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# Abstract

This document defines common test conditions and software reference configurations to be used in the context of exploration experiments conducted on V3C video content coding tools after the 144th MPEG meeting. These common test conditions are recommended for use in technical contributions to EE2.10 [1] to the 145th MPEG meeting.

# Introduction

Common test conditions (CTC) are desirable to conduct experiments in a well-defined environment and ease the comparison of the outcome of experiments. This document defines testing procedures for development and evaluation of video coding tools for V3C video content. In particular, the document states test content, testing environments and evaluation procedures, as well as anchor results in the attached Excel document.

Currently, there is one test condition considered, as stated in Table 1 below. Condition C0 mirrors video coding in the current V-PCC encoding chain. Condition C0s provides a simplified condition, assuming lossless occupancy coding and focusing on the evaluation on geometry and attribute video. AI coding result reporting is optional at the current stage.

Table 1 List of test conditions and applicability to test model

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Condition** | **Test condition** | **VTM-22.0** | | |
| **AI** | **LD** | **RA** |
| C0 | Lossy Geometry & Attributes – Lossless Occupancy | (✓) |  | ✓ |
| C0s | Lossy Geometry & Attributes – No Occupancy | (✓) |  | ✓ |

The Versatile Video Coding Test Model (VTM) version 22.0 is tested on pre-generated V3C geometry, attribute and occupancy atlas sequences. The VTM software is available at:

<https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/-/tree/VTM-22.0>

The following sections define sequences and encoding parameters to be used for each category. Input contributions on this topic should include a set of results as complete as possible that apply to the proposal. Results should be reported using the attached Excel document.

# Test sequences

Below is a list of the video test sequences generated using test model of V3C [2] to be used for tool evaluation purposes. Each test sequence package consists of three video streams (geometry, attribute, and occupancy with the same dimensions, bit depth and YUV subsampling), a TMC-2 configuration file, and a text file containing MD5 checksum and a link to a corresponding set of original PLY point cloud frames. All test sequences are available in the MPEG content repository accessible under the following URL (accessible with MPEG DMS password):

<https://content.mpeg.expert/data/Explorations/V3C/V1_PCC>

NOTE: Downloaded test material should be verified with MD5 checksums. And can be re-generated using attached configuration file. Each zip file of a test material contains an MD5 file (with the corresponding md5 sums for each file in the archive) and configuration file used to generate the test materials.

Table 2 Test material datasets (number (#) of vertices and faces are expressed per frame).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | atlas | | | |
| sequence | points/frame | framerate | frames | number | width | height | Bit depth |
| basketball\_player\_vox11 | ~ 2,800,000 | 30 fps | 64 | 1 | 2560 | 3536 | 8 |
| football\_vox10 | ~ 600,000 | 30 fps | 150 | 1 | 1280 | 1280 | 8 |
| levi\_vox10 | ~ 600,000 | 30 fps | 150 | 1 | 1280 | 1680 | 8 |
| longdress\_vox10 | ~ 800,000 | 30 fps | 150 | 1 | 1280 | 1584 | 8 |

# Reporting

Proposals will be evaluated based on bit rate, objective quality metrics, and complexity. An Excel sheet is provided together with this document to report the results. Proponents are expected to deliver a full set of results for each targeted testing condition. Each proposal must include modifications to the specification including syntax, semantics, and decoding process description when applicable.

Reference results for the unmodified test models are available on a regular basis.

# Bit rate reporting

Bitrates shall be reported separately for geometry, texture, and occupancy, where applicable. The provided Excel sheet reporting specifies which data shall be reported for which testing conditions. For conditions C0 and C0s the rate shall be reported as Mbit/s (1 Mbit = 1,000,000 bits). The evaluation will be made based on the rate-distortion (RD) performance, and RD curves shall be plotted using PSNR as the quality measure for all categories.

# Distortion reporting

Instead of using the full suite of V-PCC distortion metrics, a simplified distortion metric applied directly to the video sequences shall be used. Proposals shall also report the YUV-PSNR metrics as reported by VTM.

* + 1. **Occupancy-only PSNR for geometry and attribute video**

It was shown that occupancy-only PSNR calculations can simplify V-PCC coding efficiency evaluation, with correlation coefficients of 0.9 and higher between to the established V-PCC end-to-end metrics [3]. The following two metrics shall be reported for experiments under this CTC:

Geometry Occupancy Y-PSNR: MSE calculated for all occupied pixels (occupancy map value at pixel position x, y = 1), between uncompressed geometry video luma channel and compressed geometry video luma channel. PSNR calculated with a maximum value of 255 (8 Bit video).

Texture Occupancy Y-PSNR: MSE calculated for all occupied pixels (occupancy map value at pixel position x, y = 1), between uncompressed texture video luma channel and compressed texture video luma channel. PSNR calculated with a maximum value of 255 (8 Bit video).

# Distortion metric software

A Python script to run the occupancy-only calculations is attached to this contribution. The script requires the following inputs:

* lossless occupancy video,
* reference attribute/geometry video, and
* tested attribute/geometry video

NOTE: It is planned to move from Python to a C++ implementation until the next revision of this document.

# Complexity reporting

The encoder and decoder runtimes shall be reported with respect to the unmodified test model runtimes on the same system as reported by the VTM software. In addition, contributions should contain the following aspects regarding codec complexity:

* theoretical study of the complexity on encoder and decoder, for example number of operations, memory access patterns, floating point operations, etc.;
* theoretical study of the complexity on point cloud encoder;
* interfaces including intermediate memory requirements for pointcloud encoder and decoder to video encoder and decoder;
* execution time with respect to anchor software;
* implications with respect to the video codec type, e.g. chroma subsampling, bit depth, profiles, type, tools;
* implications with respect to the video codec configurations, e.g. multi-layer coding, screen content coding, etc.;
* suitability of the hardware implementation, i.e. avoid floating points, memory usage;
* potential for parallelization and decoder parsing dependency.

# Common Test Conditions for VTM

This sub-section describes the encoding parameter settings applied to the VTM software.

# Software – VTM-22.0

The VVC testing model (VTM) software used for experiments following this CTC is available at:

<https://vcgit.hhi.fraunhofer.de/jvet/VVCSoftware_VTM/-/tree/VTM-22.0>

As of now, tag 22.0 shall be used. Software documentation and usage description are provided in [4].

# Coding parameters and Configuration files

The VTM software supports config file handling via a -c/--config=option command line parameter. Multiple config files may be specified by repeating the option, with settings in later files overriding those in earlier ones.

The common coding parameters are available in the respective directories under the /cfg directory of the provided software. Common VVC SDR content CTC conditions are used [5]. The configuration parameters for each test sequence are attached to this document as file *per-sequence.zip*. Rate points to be used per geometry and attribute video are shown in the table below.

Table 3 Geometry and attribute video rate points.

|  |  |  |
| --- | --- | --- |
|  | QP | |
| Rate point | Geometry video | Attribute video |
| R0 | 20 | 27 |
| R1 | 24 | 32 |
| R2 | 28 | 37 |
| R3 | 32 | 42 |
| R4 | 36 | 47 |

### Coding parameters and Configuration files for test condition C0

Condition C0 uses common VVC CTC conditions for geometry and attribute video. Occupancy video is coded lossless.

### Coding parameters and Configuration files for test condition C0s

Condition C0s uses common VVC CTC conditions for geometry and attribute video. Occupancy video is not considered.

### Sub-sampling for AI configuration

For the “All Intra” configurations a temporal subsampling of the sequences is performed. A sub-sampling factor of 8 is used, i.e. only every 8th frame is coded. Bit rates are calculated using the resulting frame rate (i.e. original frame rate / 8). The subsampling can be enabled in the reference software using the parameter TemporalSubsampleRatio. The parameter is included in the VTM AI configuration file.

### Command line examples

Below is a selection of command line examples to create the CTC conditions:

# C0 AI

./EncoderApp -c cfg/encoder\_intra\_vtm.cfg -c cfg/per-sequence/Levi\_geo.cfg --QP=20

./EncoderApp -c cfg/encoder\_intra\_vtm.cfg -c cfg/per-sequence/Levi\_att.cfg --QP=27

./EncoderApp -c cfg/encoder\_intra\_vtm.cfg -c cfg/lossless/lossless.cfg -c cfg/per-sequence/Levi\_ocm.cfg

# C0 RA

./EncoderApp -c cfg/encoder\_randomaccess\_vtm.cfg -c cfg/per-sequence/Levi\_geo.cfg --QP=20

./EncoderApp -c cfg/encoder\_randomaccess\_vtm.cfg -c cfg/per-sequence/Levi\_att.cfg --QP=27

./EncoderApp -c cfg/encoder\_randomaccess\_vtm.cfg -c cfg/lossless/lossless.cfg -c cfg/per-sequence/Levi\_ocm.cfg

# C0s AI

./EncoderApp -c cfg/encoder\_intra\_vtm.cfg -c cfg/per-sequence/Levi\_geo.cfg --QP=20

./EncoderApp -c cfg/encoder\_intra\_vtm.cfg -c cfg/per-sequence/Levi\_att.cfg --QP=27

# C0s RA

./EncoderApp -c cfg/encoder\_randomaccess\_vtm.cfg -c cfg/per-sequence/Levi\_geo.cfg --QP=20

./EncoderApp -c cfg/encoder\_randomaccess\_vtm.cfg -c cfg/per-sequence/Levi\_att.cfg --QP=27

# References

[1] EE 2.10 on tools for V3C video coding, WG07, N0755, Hannover, October 2023, <https://dms.mpeg.expert/doc_end_user/current_document.php?id=90648&id_meeting=196>

[2] <http://mpegx.int-evry.fr/software/MPEG/3dgh/v-pcc/software/mpeg-pcc-tmc2/-/tree/V3CBitstreamsWithoutVideoBitstreams>

[3] S. Schwarz, M.M. Hannuksela, „Occupancy-only PSNR calculations for V3C V-PCC coding evaluation”, JVET-AE0092,

<https://jvet-experts.org/doc_end_user/current_document.php?id=13040>

[4] <https://jvet.hhi.fraunhofer.de/>

[5] VVC Common Test Conditions for SDR video (JVET-T2010)   
<https://jvet-experts.org/doc_end_user/current_document.php?id=10545>