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# Introduction

In 2019 MPEG started an investigation into the area of video coding for machines. The focus of this exploration was to study the case where images and videos are compressed not to be looked at and evaluated by humans, but rather machine vision algorithms. These algorithms can serve different purposes such as object detection, instance segmentation, or object tracking. As video compression standards such as HEVC or VVC are developed and optimized towards the human visual system, the existing standards may not be optimal for applications where the video is analyzed by machines.

As detailed in the use cases in [1], more video is produced than can be consumed and watched by humans. With video being by far the largest share of traffic on the internet, encoding video that is supposed to be analyzed by machines in a manner that is optimized for humans seems like a wasteful idea. Over the past years, MPEG has studied and seen evidence that images specifically compressed for machine vision tasks achieve a better machine vision task performance to bitrate ratio than compressing images with the VVC Test Model (VTM) and executing the machine vision task on the decoded images.

A formal call for evidence was issued in January 2021 and provided evidence that this can be achieved in different ways. This call for proposals is the start of a process which has the creation of a new international standard as its goal.

This document contains detailed information about the setup of this call, general rules for conduct, the planned timeline for both this call and the development of a standard, detailed information on what needs to be submitted, and the next steps following the evaluation of responses to the call.

This call focuses on the compression of images and videos and thus responses are expected to produce decoded images and videos that can be used by a pre-defined set of machine vision algorithms to generate the performance results.

**CLARIFICATION** (2022-06-15): This call requires proponents to submit technology suitable for compressing videos. It is mandatory to provide results for machine vision tasks such as object tracking for video datasets. The exact submission requirements are listed in Section 8.7.

# Who may participate

Proponents that respond to this call may include any persons whether they are or are not accredited delegates of ISO/IEC JTC1/SC29/WG2. However, all proponents are required to attend the meetings at which their respective proposals are evaluated. The meeting during which proposals are evaluated is identified with an \* in Table 1 and Table 2. A one-time invitation may be extended to proponents to participate in the evaluation process if the proponent is not an accredited delegate of ISO/IEC JTC1/SC29/WG2. If the proponent’s technology is accepted into the Working Draft of the Standard, then the proponents are required to participate in meetings identified with a † in Table 1 and Table 2. In such a case where the technology is accepted from a proponent who is not an accredited delegate of ISO/IEC JTC1/SC29/WG2, the proponent is expected to initiate the process to join their National Body committees in order to become accredited to participate in subsequent meetings of WG2. Information for how to join National Body committees and to become an accredited delegate for ISO/IEC JTC1/SC29/WG2 is available at [How to Get Involved](https://www.iso.org/get-involved.html).

# Code of conduct and rules of engagement

All participants shall be required to familiarize themselves with relevant [ISO Policies and Procedures](https://www.iso.org/resources.html), including in particular [ISO Code of Conduct](https://www.iso.org/publication/PUB100397.html), [ISO Declaration for Participants in ISO Activities](https://www.iso.org/declaration-for-participants-in-iso-activities.html), [ISO Privacy and Copyright](https://www.iso.org/privacy-and-copyright.html) policy, and [ISO Policy on Communication of Committee Work](https://www.iso.org/publication/PUB100382.html), and to consent to be bound by these policies.

# Source code and IPR

By responding to a CfP, the proponent affirms that he or she is willing to make source code available for use as the starting point for collaborative standardization.

It is the responsibility of the proponent to obtain any necessary internal approvals in a timely manner, otherwise more readily available source code may be selected.

Furthermore, proponents are advised that this Call is being made subject to the common patent policy of ITU-T/ITU-R/ISO/IEC (refer to [www.itu.int/ITU-T/dbase/patent/patent-policy.html](http://www.itu.int/ITU-T/dbase/patent/patent-policy.html) or Appendix I of [ISO/IEC Directives Part 1](http://isotc.iso.org/livelink/livelink?func=ll&objId=4230455&objAction=browse&sort=subtype)).

# Testing Fee

Participating in this Call for Proposals is not associated with any fees.

# Definitions

The definitions for terms associated with this Call for Proposals can be found in section 1 of [1].

Furthermore, this Call for Proposals uses the terms Working Draft (WD), Committee Draft (CD), Draft International Standard (DIS), Final Draft International Standard (FDIS) and International Standard (IS) according to the [ISO Stages and Resources for Standard Development](https://www.iso.org/stages-and-resources-for-standards-development.html).

# Documents of CfP package

The CfP package consists of the following documents:

* N190 Requirements and Use cases for Video Coding for Machines

This document describes the use cases where proposals can be applied and what requirements the final standard needs to fulfill.

* N192 Common Test Conditions and Evaluation Methodology for Video Coding for Machines

This document describes the process of generating the reference encodings and the reference results. It also explains how the different metrics are calculated and which neural networks shall be used for evaluating the machine vision performance. It furthermore contains an Excel template which shall be used to calculate performance results such as BD-rate as well as the inference scripts that should be used to generate the machine vision task performance.

* N191 Call for Proposals on Video Coding for Machines (this document)

This document contains details about the submission process and the guidelines to follow. Furthermore, it describes who may participate and what the rules for participation are.

# Submission Process

## CfP Timeline table

Each entry in the table is described in a section below. WG2 is the SC 29 working group WG2 MPEG Technical Requirements. Unless stated otherwise, deadlines refer to a specific day at 23:59 UTC.

Table 1. CfP Timeline (\* indicates attendance at the meeting is required).

|  |  |  |  |
| --- | --- | --- | --- |
| **Meeting** | **Date** | **Who** | **Action** |
| 7 | Apr 2022 | WG2 | Issue Call for Proposals package |
|  | 2022-05-06 | WG2 | Verified version of test material is available |
|  | 2022-07-06 | Proponent | Register |
| 8 | Jul 2022 (14-22) | Co-chairs | Intermediate report on CfP progress |
|  | 2022-09-30 | Proponent | Upload bitstream files, results and decoders |
|  | 2022-10-03 | Volunteers and Proponents | Begin cross-checking others' results. |
|  | 2022-10-12 | Proponent | Submit proponent documentation as a contribution to the 9th WG 2 meeting |
|  | 2022-10-14 | Volunteers and Proponents | Complete cross-checking others results |
|  | 2022-10-17 | Test administrator | Submit results of cross-checking as a contribution to the 9th WG2 meeting |
| 9\* | Oct 2022 (19-28) | WG2 | Evaluate Call for Proposals submissions and select technology. Respondents must be present at the meeting and present the proposals for information sharing.  The source code of candidate technologies for the reference model will be published. |
|  | 2022-11-25 | Software coordinators | Source code of the selected technologies published on Git |
|  | 2022-12-20 | AHG | Release reference model (RM) on Git |
|  | 2022-12-20 | AHG | Release working draft (WD) |

## Envisioned Timeline for the VCM Standard

It is envisioned that the timetable for the progress of the VCM standard will be as follows. Note that not all exact dates for future meetings are set and AhG meetings might be in advance of the WG2 meetings.

Table 2. Standardization Timeline (\* indicates attendance at the meeting is required. † indicates attendance is required if technology is selected to be included in the Working Draft and further stages.)

|  |  |  |
| --- | --- | --- |
| **WG 2 Mtg** | **Date** | **Action** |
| 7 | 2022-04-25/29 | CfP |
| 8 | 2022-07-18/22 |  |
| 9\* | 2022-10-24/28 | Evaluation, RM, WD |
| 10† | 2023-01-01 |  |
| 11† | 2023-04-01 |  |
| 12† | 2023-07-01 |  |
| 13† | 2023-10-01 | CD |
| 14† | 2024-01-01 | DIS |
| 15† | 2024-04-01 | Verification Test |
| 16† | 2024-07-01 | FDIS |
| 17 | 2024-10-01 | IS |

## Register your participation

Proponent must register on or before the date shown in the CfP Timeline table above, an intention to participate in the CfP. Registering an intent is not binding and registered parties are not required to submit proposals. However, parties that do not register will not be able to submit proposals. Each organization shall only register once. Register by sending an email to the people detailed in section 9. This email should indicate

* Company name
* Contact name and contact email address
* The number of proposals the proponent plans to submit
* The envisioned scope of the proposal(s) (e.g., will it process all or only some content types, will it meet all or only some requirements). This envisioned scope is not binding and is not a restriction on proponent response but is rather for planning purposes only.

Upon registration, the proponent also agrees to cross-check up to two proposals from other proponents for each proposal the proponent is submitting. As an example, if a proponent submits three proposals, they agree to cross-check up to six proposals from other proponents. The number of cross-checks will depend on the number of submitted proposals and not the planned number of proposals stated in the registration.

After registration, the proponent will receive a number of “ProponentIDs” (<Proponent\_ID>) for use in the submission of bitstreams, decoders and other materials. This permits each proponent to have several submissions, e.g., each tuned to a different operating point. Furthermore, the proponent will receive information on how to access the verified version of the test material.

## Mandatory Equipment, Software and Data Components

The use of the software and data components for regenerating the anchors used in the CfP can be found in [2]. Where applicable, the same software and configuration shall be used for the proposed technology as for the anchors, e.g., for converting YCbCr files to PNG FFmpeg shall be used.

## Access to Test Material

Registered proponents can get access to a verified version of the test material by the date shown in the CfP Timeline table above. The datasets are currently publicly available, but a verified collection of the data will be made available together with the reference results. The scripts to generate the inference results for the machine tasks from reconstructed images or videos will also be included in the test material. How to access this verified version of the datasets and inference scripts will be communicated directly to proponents. The purpose of this verified collection of datasets is to be independent of changes made to the datasets, as MPEG does not own these datasets.

The set of scripts to generate inference results can also be found in [2].

An overview of the datasets to be used can be found in Section 2.1 in [2].

Information on how to access the datasets can be found in [2].

## Conduct Objective Evaluations

Proponents must provide the objective measurement of the following parameters. Details on how to measure the following metrics are given in [2].

The main evaluation metrics are:

* machine vision task performance
* bitrate

The following metrics shall be reported to provide additional information about the proposal and may be used in selecting the technology for the reference model:

* decoder runtimes
* decoder size
* encoder runtimes
* encoder size

The following metrics can optionally be reported:

* image/video reconstruction performance

A template for the submission of this information is given in [2]. The proponent shall include a summary of the objective results in the contribution document describing the proposed technology. This shall include a description about the hardware and software environment where the objective evaluation is performed.

The performance for the machine vision tasks shall be evaluated using the neural networks detailed in section 3 in [2].

A detailed description of how to calculate runtimes can be found in section 4.3 in [2].

## Details of the Submission

Proponents must submit proposal materials no later than the date shown in the CfP Timeline table above. The materials shall be submitted via FTP with a site URL and username/password communicated by the Call Administrator to all registered proponents.

The randomly assigned proponent IDs will be delivered to each proponent by the Call Administrator, sufficient to permit separate proponent submissions. The assignment of the IDs is confidential so that it is not possible to determine the source of a submission (i.e., name of the proponent) except for the Call Administrator and the proponent of that submission. A proponent or a cross-checker must not share any information that may lead to a disclosure of its own or another proponent’s ID, or information that may identify its own or another proponent’s submission otherwise (e.g., information about the method itself).

Proponents shall not manually select nor hardcode the encoder and decoder algorithm or parts of the encoder and/or decoder algorithm according to the testing dataset, test data (input image or video) or machine tasks. A single bitstream file for each test image or video and for each bitrate point shall support all mandatory machine tasks (object detection, instance segmentation and object tracking).

Post-processing is only allowed if it is part of the decoding process, i.e., any processing that is applied to a picture prior to its use as a reference for inter prediction of other pictures. Such processing can also be applied to non-reference pictures.

If a proposal contains one or more components that are learned, the training dataset shall be publicly available with license terms that allow commercial usage before the time the CfP is issued. No images or videos from the VCM validation datasets shall be used in training. Where a subset of the frames of a video is used for validation, it is not allowed to use other frames of the video for training.

Proponents shall submit a bitstream file for each bitrate point for each of the image or video datasets:

* OpenImages (object detection and object segmentation),
* TVD (object detection, object segmentation and object tracking),
* FLIR (object detection)
* SFU-HW (object detection)

The official inference scripts provided in the test material shall be used to generate the inference results for the mandatory machine tasks. Changes to the scripts are allowed but shall be described in detail.

A diagram describing the expected pipeline of proposals can be found in Figure 1a of [1]. Note that for image datasets the input of the VCM encoder is an image and the output of the VCM decoder a reconstructed image.

The directory structure of the decoded images and video frames shall follow the structure required by the official inference scripts for each dataset.

The submission shall contain

* a zip file containing compressed bitstreams for each dataset,
* the reporting template [2] with all mandatory information filled out accordingly,
* compiled decoders for Linux, and
* a short description of how to set up the decoding environment from a clean Linux (e.g., Ubuntu) and how to use the decoder.

Information on how to name bitstream files and how to structure the submission on the FTP server will be communicated to proponents directly.

### Submission details for image datasets

For each dataset that the proponent wants to submit their proposal for, six sets of bitstreams shall be submitted. One set of bitstreams contains one bitstream for each image of the dataset. The bitrate targets are defined in section 2.3.2 of the CTC document [2].

### Submission details for video datasets

For each video dataset that proponents are submitting their proposal for, six bitstreams shall be submitted per sequence. Each sequence is assigned to a group. For each group, the bitrate targets are defined in section 2.3.2 of the CTC document [2].

## Cross-checking of results

After the submission of bitstreams and decoders, each proponent shall cross-check the results reported by two other proponents. Non-proponent participants might assist with cross-checking. A report on the results of this cross-checking activity shall be made available by the cross-checkers by the date listed in the CfP Timeline table above. This report shall be uploaded as an input contribution to the 9th WG2 meeting.

The Call Administrator communicates the proponent IDs in an anonymized fashion to the Test Administrator, i.e., indicating which IDs belong to the same proponent, but not disclosing who the proponent is. The Test Administrator assigs the cross-checking tasks to cross-checkers and informs the Call Administrator. The Call Administrator then communicates the cross-checking tasks to the proponents.

A cross-checker shall not disclose information about the IDs of their cross-checking assignments or information about the methods in their cross-checking assignments until the cross-checking contribution to the MPEG has been submitted.

The cross-check for a proposal is considered successful if the bit rates of the proposal are matched exactly, and the relative error of the machine vision performance in cross-checking is less than 1% compared to the performance reported in the cross-checked proposal. For example, any value between 9.9% and 10.1% is considered successful in cross-checking when the reported machine vision performance in a proposal is 10%.

Non-proponents that are interested in participating in the cross-checking effort are welcome to contact the Call and Test Administrators and indicate the number of proposals they would like to cross-check.

## Submit Proponent Documentation

Proponents shall submit the following information as a contribution to the MPEG meeting indicated in the CfP Timeline table above:

* A written description of the technology having sufficient detail to permit technical discussions
* Objective test results, as indicated in Annex A
* Description of how the requirements in [1] are met
* Description of the training details if the proposal contains components that are learned
* Description of the encoder runtime, computing platform and encoder size

A template for reporting the training details can be found in Section 4.4 of [2].

Proponents that are WG2 members shall register and upload an input contribution to the WG2 meeting and send title and author information to co-chairs of the group as indicated in section 9 prior to the contribution upload deadline. The contribution shall contain all documentation mentioned above.

However, proponents that are not WG2 members shall email the documents to the convenor of WG2 two weeks prior to the 9th WG2 meeting, so that the documents can be registered and uploaded. The documents should be written in Microsoft Word, a template for input contributions can be found at the FTP site where the test data is available (see section 8.5). The Convenor of WG2 will extend a one-time-only invitation to the WG2 meeting so that a non-member proponent can present their contributions and participate in the selection process.

All proponents are urged to become members of the WG that will develop a potential VCM standard (see Section 2).

## Evaluate CfP Submissions and Select Technology

At the WG2 meeting indicated in the CfP Timeline table above, submissions will be evaluated by the WG2 experts. It is strongly urged that proponents have experts familiar with the proposed technology attend in order to allow discussions on details of the proposals. It is envisioned that at least one submission will be selected as technology for the Working Draft of the VCM standard. Submissions shall be evaluated considering all submitted information.

The metrics for evaluating the submissions can be found in Section 8.6.

Proposals do not have to fulfill all optional requirements. Requirements that are not fulfilled by the selected technology will be addressed in the Core Experiment (CE) process, which may include CEs using other submitted technologies in order to address all requirements.

If by the assessment of the WG2 experts, there is no single best proposal, then WG2 will draft a workplan on how to merge the best-performing technologies into a single unified technology.

## Submit WD Specification and RM Source Code

At the WG2 meeting indicated in the timetable above, the AHG shall submit an initial version for the Working Draft (WD) of the specification as an input contribution. Based on this contribution, the group will collaborate to create a WD.

The WD must include a normative specification of the VCM decoding process, signaling aspects and bitstream syntax.

The source code of the selected technologies shall be published in Git within 4 weeks after the 9th WG2 meeting where the selected technology is announced. If the proponent(s) fail to publish the source code on time, new technologies will be selected, and a new work plan will be drafted by the WG2 experts. Software coordinators shall be selected from proponent(s) of the selected technology and/or interested experts. If necessary, the merge activity shall be carried out as an open process (i.e., visible to all members of WG2) on the Git repository. The merging of the code shall be completed before the date indicated in the timeline and a contribution by the software coordinator shall describe the merging process, details of how to access the code, and how to jointly develop the code during the standardization process.

The RM shall be cross-checked by at least 2 independent WG2 member organizations. If a single proposal was chosen, the cross-checking shall verify that

* the bitstreams generated by the encoder in the RM match the bitstreams in the original CfP submission
* the reconstructed images/videos generated by the decoder in the RM match the reconstructed image/videos generated by the compiled decoder in the original CfP submission

If the RM is not based on a single proposal, the cross-checking shall produce a set of baseline results for the collaborative development of the VCM standard.

In addition, the contribution containing the WD shall include a description of the encoding and decoding algorithms. To match this, the RM must include source code that implements the described encoding and decoding algorithms. Note that this does not need to be the exact algorithm used in the proponent’s submission to the CfP but rather the merged software. Subsequent Core Experiment work for the collaborative development of VCM standard shall use the RM as the “baseline” system in CE performance comparisons*,* against which CE technology is evaluated.

# Call Administrator

This Call for Proposals is issued by WG2. The WG2 convenor serves as the administrator:

Igor Curcio

Convenor, WG2 MPEG Technical Requirements

[igor.curcio@nokia.com](mailto:igor.curcio@nokia.com)

For any questions related to this Call for Proposals or associated evaluation procedures please contact the co-chairs of the VCM AhG:

|  |  |
| --- | --- |
| Christopher Hollmann  Ericsson  [christopher.hollmann@ericsson.com](mailto:christopher.hollmann@ericsson.com) | Shan Liu  Tencent  [shanl@tencent.com](mailto:shanl@tencent.com) |
| Chris Rosewarne  Canon  [Chris.Rosewarne@canon.com.au](mailto:Chris.Rosewarne@canon.com.au) | Yuan Zhang  China Telecom  [zhangy666@chinatelecom.cn](mailto:zhangy666@chinatelecom.cn) |

# Test Administrator

The cross-checking activities for proposals are coordinated by Chris Rosewarne ([Chris.Rosewarne@canon.com.au](mailto:Chris.Rosewarne@canon.com.au)).

# Email reflector

For communication, usage of the reflector is encouraged: [mpeg-vcm@lists.aau.at](mailto:mpeg-vcm@lists.aau.at)

You can subscribe etc. to the VCM reflector on the following webpage: <https://lists.aau.at/mailman/listinfo/mpeg-vcm>

Important information such as scheduling for AhG, BoG or WG2 meetings may be shared via this reflector.

WG2 is using the following reflector: [mpeg-req@lists.aau.at](mailto:mpeg-req@lists.aau.at)

You can subscribe etc. to the WG2 reflector on the following webpage: <https://lists.aau.at/mailman/listinfo/mpeg-req>

# References

1. N190 Requirements and Use cases for Video Coding for Machines
2. N192 Common Test Conditions and Evaluation Methodology for Video Coding for Machines

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