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**ISO/IEC JTC 1/SC 29/WG 11**

**CODING OF MOVING PICTURES AND AUDIO**

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| **Title** | **V-PCC EE4FE 2.7 on multiple video codec integration in V-PCC software** |
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# Abstract

This document provides a description of the Exploration Experiment on future Extensions 2.7 on multiple video codec integration in V-PCC software.

# Introduction

The goal of the Exploration Experiment on future extensions 2.7 on multiple video codec integration in V-PCC software is to evaluate the video codec agnostic approach in V-PCC solution for various video codecs applied for different components and codec implementations. The video codec implementations used for this benchmarking are based on ffmpeg distribution package [4] and Advace Video Coding[5].

The performance of the approach described in m52889 [3] , m53410 [6] and m53510[7] mare evaluated in the scope of the EE4FE 2.7, in terms of RD performance and computation speed, compared to the reference software for the HEVC standard, the HM video codec, used in TMC2 release-v9.0 [1], release-v8.1 under the CTC conditions [2].

# Mandates

The mandates for CE are as follows:

1. To study the coding performance of separate components and their combinations with the reference HM video codec implementation and the video codecs available in ffmpeg distribution package
2. To generate best practices for video coding of v-pcc components as geometry, attribute and occupancy map using various video coding solutions.
3. To verify the codec-agnostic approach feasibility in the v-pcc architecture
4. To implement carriage of the video components in a sample stream format
5. To evaluate coding parameters for the video components with matching bit-rates and propose corresponding configuration files

# Participants

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(P=proponent, C=crosss checker)

# Methods to be evaluated

## M52889 [V-PCC][SW] on ffmpeg integration in TMC2

The ffmpeg package [4] provides multiple image and video compression technology integrations in a single package. The integration of the ffmpeg implementation of the hevc decoder has demonstrated significant decoder performance improvement. It has been suggested to conduct an expiration experiment that would confirm the possibility of re-using existing video codec capabilities and come up with the best practices for dynamic point cloud compression using the v-pcc codec.

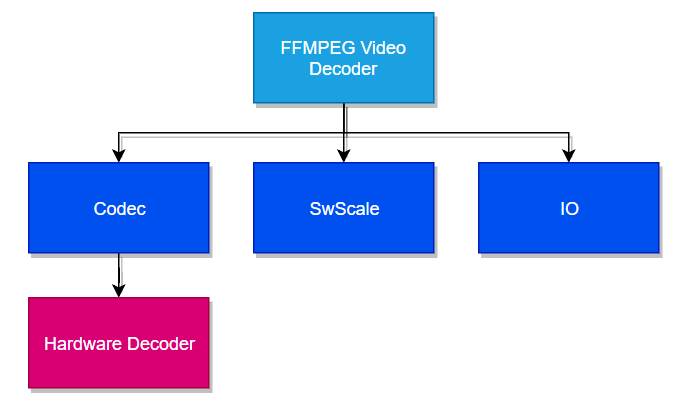


figure. 1. ffmpeg decoder architecture

## [VPCC] [EE4FE 2.7 related] AVC codec integration in V-PCC test model

Today, AVC is the dominant video coding technology used world-wide. A lot of video services use AVC, such as terrestrial broadcasting, direct broadcast satellite TV services, IPTV services…etc. In addition, AVC can provide more hardware friendly implementation compared to HEVC.

In this contribution, we proposed to implement AVC into the V-PCC test model. JM19.0 is the software that has been to integrate into V-PCC TMC2 V9 in this experiment. There is no need to do any modification for the AVC decoder. However, there are some modifications in JM’s configuration files to support the integration of V-PCC. The detail of the modifications are shown in the following table1-3:

*Table 1.The modifications of occupancy map configuration*

|  |  |
| --- | --- |
| Before (encoder.cfg in JM19.0) | After(modifications for PCC) |
| ProfileIDC = 100 | ProfileIDC = 244(High 4:4:4) |
| LevelIDC = 40 | LevelIDC = 51 |
| IntraPeriod = 0 | IntraPeriod = 1 |
| QPISlice = 28 | QPISlice = 0 |
| QPPSlice = 28 | QPPSlice = 0 |
| LosslessCoding = 0 | LosslessCoding = 1 |

*Table 2.The modifications of geometry map configuration*

|  |  |
| --- | --- |
| Before (encoder.cfg in JM19.0) | After(modifications for PCC) |
| LevelIDC = 40 | LevelIDC = 51 |
| IDRPeriod = 0 | IDRPeriod = 2 |
| EnableIDRGOP = 0 | EnableIDRGOP = 1 |
| NumberBFrames = 7 | NumberBFrames = 0 |

*Table 3.The modifications of attribute map configuration*

|  |  |
| --- | --- |
| Before (encoder.cfg in JM19.0) | After(modifications for PCC) |
| LevelIDC = 40 | LevelIDC = 51 |
| IDRPeriod = 0 | IDRPeriod = 2 |
| EnableIDRGOP = 0 | EnableIDRGOP = 1 |
| NumberBFrames = 7 | NumberBFrames = 0 |

## Versatile Video Coding for VPCC

The current VPCC design is video codec agnostic. However, for the current testing procedure in the VPCC test model implementation TMC2, one specific coder needs to be used in order to achieve comparable results for all contributions. Therefore, the HM HEVC coder implementation is used for the video-based coding part. It is interesting to see how using a different video coder influences the behaviour and output of the coding process. Especially for VVC it might also be useful to know whether the achieved gains over HEVC can as well be seen on the type of video content that is produced by TMC2.

*Table 4 - Performance impact of using VVC instead of HEVC (AI, 32 frames)*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Class | D1 | D2 | Luma | Cb | Cr |
| loot | -17.1% | -14.9% | -17.8% | -24.0% | -17.3% |
| redandblack | -23.4% | -23.2% | -23.1% | -20.8% | -6.2% |
| soldier | -12.6% | -12.3% | -16.5% | -28.4% | -28.6% |
| queen | -27.9% | -27.8% | -19.3% | -24.7% | -18.4% |
| longdress | -20.1% | -21.1% | -21.3% | -19.4% | -11.8% |
| basketball | -30.6% | -28.5% | -21.1% | -20.1% | -28.5% |
| dancer | -28.4% | -26.4% | -21.2% | -21.0% | -22.8% |
| AVG | -22.9% | -22.0% | -20.0% | -22.6% | -19.1% |

*Table 5 - Performance impact of using VVC instead of HEVC (AI, full)*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Class | D1 | D2 | Luma | Cb | Cr |
| loot | -16.5% | -14.5% | -17.8% | -24.4% | -18.0% |
| redandblack | -22.8% | -22.5% | -22.9% | -20.5% | -5.9% |
| soldier | -12.5% | -12.5% | -16.6% | -28.3% | -29.8% |
| queen | -26.8% | -26.9% | -19.6% | -27.8% | -22.4% |
| longdress | -21.1% | -21.1% | -21.5% | -21.6% | -12.8% |
| basketball | -30.2% | -28.0% | -21.1% | -19.7% | -27.5% |
| dancer | -28.5% | -26.3% | -20.9% | -20.0% | -22.9% |
| AVG | -22.6 | -21.7% | -20.1% | -23.2% | -19.9% |

*Table 6 - Performance impact of using VVC instead of HEVC (RA, 32 frames)*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Class | D1 | D2 | Luma | Cb | Cr |
| loot | -25.0% | -24.7% | -24.1% | -37.6% | -29.3% |
| redandblack | -26.7% | -27.1% | -24.5% | -29.6% | -19.5% |
| soldier | -25.5% | -25.7% | -26.5% | -40.6% | -41.9% |
| queen | -33.1% | -33.4% | -23.7% | -35.4% | -31.2% |
| longdress | -25.8% | -26.6% | -25.7% | -28.9% | -23.4% |
| basketball | -33.4% | -32.5% | -25.1% | -29.5% | -31.8% |
| dancer | -30.9% | -29.7% | -24.1% | -21.9% | -20.9% |
| AVG | -28.6% | -28.5% | -24.8% | -31.9% | -28.3% |

*Table 7 - Performance impact of using VVC instead of HEVC (RA, full)*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Class | D1 | D2 | Luma | Cb | Cr |
| loot | -24.4% | -23.8% | -33.4% | -33.4% | -27.5% |
| redandblack | -26.0% | -26.3% | -24.2% | -27.1% | -18.7% |
| soldier | -23.6% | -23.9% | -25.2% | -37.3% | -36.8% |
| queen | -32.1% | -32.3% | -23.8% | -37.6% | -32.9% |
| longdress | -27.4% | -27.6% | -26.7% | -31.9% | -25.6% |
| basketball | -32.9% | -31.7% | -24.9% | -26.4% | -29.0% |
| dancer | -30.8% | -29.6% | -24.1% | -21.9% | -20.3% |
| AVG | -28.2% | -27.9% | -24.7% | -30.8% | -27.3% |

# Evaluation

## Item

1. CTC anchor
2. CTC anchor with 3d motion compensation disabled
3. TMC2v9.1 with ffmpeg implementation of the hevc encoder and ffmpeg implementation of the hevc decoder
4. TMC2v9.1 with ffmeg implementation of the avc encoder for occupancy map and geometry and the ffmpeg implementation of the hevc encoder for the attribute coding
5. TMC2v9.1 with ffmeg implementation of the jpeg encoder for occupancy map and geometry and the ffmpeg implementation of the hevc encoder for the attribute coding
6. TMC2v9.1 with ffmeg implementation of the avc encoder for occupancy map and the ffmpeg implementation of the hevc encoder for the geometry and attribute coding
7. CTC anchor with avc encoder for occupancy map and hevc encoder for the geometry and attribute coding.
8. CTC anchor with avc encoder for occupancy map and the ffmpeg implementation of the hevc encoder for the geometry and attribute coding.
9. CTC anchor with avc encoder for occupancy map and the ffmpeg implementation of the avc encoder for the geometry and attribute coding.
10. Additional combinations suggested at the evaluation process

## Test

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test no |  | Component | Occupancy map component | Geometry component | Attribute component |
|  | Codec |  |
| 1.0 | Reference, CTC | | HM16.20 | HM16.20 | HM16.20 + 3DME |
| 1.1 | Reference, constrained | | HM16.20 | HM16.20 | HM16.20 |
| 2.1 | OM-AVC | | AVC | HM16.20 + 3DME | HM16.20 + 3DME |
| 2.2 | OM-HEVC-ffmpeg | | ffmpeg hevc | HM16.20 + 3DME | HM16.20 + 3DME |
| 2.3 | OM-X | | ffmpeg-x | HM16.20 + 3DME | HM16.20 + 3DME |
| 3.1 | GM-HEVC-ffmpeg | | HM16.20 | ffmpeg hevc | HM16.20 + 3DME |
| 3.2 | GM-X | | HM16.20 | ffmpeg-x | HM16.20 + 3DME |
| 4.1 | ATTR-HEVC-ffmpeg | | HM16.20 | HM16.20 + 3DME | ffmpeg hevc |
| 4.2 | ATTR-X | | HM16.20 | HM16.20 + 3DME | ffmpeg-x |
| 5.1 | ffmpeg-hevc | | ffmpeg hevc | ffmpeg hevc | ffmpeg hevc |
| 5.2 | ffmpeg-xyz | | ffmpeg-x | ffmpeg-y | ffmpeg-z |
| 6.1 | OM-JM19 | | JM19.0 | HM16.20 | HM16.20 |
| 6.2 | OM-JM19-GEO-ATTR- ffmpeg-hevc | | JM19.0 | ffmpeg hevc | ffmpeg hevc |
| 6.3 | OM-JM19-GEO-ATTR- ffmpeg-avc | | JM19.0 | ffmpeg avc | ffmpeg avc |
| 7.0 | Additional combinations | | TBD | TBD | TBD |

## BDBR performance

The coding efficiency and runtime are evaluated between 2 items. For the full decoded point cloud, the BDBR in the CTC spreadsheet is used for evaluation.

## Additional software modifications

* A new branch “release-v9.1-hm” was created. In “release-v9.1-hm”, the video encoding and decoding processes use the HM libraries instead of using system commands. It is highly encouraged that integrate and test various codec wrappers in “release-v9.1-hm”.

# Timeline

* 2020-05-08: V-PCC Expected date for release of finalized CE description CTC
* 2020-05-24: V-PCCv10 release software
* 2020-05-30: Expected date for the release of cross-verified TMC2v10 software and anchors
* 2020-06-06: V-PCC CE software and results are released to cross-checkers.
* 2020-06-13: V-PCC Preliminary feed back from cross-checkers to proponents
* 2020-07-01: MPEG document upload deadline
* 2020-07-06: MPEG #131(Geneva) meeting start

# References

1. “V-PCC Test Model v9”, ISO/IEC JTC1/SC29/WG11 MPEG2020 Doc. w19085, Brussels, BE, January 2020
2. “Common Test Conditions for PCC” ISO/IEC JTC1/SC29 WG11 MPEG2020 Doc, w19083, Brussels, BE, January 2020
3. “[V-PCC][SW] on ffmpeg integration in TMC2” , ISO/IEC JTC1/SC29 WG11 (MPEG) input document m52889, Brussels, BE, January 2020
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5. Advanced Video Coding- <https://en.wikipedia.org/wiki/Advanced_Video_Coding>
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7. “[VPCC] Versatile Video Coding for VPCC” , ISO/IEC JTC1/SC29 WG11 (MPEG) input document m53510, Brussels, BE, January 2020