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Coding of Still Pictures

JBIG	**JPEG**
Joint Bi-level Image Experts Group	Joint Photographic Experts Group

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Final Call for Proposals for a Next-Generation Image Coding Standard

Summary

The JPEG Committee has launched the Next-Generation Image Coding activity, also referred to as JPEG XL. This activity aims to develop a standard for image coding that offers substantially better compression efficiency than existing image formats (e.g. >60% over JPEG), along with features desirable for web distribution and efficient compression of high-quality images.

This document is the final Call for Proposals (CfP) for a Next-Generation Image Coding Standard, and has been issued as outcome of the 79th JPEG meeting, La Jolla, USA, 9-15 April 2018. The deadline for expression of interest and registration is August 15, 2018. Submissions to the Call for Proposals are due September 1, 2018.

1. Background

1.1 Introduction

The need for efficient image compression is self-evident, when taking into account that billions of images are captured, created, uploaded, and shared daily. Applications are becoming increasingly image-rich, and websites and user interfaces (UIs) rely on images for sharing experiences and stories, visual information and appealing design.

On the low end of the spectrum, UIs can target devices with stringent constraints on network connection and/or power consumption. Even though network download speeds are improving globally, in many situations bandwidth is constrained to speeds that inhibit responsiveness in applications. On the high end, UIs utilize images that have larger resolutions, higher dynamic range and wider color gamut, as well as higher bit depths, which leads to a further explosion of image data.

For most applications, JPEG, PNG and WebP are still used as the primary coding formats. More efficient compression will benefit the described applications, and will lead to reduced network transmission times and more interactive applications.

When compared to video data, images can be stored with relatively few bits. Still, websites and UIs can contain hundreds of images, or several high-resolution images, leading to several megabytes worth of data – which could be equivalent to more than a minute of video. While video streams can be buffered before playback, image-based UIs have to be responsive and interactive, without several seconds of loading and stalling when downloading or scrolling.

Newer image formats with more efficient compression performance than JPEG have been developed over the last decades, but these formats have various shortcomings with respect to the use cases detailed below.

Recently, evidence has been presented of compression technologies that outperform image coding standards in common use. For example, in the conclusions of the Grand Challenge comparisons held at the Picture Coding Symposium (PCS 2015) [1] and the IEEE Conference on Image Processing (ICIP 2016) [2], it was reported that "there is evidence that significant improvements in compression efficiency can be obtained using latest state of the art in lossy and lossless cases". Several metrics showed the HEVC HM encoder with SCC extensions [3] to be superior according to most metrics, and for most test images. Subjectively, Daala [4] was competitive, with a limited difference in MOS scores between HEVC and Daala. Despite these technical advances, no widespread standard is available that has state-of-the-art compression performance, and is widely supported in consumer devices and browsers.

This new JPEG activity aims to develop a new image coding standard that provides state-of-the-art image compression performance, and that addresses shortcomings in current standards. To encourage widespread adoption, an important goal for this standard is to support a royalty-free baseline.

1.2 Scope

The next-generation image coding activity aims to develop an image coding standard that offers:

- Significant compression efficiency improvement over coding standards in common use at equivalent subjective quality, e.g. >60% over JPEG.
- Features for web applications, such as support for alpha channel coding and animated image

sequences.

- Support of high-quality image compression, including higher resolution, higher bit depth, higher dynamic range and wider color gamut coding.

2. Timeline

The intended timeline for the evaluation of the proposals is the following:

09-15/04/2018	WG1 meeting (La Jolla): Final Call for Proposals issued.
11/06/2018	JPEG XL AHG meeting (Brussels) for anchor generation and final selection of content, bitrates and metrics.
06/07/2018	Report on objective and subjective quality evaluation for anchors available.
07-13/07/2018	WG1 meeting (Berlin): review of anchor evaluation results and agreement on final test set and evaluation procedures. Issue amendment to Call for Proposals regarding final content, bitrates and metrics.
15/08/2018	Deadline for expression of interest and registration – send emails to the people listed in Section 9.
01/09/2018	Deadline for submission of binaries, algorithm description and design, and encoded-decoded test material.
12/10/2018	Report on objective and subjective evaluation of proposals and anchors available.
13-19/10/2018	WG1 meeting (Vancouver). Assessment of technical proposals and objective/subjective evaluation results (attendance of proponents to the meeting is required).

The intended timeline for the standardization process is as follows:

October 2018	WD
January 2019	CD
April 2019	DIS
October 2019	IS

3. Use Cases

This section presents a list of use cases that motivate the need for a new image coding standard.

3.1 Image-rich UIs and web pages on bandwidth-constrained connections

Web sites and user interfaces become more and more image-driven. Images play a major role in the interaction between users, the selection of topics, stories, movies, articles and so on. In these UIs, formats are preferred that are widely supported in browsers and/or CE devices, such as JPEG, PNG and WebP.

3.1.1 Social media applications

Billions of user-generated images are captured and uploaded daily. After uploading, the images are typically converted into multiple quality versions and formats and stored on content delivery network (CDN) servers. More efficient image compression will aid to distribute social media images to users worldwide, including to locations with limited connectivity or low-bandwidth mobile connections. Image formats need to be supported that are widely supported on consumer devices, such as smartphones and tablets, and on browsers. Compression efficiency is key in delivering the images to devices over low-bandwidth connections, and in making the UIs and web sites as responsive as possible.

3.1.2 Media distribution applications

In many media distribution applications, UIs and web sites contain a wide array of artwork images that guide users through the catalog. Images are typically derived from high-quality studio shots, artwork or movie/show masters. Derived images can include natural and synthetic images, transparent overlays, multilingual text, animation, gradients etc. Multiple quality/resolution versions of the same image are finally encoded, and stored in the CDN. The UIs can contain hundreds of images, ranging from small thumbnail-like images to screen-spanning billboard images.

3.1.3 Cloud storage applications

Cloud storage applications amass a huge amount of images captured by users. After uploading, these images are stored on servers either as a copy, or after a lossless [5] or lossy transcoding operation. For browsing and timeline-style thumbnail generation, lossy transcoding can be performed to more efficient formats, lower resolutions, and preview images. Both for storage and browsing, more efficient formats are desirable.

3.1.4 Media web sites

Images are captured by news agencies, journalists and users, and are selected for publication on media web sites. Images can range from high resolution to thumbnail-size, resulting in web pages that contain dozens of megabytes worth of images.

3.1.5 Animated image applications

For increased interactivity and expressing emotions, animated image sequences have become very popular. The wide majority of animated image sequences currently rely on the GIF image format, which suffers from inefficient compression and a limited color palette.

3.2 High-quality imaging applications

On the high end, UIs utilize images that have larger resolutions and higher bit depths, and the availability of higher dynamic range and wider color gamut is a benefit for vivid color imagery. 4K TVs are becoming mainstream, and HDR/WCG technology is picking up, leading to a shift to high-quality UIs.
Although these higher-end applications typically target more stable network connections, transmission of multiple high-quality images still takes a significant time on most current network connections. A new standard should provide efficient compression and high visual quality for these applications.

Images in these applications can contain a mixture of natural images and synthetic elements (overlays, multilingual text, gradients etc.). A new standard should include coding tools that can efficiently compress synthetic content while avoiding visible quality artifacts (e.g. aliasing, banding).

3.2.1 HDR/WCG user interfaces

In many applications, such as on-demand video services and gaming, HDR/WCG images are necessary to support HDR/WCG video or to increase user experience. Current popular image formats do not allow for representation of HDR/WCG content. A new HDR/WCG image coding standard is needed to efficiently cope with such applications.

3.2.2 Augmented/virtual reality

Applications such as augmented reality, virtual reality, and 360-degree images require high-resolution images that need to be efficiently compressed. For these high-resolution images, region-of-interest coding is a desirable feature to support interactive applications.

4. Requirements

This section presents the requirements that should be met by the proposals so as to be suitable for the above described use cases. Requirements are split between "core requirements" which are essential and "desirable requirements" which are nice to have and will be decided depending on their cost. The latter are not strictly required for a proposal to be eligible and evaluated. However, if some additional/optional features are present, this will be taken into account in their assessment.

4.1 Uncompressed image attributes

This CfP targets image coding technology that can at least support images with the following attributes:

- Image resolution: from thumbnail-size images up to at least 40 MP images.
- Transfer functions including those listed in BT. 709 [10] and BT. 2100 [11].
- Bit depth: 8-bit and 10-bit.
- Color space: at least RGB, YCbCr, ICtCp.
    - Input type of the encoder shall match output type of the decoder.
    - Internal color space conversion is permitted (as part of the proposal).
- Color primaries including BT. 709 and BT. 2100.
- Chrominance subsampling (where applicable): 4:0:0, 4:2:0, 4:2:2, and 4:4:4.
- Different types of content, including natural, synthetic, and screen content.

A desirable attribute for submitted technology is the support of up to 12 bit for non-linear images and up to 16 bit for linear images.

4.2 Compressed bitstream requirements

Submissions shall cover at least the core requirements, and are encouraged to cover desirable requirements as well.

Core requirements
Significant compression efficiency improvement over coding standards in common use at equivalent subjective quality.
Hardware/software implementation-friendly encoding and decoding (in terms of parallelization, memory, complexity, power consumption)
Support for alpha channel / transparency coding.
Support for animation image sequences.
Support for 8-bit and 10-bit bit depth.
Support for high dynamic range coding.
Support for wide color gamut coding.
Support for efficient coding of images with text and graphics.
Desirable requirements
Support for higher bit depth (e.g. 12 to 16-bit integer or floating-point HDR) images.
Support for different color representations, including Rec. BT.709, Rec. BT.2020, Rec. BT.2100, LogC.
Support for embedded preview images
Support for very low file size image coding (e.g. <200 bytes for 64×64 pixel images) [6].
Support for lossless alpha channel coding.
Support for a low-complexity profile.
Support for region-of-interest coding.

5. Royalty-free goal

The royalty-free patent licensing commitments made by contributors to previous standards, e.g. JPEG 2000 Part 1, have arguably been instrumental to their success. JPEG expects that similar commitments would be helpful for the adoption of a next-generation image coding standard.

6. Call for Proposals Details

This CfP invites proponents to submit technology contributions that fulfill the scope, objectives, requirements and use cases therein. Proponents are expected to present their proposals at the 81st WG1 meeting in Vancouver. Proponents are also reminded that they are expected to contribute to the standardisation process, as described in Section 7, and attend meeting and present their findings, as specified in Section 2.

6.1 Submission requirements

A submission shall consist of the elements specified in Annex A. All the elements to be submitted, excluding the decoded images, should be uploaded to the WG1 document registry. For the decoded images, instructions will be provided after the expression of interest and registration. Those proponents without access to the registry should contact the WG1 members listed in Section 9.

6.2 Evaluation of proposals

The committee plans to select technologies to be included in the standard based on satisfying the requirements and evaluating the results obtained through the evaluation procedure documented in Annex B. The subjective evaluation results will be the primary attribute for the decision making process.

6.3 IPR conditions (ISO/IEC Directives)

Proponents are advised that this call is being made in the framework and subject to the common patent policy of ITU-T/ITU-R/ISO/IEC and other established policies of these standardization organizations. The contact persons named in Section 9 can assist potential submitters in identifying the relevant policy information.

7. Contribution to Standardization

Proponents are informed that based on the submitted proposals, a standard specification will be created. If they submit a proposal and (part of) the proposed technology is accepted for inclusion in the standard, they will be expected to attend subsequent WG1 meetings and contribute to the creation of the relevant documents. Within this process, evolution and changes are possible as several technologies may be combined to obtain a better performing solution.

8. JPEG XL e-mail reflector information

E-mail reflector: jpeg-xl@jpeg.org
In order to subscribe to the mailing list send an e-mail (its content is unimportant) to the address: jpeg-xl-request@jpeg.org.

9. Contacts

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Seungcheol Choi (AHG Co-Chair)
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ANNEX A – SUBMISSION REQUIREMENTS

The process to evaluate proposals will be done following the timeline defined in Section 2. The successive deliverables are further defined hereunder. In addition to documents and binaries to be submitted, proponents are reminded that they are expected to contribute to the standardisation process, as described in Section 7.

A.1. Proposal overview

The proposal overview shall include:

- A high-level description of the proposal including block diagrams of encoder and decoder.
- Arguments on why the proposal is meeting the requirements.

Accepted formats for the submission are Word and PDF. Presentations can be in PowerPoint or PDF.

A.2. Binary encoder/decoder executables and scripts

Proponents need to submit separate encoder and decoder executable programs (statically linked Linux executables with all required libraries and system dependencies), configurable via command line or configuration file. Binaries should preferably be optimized software meeting the performance requirements described above in order to speed up the evaluation process.
Proponents can choose to use executable compression or similar tools to prevent reverse engineering or disassembly of the submitted executable files.
Proponents shall provide the command-line parameters intended to be used for encoding/decoding, and shall provide scripts to run their executable in the objective evaluation framework detailed below. More information on the evaluation framework, along with a list of test material and target bitrates is provided in Annex B.1.

A.3. Encoded-decoded material and results

Proponents need to submit the final test material processed by their coding system:

- Encoded codestreams for the test images listed in Annex B.1.
- The corresponding decoded images for subjective evaluation.
- Encoding-decoding evaluation results, according to the objective quality evaluation described in Annex B.1.4.2.

A.4. Algorithm and design description

Each proposal shall include a presentation that provides a detailed description of the proposed algorithm and codec design. This presentation shall be in Word document and PDF format. The presentation shall clearly explain how the proposed algorithm meets the requirements described above: quality, complexity, and additional features.

A.5. Technical documentation

If (part of the) the proposal has been selected to be part of the upcoming standard, a technical description of the selected technology shall be provided. This includes:

- Description of operations, as described in algorithm and design description.
- Coded bitstream syntax.
- Coding process (encoding and decoding) methodology.

The description shall include all necessary processing (including performance optimizations) that are used to create the bitstream in a bit-exact manner.

A.6. Complexity analysis

Proponents are invited to submit an evaluation of the complexity of their algorithm. Such evaluation shall include:

- Encoder/decoder runtimes as measured on the test images in Annex B.1.2, as a percentage of the JPEG 2000 anchor.
- A detailed block diagram of the proposed encoder/decoder showing the algorithmic blocks and flow of the data.
- An explanation of the achievable parallelism of the algorithmic blocks for both the encoder and the decoder.
- All information available at the time of submission showing the performance of the encoder and decoder once implemented in software (including overall encoding/decoding time, encoding/decoding time per algorithmic block, memory usage).

A.7. Verification model source code

Proponents agree to release source code to serve as (part of) a Verification Model (VM), written in a high-level language, such as C or C++, if parts of their technology are selected in the evaluation process. Source code shall be documented and understandable. All libraries used by the source code shall be either public or provided in source code form with ISO/IEC and ITU-T compliant terms.

Make files or project files need to support compilation on at least Linux. The compiled decoder should correctly decode any codestream generated by the submitted encoder executable binary. Moreover, the compiled decoder and the submitted decoder executable binary shall both generate the exact same output.

ANNEX B – EVALUATION PROCEDURES

B.1. Test material

B.1.1. General

Test material consists of the still images detailed in Annex B.1.2. All test material is available to proponents on an FTP server for the purpose of this standardisation project only. Proponents shall email the contacts listed in Section 9 to receive the login information required to access the test images, together with copyright information related to this test material.

B.1.2. Image Data

Test images include natural (color and grayscale), computer generated and screen captured content, and HDR/WCG images.

A full list of the used images is provided in the following table:

Class A: Natural images (color)	**Class B: Natural images (grayscale)**
- 8-bit, 4:4:4: o ARRI_Lake2_2880x1620p_24_8b_bt709_444_0000.ppm o ARRI_PublicUniversity_2880x1620p_24_8b_bt709_444_0000.ppm o BIKE_2048x2560_8b_RGB.ppm o bike3.ppm o bird_of_paradise.ppm o CAFE_2048x2560_8b_RGB.ppm o FemaleStripedHorseFly_1920x1080_8b.ppm o HintergrundMusik_1920x1080_8b.ppm o honolulu_zoo.ppm o oahu_northcoast.ppm o p01.ppm o p04.ppm o p06.ppm o p08.ppm o p10.ppm o p14.ppm o p26.ppm	- 8-bit: o AERIAL2_2048x2048_8b_Y.pgm o CATS_3072x2048_8b_Y.pgm o COMPOUND2_5120x6624_8b_Y.pgm o FINGER_512x512_8b_Y.pgm o GOLD_720x576_8b_Y.pgm o HOTEL_720x576_8b_Y.pgm o MAT_1528x1146_8b_Y.pgm o SEISMIC_512x512_8b_Y.pgm o TEXTURE1_1024x1024_8b_Y.pgm o TEXTURE2_1024x1024_8b_Y.pgm o TOOLS_1524x1200_8b_Y.pgm o ULTRASOUND_512x448_8b_Y.pgm o WATER_1465x1999_8b_Y.pgm - 12-bit: o XRAY_2048x1680_12b_Y.tif o noise_3840x2160_12b.tif

o TOOLS_1520x1200_8b_RGB.ppm o VQEG_CrowdRun_3840x2160p_50_8b_bt709_444_07111.ppm o VQEG_ParkJoy_3840x2160p_50_8b_bt709_444_15523.ppm o WALTHAM1_3600x2600_8b_RGB.tif o WALTHAM2_3800x2600_8b_RGB.tif o WOMAN_2048x2560_8b_RGB.ppm - 10-bit: o EBU_PendulusWide_3840x2160p_50_10b_bt709_444_0001.ppm o HDCA_set2_0000_0000.ppm o HDCA_set6_0000_0000.ppm o HDCA_set9_0000_0000.ppm o HDCA_set10_0000_0000.ppm o El Fuente 1 o El Fuente 2 o Chimera 1 o Chimera 2 o Chimera 3	
Class C: Computer-generated images	**Class D: Screen content images**
- 8-bit: o BLENDER_Sintel1_4096x1744p_24_8b_sRGB_444_00003096.ppm - 10-bit: o BLENDER_Sintel2_4096x1744p_24_10b_sRGB_444_00004606.ppm - 12-bit: o BLENDER_TearsOfSteel_4096x1714p_24_12b_sRGB_444_01290.ppm	- 8-bit: o APPLE_BasketBallScreen_2560x1440p_60_8b_sRGB_444_000.ppm o HUAWEI_ScMap_1280x720p_60_8b_sRGB_444_000.ppm o RICHTER_ScreenContent_4096x2160p_15_8b_sRGB_444_0001.ppm
Class E: HDR/WCG images	**Class F: Natural images with overlays (text, logos etc)**
- 16-bit floating point (IEEE 754) o 507.pfm o BloomingGorse2.pfm o CanadianFalls.pfm o DevilsBathtub.pfm o HancockKitchenInside.pfm o LabTypewriter.pfm o LasVegasStore.pfm o McKeesPub.pfm	- Netflix_text1 - Netflix_text2 - Netflix_text3 - Netflix_logo1 - Netflix_logo2

o MtRushmore2.pfm o WillyDesk.pfm o dragon_3.pfm o set18.pfm o set22.pfm o set23.pfm o set24.pfm o set31.pfm o set33.pfm o set70.pfm o showgirl.pfm o sintel_2.pfm - 10-bit, 1080p: o Auto Welding o Bike Sparklers o Blue Glass Bowl o Lighter o Clouds o Market3 o Hurdles o Starting o Sunrise - 10-bit, 4K: o Meridian_1 o Meridian_2 o Cosmos_Laundromat_1 o Cosmos_Laundromat_2 o DayStreet o PeopleInShoppingCenter o SunsetBeach	

B.1.3. Anchors

Proposals will be compared against the following anchors:

- JPEG (ISO/IEC 10918-1 \| ITU-T Rec. T.81) [12]
- JPEG 2000 (ISO/IEC 15444-1 \| ITU-T Rec. T.800) [13]
- HEVC (ISO 23008-2 \| ITU-T Rec. H.265) [14]
- WebP [9].

Information on available software and configurations to be used for these anchors is given in Annex C.

B.1.4. Evaluation procedures

Objective and subjective quality evaluation of the proposals will each be done by at least two independent labs, following procedures described hereunder in Annex B.1.4.3 and B.1.4.3, and based on the encoded-decoded test material provided by each proponent. Submitted binaries will be used for verification purposes.

For objective quality testing, evaluation tools described in Annex B.1.5 are made available freely to let proponents perform their own assessments.

B.1.4.1. Target rates

Target bitrates for the *objective* evaluations include 0.06, 0.12, 0.25, 0.50, 0.75, 1.00, 1.50, and 2.00 bpp. Target bitrates for the *subjective* evaluations will be a subset of the target bitrates for the objective evaluations, and will depend on the complexity of the test images.

B.1.4.2. Objective quality testing

Objective quality testing shall be done by computing several quality metrics, including PSNR, SSIM, MS-SSIM, VIF [15], and VMAF [16] between compressed and original image sequences, at the target bitrates mentioned in Annex B.1.4.1. For HDR/WCG images, quality metrics include PQ-PSNR-Y, PQ-MS-SSIM-Y (in PQ space), and HDR-VDP (linear space) [17].

B.1.4.3. Subjective quality testing

Subjective quality evaluation of the compressed images will be performed on test images described in Annex B.1.2. Testing methodologies include DSIS and absolute category rating with hidden reference (ACR-HR), with a randomized presentation order, as described in ITU-T P.910 [7].
As anchors, JPEG, WebP, HEVC, and JPEG 2000 will be used. The list of anchors may be reduced if the number of proposals is too high. The final details for subjective testing will be communicated to proponents after receiving their expression of interest.

B.1.5. Evaluation tools

To ease the objective assessment of the different proposals, a Docker [18] container and set of Python scripts have been provided to automatically perform the objective assessment of a given set of codecs. Its features include:

- Automatic installation of software: the Docker container automatically downloads and configures all anchor codecs, metrics and dependencies.
- Easy addition of new (proprietary) codecs by placing binaries and Python encoder/decoder scripts in the designated folder.

- Supported input format: ppm for RGB content and YUV planar for YCbCr content, pfm for a subset of the HDR/WCG images.
- Easy addition of new test images.
- Scripts for running encoding, decoding, and objective evaluation.
- Objective metrics:
  - For SDR images: PSNR, SSIM, MS-SSIM, VIF, and VMAF.
  - For HDR/WCG images: PQ-PSNR-Y, PQ-MS-SSIM-Y, and HDR-VDP.
- Automatic generation of graphs using Python libraries.

The Docker container can run on different platforms, including Windows, Ubuntu and macOS. The source code and installation instructions are available at https://github.com/Netflix/codec_compare. The code was made available under Apache License 2.0. The evaluation framework will be finalized after the June 11 AHG meeting, and will be made available as outcome of the 80th WG1 meeting in Berlin.

ANNEX C – ANCHOR CONFIGURATION

The configurations detailed below are relevant for non-HDR/WCG content. For HDR/WCG content, the configurations will be defined after the June 11 AHG meeting in Brussels.

C.1. JPEG (ISO/IEC 10918-1 | ITU-T Rec. T.81)

- Configuration
  - JPEG does not specify a rate allocation mechanism allowing to target a specific bitrate. Hence, an external rate control loop is required to achieve the targeted bitrate.
  - Irreversible RGB to YCbCr conversion has to be disabled when dealing with YCbCr content
- Available software: JPEG XT reference software, v1.53
  - Available at http://jpeg.org/jpegxt/software.html.
  - License: GPLv3
  - Only supports 8 bpc and 12 bpc content
  - Command-line examples (to use within rate-control loop)
    - RGB

      jpeg -q [QUALITY_PARAMETER] [INPUTFILE] [OUTPUTFILE]
    - YCbCr

      jpeg –c -q [QUALITY_PARAMETER] [INPUTFILE] [OUTPUTFILE]

C.2. JPEG 2000 (ISO/IEC 15444-1 | ITU-T Rec. T.800)

- Configuration
  - Two configurations
    - PSNR optimized
    - Visually optimized
  - A target rate can be specified using the –rate [bpp] parameter.
- Available software: Kakadu, v7.10.2
  - Available at http://www.kakadusoftware.com.
  - License: demo binaries freely available for non-commercial use
  - Command-line examples:
    - PSNR-optimized (4:4:4): kdu_compress -i [INPUTFILE] -o [OUTPUTFILE] –rate [BPP] -no_weights
    - PSNR-optimized (4:2:0): kdu_v_compress -i [INPUTFILE] -o [OUTPUTFILE] –rate [BPP] -precise -no_weights –tolerance 0
    - Visually: kdu_compress -i [INPUTFILE] -o [OUTPUTFILE] –rate [BPP] -rgb_to_420

C.3. HEVC (ISO 23008-2:2018 | ITU-T Rec. H.265 (v5))

- Configuration:
  - An external rate control loop is required to achieve targeted bitrate.

- Available software: HEVC Test Model (HM 16.16)
    - Available at https://hevc.hhi.fraunhofer.de/
    - License: BSD
    - Configuration files to be used will be available in the repository of the evaluation tools described in Annex B.1.5.

C.4. WebP

- WebP only supports YCbCr 4:2:0 output, and will only be used as anchor in YCbCr 4:2:0 comparisons.
- Configuration:
    - An external rate-control loop is required to achieve targeted bitrate.
- Available software: WebP (v1.0.0-rc2)
    - Available at https://developers.google.com/speed/webp/download
    - License: Apache License, Version 2.0
    - Command-line example (to use within rate-control loop)
      cwebp –m 6 -q [QUALITY_PARAMETER] [INPUTFILE] –o [OUTPUTFILE]

ANNEX D– REFERENCES

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[4] J.-M. Valin, "Daala: a Perceptually-Driven Still Picture Codec", IEEE Conference on Image Processing (ICIP), Phoenix, USA, September 2016.

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