV, Animation, 720p | 0.0% | -0.2% | -0.3% |
| YUV, camera captured, 1080p | 0.1% | 0.1% | 0.1% |
| Enc Time[%] | 116% | | |
| Dec Time[%] | 99% | | |
|  |  |  |  |
|  | **Random Access** | | |
|  | G/Y | B/U | R/V |
| RGB, text & graphics with motion, 1080p & 720p | -3.4% | -5.0% | -4.9% |
| RGB, mixed content, 1440p & 1080p | -1.2% | -3.3% | -3.3% |
| RGB, Animation, 720p | 0.2% | 0.0% | -0.2% |
| RGB, camera captured, 1080p | -0.1% | -0.1% | -0.3% |
| YUV, text & graphics with motion, 1080p & 720p | -3.2% | -5.6% | -5.9% |
| YUV, mixed content, 1440p & 1080p | -1.7% | -4.3% | -3.9% |
| YUV, Animation, 720p | 0.3% | -0.3% | -0.2% |
| YUV, camera captured, 1080p | -0.2% | 0.1% | -0.1% |
| Enc Time[%] | 87% | | |
| Dec Time[%] | 87% | | |
|  |  |  |  |
|  | **Low delay B** | | |
|  | G/Y | B/U | R/V |
| RGB, text & graphics with motion, 1080p & 720p | -2.9% | -4.4% | -4.2% |
| RGB, mixed content, 1440p & 1080p | -1.7% | -3.7% | -3.8% |
| RGB, Animation, 720p | 0.1% | -0.1% | -0.2% |
| RGB, camera captured, 1080p | 0.1% | 0.1% | 0.1% |
| YUV, text & graphics with motion, 1080p & 720p | -2.8% | -4.6% | -5.1% |
| YUV, mixed content, 1440p & 1080p | -2.6% | -5.9% | -5.2% |
| YUV, Animation, 720p | 0.1% | -0.1% | -0.2% |
| YUV, camera captured, 1080p | 0.0% | 0.1% | 0.0% |
| Enc Time[%] | 85% | | |
| Dec Time[%] | 86% | | |

Table 2. BD-Rate change in Lossless 444 configuration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **All Intra** | | | |
|  | Bit-rate change (Total) | Bit-rate change (Average) | Bit-rate change (Min) | Bit-rate change (Max) |
|  |
| RGB, text & graphics with motion, 1080p & 720p | -1.0% | -0.9% | -2.9% | 0.2% |
| RGB, mixed content, 1440p & 1080p | -1.1% | -0.9% | -2.3% | 0.2% |
| RGB, Animation, 720p | 0.0% | 0.0% | 0.0% | 0.0% |
| RGB, camera captured, 1080p | 0.0% | 0.0% | 0.0% | 0.0% |
| YUV, text & graphics with motion, 1080p & 720p | -0.7% | -0.6% | -3.2% | 1.0% |
| YUV, mixed content, 1440p & 1080p | -0.5% | -0.4% | -1.6% | 0.3% |
| YUV, Animation, 720p | 0.1% | 0.1% | 0.1% | 0.1% |
| YUV, camera captured, 1080p | 0.0% | 0.0% | 0.0% | 0.1% |
| Enc Time[%] | 111% | | | |
| Dec Time[%] | 97% | | | |
|  |  |  |  |  |
|  | **Random Access** | | | |
|  | Bit-rate change (Total) | Bit-rate change (Average) | Bit-rate change (Min) | Bit-rate change (Max) |
|  |
| RGB, text & graphics with motion, 1080p & 720p | 0.4% | -0.2% | -1.5% | 1.2% |
| RGB, mixed content, 1440p & 1080p | 0.1% | 0.0% | -0.1% | 0.1% |
| RGB, Animation, 720p | 0.7% | 0.7% | 0.7% | 0.7% |
| RGB, camera captured, 1080p | 0.1% | 0.1% | 0.0% | 0.1% |
| YUV, text & graphics with motion, 1080p & 720p | 0.6% | -0.4% | -4.2% | 1.8% |
| YUV, mixed content, 1440p & 1080p | 0.1% | 0.1% | -0.1% | 0.2% |
| YUV, Animation, 720p | 0.5% | 0.5% | 0.5% | 0.5% |
| YUV, camera captured, 1080p | 0.0% | 0.0% | 0.0% | 0.1% |
| Enc Time[%] | 118% | | | |
| Dec Time[%] | 103% | | | |
|  |  |  |  |  |
|  |  |  |  |  |
|  | **Low Delay B** | | | |
|  | Bit-rate change (Total) | Bit-rate change (Average) | Bit-rate change (Min) | Bit-rate change (Max) |
|  |
| RGB, text & graphics with motion, 1080p & 720p | 0.2% | -0.5% | -2.4% | 0.8% |
| RGB, mixed content, 1440p & 1080p | 0.1% | 0.1% | 0.1% | 0.1% |
| RGB, Animation, 720p | 0.2% | 0.2% | 0.2% | 0.2% |
| RGB, camera captured, 1080p | 0.0% | 0.0% | 0.0% | 0.0% |
| YUV, text & graphics with motion, 1080p & 720p | 0.3% | -0.7% | -3.7% | 1.3% |
| YUV, mixed content, 1440p & 1080p | 0.1% | 0.1% | 0.0% | 0.1% |
| YUV, Animation, 720p | 0.0% | 0.0% | 0.0% | 0.0% |
| YUV, camera captured, 1080p | 0.0% | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 126% | | | |
| Dec Time[%] | 117% | | | |

## HM-16.4\_SCM-4.0rc1 and HM-16.3+SCM-3.2

HM-16.4\_SCM-4.0rc1 was tagged on the SVN HHI repository on March 13th 2015 before the release of HM-16.4\_SCM-4.0 to allow proponents to cross-check integrations and interactions with other adoptions. Further minor cleanup and bug fix were done before tagging HM-16.4\_SCM-4.0.

The release was announced on the email reflector. The software can be downloaded at <https://hevc.hhi.fraunhofer.de/svn/svn_HEVCSoftware/tags/HM-16.4+SCM-4.0rc1/>

HM-16.3+SCM-3.2 has been tagged on HHI Server on February 25th 2015 and can be downloaded at <https://hevc.hhi.fraunhofer.de/svn/svn_HEVCSoftware/tags/HM-16.3+SCM-3.2/>

The changes included in this release were:

* Updated SCM codebase to HM 16.3
* Removal of macro’s related to previous integrations.

Bug fix when high bit-depth support is enabled.

The JCT-VC issue tracker at <https://hevc.hhi.fraunhofer.de/trac/hevc/> has been updated to allow bug reports to be entered for SCM, currently under milestone HM+SCC-5.0, version SCC-4.0.

## After SCM-4.0

Several changes were made after the release of SCM-4.0. Among them, the following changes have impact on CTC:

* r4450, fix ticket 1311, which has minor performance impact on 444 lossless coding (when ACT is enabled).
* r4451, Intra BC clean up to align with spec, which requires to signal RPLM for RA coding under CTC (when Intra BC is enabled). Additional bits are signaled at slice header.

# Recommendations

* Continue to develop reference software based on HM16.4\_SCM4.0 and improve its quality and release HM16.4\_SCM4.1.
* Remove macros introduced in previous versions before starting integration towards SCM-3.0 such as to make the software more readable.
* Continue merging with later HM versions.