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# Abstract

This document is draft 1 of a conformance testing specification for Versatile Video Coding (VVC).

# General

This document provides a preliminary description of a conformance testing bitstream set and testing process for VVC. See clause 3 for a preliminary list of planned bitstreams and volunteered contributors. It is encouraged for participants to contribute additional bitstreams that test other features and combinations.

# Procedure

## ftp site

An ftp site at ITU-T is used to exchange bitstreams. The site for ftp download of bitstreams is:

<ftp://ftp3.itu.int/jvet-site/bitstream_exchange/>

(user id: avguest, password: Avguest201007)

Use FileZilla site manager configured to “Require implicit ftp over TLS”.

The site is also accessible by HTTP (without a password) at:

<http://wftp3.itu.int/av-arch/jvet-site/bitstream_exchange>

A spreadsheet to summarize the status of bitstream exchange, conformance bitstream generation will be available at this directory. (See clause 3 for a preliminary list of planned bitstreams.) It includes the list of bitstreams, configuration features and settings, and status of verification.

The ftp site for *uploading* bitstream files is as follows:

<ftp://ftp3.itu.int/jvet-site/dropbox/>

(user id: avguest, password: Avguest201007)

Use FileZilla site manager configured to “Require implicit ftp over TLS”.

The guest account has write access to the dropbox, but not read access. Once a bitstream is uploaded to the dropbox, please send email to [xx@xx.com](mailto:xx@xx.com) to notify the coordinators of its availability. After some potential checking, the bitstream will be moved to the downloading area of the ftp site.

## Bitstream files

Volunteers should upload the bitstream and associated files in a zip archive. All files inside the zip archive should have the same base name. Only the extension is changed in the following way:

\*.bit – bitstream as described in section 2.3 (mandatory)

\*.txt – description (mandatory)

\*.yuv.md5 – MD5 check sum of the complete decoded yuv file (mandatory)

\*.md5 – MD5sum of the bitstream file (mandatory)

\*.opl – output picture log as described in section 2.4 (mandatory)

\*.cfg – config file used to generate bitstream with VTM encoder SW (optional, not applicable if VTM encoder release version not used)

All bitstreams are required to use the decoded picture hash SEI message to enable validity checking.

The following naming convention is to be used.

*Feature\_BistreamID\_Source\_VersionLetter*

* *Feature* is summarized in Sec. 2
* *BitstreamID* is a single capital letter, used when more than one bitstream is used for a particular feature.
* *Source* is the name of the company who provided the bitstream. [Ed. (JB): Should this still be included in the file names?]
* *Version* is the version number of the file, in case a bitstream must be replaced because of an identified problem (starting from 1.)

For example, if you archive is named "feature\_A\_companyA\_1.zip", the files would be named

feature\_A\_companyA\_1.bit

feature\_A\_companyA\_1.txt

feature\_A\_companyA\_1.yuv.md5

feature\_A\_companyA\_1.md5

feature\_A\_companyA\_1.opl

feature\_A\_companyA\_1.cfg

## Description of the bitstream (name.txt)

In a short text file which describes the bitstream, the following information should be provided.

* Bitstream file name
* Explanation of bitstream features
* Profile, tier, and level for the bitstream
* Max picture width and height, and any additional picture width and height values used (i.e., for reference picture resample or scalability)
* Picture rate
* VTM release version number used to generate the bitstream, if applicable
* Contact name and email (to be confirmed; please check with the coordinators)

## Output picture log file for each output layer set (name.opl)

Per picture in output order: Picture width, picture height, MD5sum for each of Y, U, and V

Each output picture log file contains one row for each output picture in the bitstream, in output order.

Each row contains the following information, as CSV.

* PicOrderCntVal
* pic\_width\_max\_in\_luma\_samples
* pic\_height\_max\_in\_luma\_samples
* MD5 checksum for the Y component
* MD5 checksum for the U component
* MD5 checksum for the V component

[Ed. (JB): Support to be added to the VTM SW to output this log file, and command line option provided here.]

## Acceptance of bitstreams

The uploaded bitstreams should be verified by at least two organizations. The following aspects should be verified.

* Confirm if bitstream is decoded with perfect match
* Confirm if all intended features are included in the bitstream

## Recommendations

Test bitstreams should exercise the full range of parameters of modes of the tool tested in the category, including corner cases.

It is recommended to include both low resolution (512x512) and short duration (10 frame) test bitstreams as well as typical resolutions and longer duration test bitstreams for each test category.

# Conformance bitstream list

The conformance bitstreams are listed in three categories, described below.

Table 1: Coding tools

* Streams with a minimum “basic” set of coding tools, where all the coding tools for which an enable flag is present in the syntax has the enable flag set to 0 to disable the corresponding tool.
* Streams with a single coding tool enabled.
* Streams with sets of varying combinations of coding tools enabled.

The purpose of these streams is to check that the decoder can correctly decode combination of tools and particular cases due to the interaction of tools and coding modes (i.e. IBC and dual tree, LMCS and dual tree, palette and DB, DB and trans-quant bypass, etc.).

In addition, Table 1 contains streams whose purpose is to check that the decoder can properly decode minimum and maximum parameters and syntax elements of basic coding tools, i.e. CTU partition, transform, quantization, etc.

Table 2: Features and high-level syntax

* Streams with multiple coding tools and high-level syntax features.

The purpose of these streams is to check that the decoder can correctly decode combination of tools and features & High Level Syntax, and particular cases due to the interaction between tools and features & High Level Syntax (i.e. loop filters across slices and sub-pictures, loop filters and virtual boundaries, etc.). These streams also check that the decoder can correctly decode all the features supported in VVC (i.e. spatial scalability, gradual decoder refresh, etc.).

Table 3: Bit depths and chroma formats

* Streams with all allowable combinations of bit-depth and chroma formats for the supported profiles

4:4:4 specific coding tools should be enabled in 4:4:4 streams.

**Table 1: Coding tools**

(10-bit 4:2:0 is used in all the bitstreams in this table.)

|  |  |  |  |
| --- | --- | --- | --- |
| **Tool description** | **Feature**  **Name** | **Bitstream features** | **Submitter** |
| Tool set 0 | SET0 | Basic set, with all tools with enable flags disabled |  |
| Tool set 1 | SET1 | ???? |  |
| Tool set 2 | SET2 | SET1 + ???? |  |
| Tool set 3 | SET3 | SET2 + ???? |  |
| CTC tool set | SETCTC | All tools enabled in CTC version X |  |
| Chroma separate tree | CST |  | Tzu-Der Chuang (MediaTek) |
| Dependent quantization | DQ |  | H. Schwarz (HHI) |
| Cross-component linear model | CCLM | Exercise different variants of down-sample filters  Corner cases for liner model parameters | Alexey Filippov (Huawei) |
|  |  | Corner cases for enabling conditions of coding structures | Kei Kawamura (KDDI) |
| Multiple transform set | MTS | include MTS combinations of (intra, inter): (implicit, none), (explicit, none), (implicit, explicit), (explicit, explicit) | Moonmo Koo (LGE)  Mehdi Salehifar (LGE) |
| Adaptive loop filter | ALF | ALF virtual boundary processing for line buffer reduction | Anand Meher Kotra (Huawei) |
|  |  | Exercise clipping values of Non-linear ALF | Kyohei Unno (KDDI) |
| Affine motion model | AFF | include Affine AMVP and | Chen Huanbang (Huawei) |
|  |  | Affine Merge;  Control flags |  |
| Subblock-based temporal merging candidates | SbTMVP |  |  |
| Adaptive motion vector resolution | AMVR | include SIF | M. Winken (HHI) |
| Triangular partition mode | TPM | include triangle part. pred. | C.-W Kuo  (Panasonic) |
| Bi-directional optical flow | BDOF |  | Ching-Yeh Chen (MediaTek) |
| Combined intra/inter prediction | CIIP |  | Chih-Wei Hsu (MediaTek) |
| Merge with MVD | MMVD |  | Kiho Choi (Samsung) |
| Bi-predictive with CU weights | BCW |  | Ching-Yeh Chen (MediaTek) |
| Multi-reference line prediction | MRLP |  | B. Bross (HHI) |
| Intra block copy mode | IBC |  |  |
| Intra sub-partitioning | ISP |  | S. de Luxan Hernandez (HHI) |
| Decoder motion vector refinement | DMVR | Exercise enabling conditions, MV wraparound and MV clip at picture boundary | Semih Esenlik (Huawei) |
|  |  | Exercise corner cases of SAD variations | Kyohei Unno (KDDI) |
| Sub-block transform | SBT | Different block sizes; control flag | Zhao Yin (Huawei) |
| Luma mapping with chroma scaling | LMCS | Exercise multiple APSes | T. Lu (Dolby) |
| Sign data hiding | SDH |  | T. Lu (Dolby) |
| Symmetric motion vector difference | SMVD | Long-term reference handling  mvd\_l1\_zero\_flag handling | Chen Huanbang (Huawei) |
| Quantized residual DPCM | RDPCM |  |  |
| Matrix based intra prediction | MIP |  | J. Pfaff (HHI) |
| Low frequency non-separable transform | LFNST | Various block sizes /shapes  Combinations with intra coding tools | Moonmo Koo (LGE)  Mehdi Salehifar (LGE)  M. Siekmann (HHI) |
| Transform tool set | MTS, LFNST | Tool on or off of MTS and  LFNST together with implicit or explicit MTS | Moonmo Koo (LGE)  Mehdi Salehifar (LGE) |
| Joint coding of chrominance residuals | JCCR |  | H. Schwarz (HHI) |
| Temporal motion vector predictor | TMVP |  |  |
| Sampled adaptive offset | SAO |  | Kiho Choi (Samsung) |
| Prediction refinement using optical flow | PROF | Various non-translational motion parameters for PROF | Yuwen He (InterDigital) |
| Deblocking | DBF | Exercise luma adaptive deblock filter and long tap filter | K. Andersson (Ericsson) |
|  |  | Deblocking at 4 x 4 grid | Anand Meher Kotra (Huawei) |
| Adaptive loop filter | ALF | Use multiple APSes |  |
| Weighted prediction | WP | Various combinations with other inter tools | Philippe Bordes (InterDigital) |
| Intra prediction | IP | Enable all modes, especially the wide-angle modes. | Alexey Filippov (Huawei) |
| Luma intra prediction mode | MPM | Enable all conditions to generate MPM candidate | Jin Heo(LGE) |
| CTU sizes | CTU | Exercise range of CTU, CU sizes | Chih-Wei Hsu (MediaTek) |
|  | CU |  |  |
| Trees and partitioning | BT | Exercise range of sizes and depths of BT, TT, QT | A. Wieckowski (HHI) |
|  | TT |  | Chih-Wei Hsu (MediaTek) |
|  | QT |  |  |
| Boundary partition |  | Boundary are sizes 8…120 samples, all combinations of QT and BT | Han Gao (Huawei) |
| Transform |  | min and max transform |  |
|  |  | min number of entropy coded coeff. |  |
|  |  | max number of coeff. |  |
| Quantization |  | CU level delta QP  CU level Chroma delta QP  transform-quant bypass with DB |  |
| Scaling list |  | Exercise multiple APSes  Quantization Matrices | Philippe de Lagrange (InterDigital) |
| Entropy coding |  | max bins and bits |  |
|  |  | min bits |  |
| All merge modes |  | max number of merge candidates |  |
| Position dependent prediction combination (PDPC) |  | Force clipping. Different PU sizes and shapes. |  |
| Palette mode |  | For 4:4:4 |  |

**Table 2: Features and high-level syntax**

|  |  |  |  |
| --- | --- | --- | --- |
| **Tool description** | **Feature**  **Name** | **Bitstream features** | **Submitter** |
| Tile rows / columns |  | pictures partitions in tiles, bricks and slices  Different tile sizes in same picture  loop filters on/off |  |
|  |  | loop filters on/off across | Y.-K. Wang (Futurewei) |
| Slices |  | raster-scan slices |  |
|  |  | rectangular slices |  |
|  |  | loop filters on/off across |  |
| Sub-pictures |  | various number of sub-pictures | Y.-K. Wang (Futurewei) |
|  |  | sub-pictures of varying sizes |  |
|  |  | multiple tiles in some sub-pictures |  |
|  |  | loop filters on/off across |  |
| Reference picture resizing |  |  |  |
| Ref pic wrap-around |  |  |  |
| Spatial scalability |  | Exercise Inter-layer ref pic list | Y.-K. Wang (Futurewei) |
| Temporal scalability |  |  |  |
| Lossless and near-lossless |  |  | T. Nguyen |
| Transform skip |  |  | T. Nguyen |
| Gradual decoder refresh |  |  | R. Sjöberg (Ericsson) |
| Reference picture lists |  |  | R. Sjöberg (Ericsson) |
| Long term ref picture |  |  | R. Sjöberg (Ericsson) |
| Virtual boundaries |  | Loop filters on/off at non-tile/slice boundaries |  |
| 360 Video w/ cube map layout and SEI |  |  |  |
| 360 Video bitstream created using sub-picture extraction & merging |  |  |  |
| Wavefronts |  |  |  |
| Conformance cropping window |  |  |  |
| Transfer characteristics |  | PQ, HLG | PQ: T. Lu (Dolby) |
| NAL unit type |  | Exercise all types, including STSA and random access |  |

**Table 3: Chroma formats and bit depths**

|  |  |  |  |
| --- | --- | --- | --- |
| **Tool description** | **Feature**  **Name** | **Bitstream features** | **Submitter** |
| 8b 4:0:0 |  | Main 10 profile |  |
| 8b 4:2:0 |  | Main 10 profile |  |
| 8b 4:2:2 |  | Main 4:4:4 10 profile |  |
| 8b 4:4:4 |  | Main 4:4:4 10 profile |  |
| 10b 4:0:0 |  | Main 10 profile |  |
| 10b 4:2:2 |  | Main 4:4:4 10 profile |  |
| 10b 4:4:4 |  | Main 4:4:4 10 profile |  |