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| **ITU – Telecommunications Standardization Sector**STUDY GROUP 16 Question 6**Video Coding Experts Group (VCEG)**73th Meeting: 16-20 October 2023, Hannover, GER | Document: VCEG-BT06 |

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| Question: | Q.6/SG16 (VCEG) |
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| Title: | Proposed draft Call for Proposals on the coding of biomedical waveform data |
| Purpose: | Proposed update of draft CfP |

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1. **Introduction**

This document is a [PROPOSED DRAFT] Call for Proposals (CfP) on the coding of biomedical waveform data. A need for the coding of such time-based neurophysiology signal data is reported in the liaison statement [TD 103/Gen](https://na01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.itu.int%2Fmd%2Fmeetingdoc.asp%3Flang%3Den%26parent%3DT22-SG16-230710-TD-GEN-0103&data=05%7C01%7C%7Cf93d93f41ec743329b3208daf6438636%7C84df9e7fe9f640afb435aaaaaaaaaaaa%7C1%7C0%7C638093067122342522%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C3000%7C%7C%7C&sdata=8%2FKJ476FS6B0ZjOxkx9v8iHU12DPdG3CgkyUboBv0Fo%3D&reserved=0) from DICOM WG32. It is also noted that there is no well-accepted codec for biomedical waveform data such as electrocardiography (ECG), electroencephalography (EEG), and electromyography (EMG) signals.

1. **Purpose and procedure**

The purpose of this CfP is to collect and evaluate coding technology for biomedical waveform data. Companies and organizations that have developed such technology are invited to submit a proposal in response to this Call.

To evaluate a proposed compression technology, bit rates will be traded off against distortion measures as specified in section 4. Moreover, DICOM experts will evaluate whether data compressed by a proposed technology in the coding conditions specified in section 5 result in the same medical diagnoses (performed either by human experts or by machines) as the original data. These evaluations should follow the protocol which was developed by the DICOM WG32 group for an assessment of the impact of artificially added signal noise on medical diagnoses. Based on the results of the tests and based on technical aspects (like, e.g., computational complexity, memory requirements, minimum structural delay) the course of action regarding the proposed technologies will be decided.

Descriptions of proposals shall be registered as input documents to the proposal evaluation meeting of MONTH/YEAR. Proponents also need to attend this meeting, either in person or remotely, to present their proposals.

1. **Timeline**

The timeline for the Call for Proposals is as follows:

YYYY/MM/DD: Final Call for Proposals (public release)

YYYY/MM/DD: Upload of bitstreams and decoder software

1. **Error measures**

Two error measures are employed to objectively evaluate the compressed representations of the test data. The input sequences are specified in section 5. Let *N* be the number of channels and let *M* be the number of samples per channel of an input sequence. Furthermore, let $a\_{i,j}$ be the *j*-th sample (with $0\leq j<M$) of channel *i* (with $0\leq i<N$) and let $\tilde{a}\_{i,j}$ be the corresponding reconstructed sample after decoding a bitstream. The maximum absolute error (*MAE*) is then defined as

$$MAE=max\left\{0\leq i<N,0\leq j<M\right\}.$$

Moreover, if $m\_{i}$ is the mean of the i-th channel, i.e.

$$m\_{i}=\frac{1}{M}∙\sum\_{j=0}^{M-1}a\_{i,j},$$

 the percentage root mean square distortion (PRD) is defined as

$$PRD=100\%∙\sqrt{\frac{\sum\_{i=0}^{N-1}\sum\_{j=0}^{M-1}\left(a\_{i,j}-\tilde{a}\_{i,j}\right)^{2}}{\sum\_{i=0}^{N-1}\sum\_{j=0}^{M-1}\left(a\_{i,j}-m\_{i}\right)^{2}}}.$$

Please note that, in contrast to some definitions found in the literature, this definition of the PRD includes a mean-removal in order to be invariant towards constant signal-shifts. In order to take different variance-ranges in different channels into account, the channel-normalized percentage root mean square distortion (CPRD) shall be defined as

$$CPRD=\frac{100\%}{N}∙\sum\_{i=0}^{N-1}\sqrt{\frac{\sum\_{j=0}^{M-1}\left(a\_{i,j}-\tilde{a}\_{i,j}\right)^{2}}{\sum\_{j=0}^{M-1}\left(a\_{i,j}-m\_{i}\right)^{2}}}.$$

1. **Test data and coding conditions**

The input sequences to be tested are specified in three categories as specified in subsections 5.2.to 5.4. Nine working points (WP0 to WP8) are defined. Here, the first working point (WP0) defines a lossless compression while the last eight working points (WP1 to WP8) are defined in terms of restrictions on the bitstream size. The latter is measured by the number of bits per sample (BPS), defined as

$$BPS=\frac{\#number of bis in the bitstream}{N∙M},$$

where *N* is the number of channels and *M* is the number of samples per channel of a given input sequence. The last eight working points target compression technologies which, for a given maximal BPS, minimize the PRD.

The working points are defined as follows:

* WP0: *MAE* = 0 (lossless)
* WP1: *BPS* <= 3.0
* WP2: *BPS* <= 2.5
* WP3: *BPS* <= 2.0
* WP4: *BPS* <= 1.5
* WP5: *BPS* <= 1.0
* WP6: *BPS* <= 0.75
* WP7: *BPS* <= 0.5
* WP8: *BPS* <= 0.3

One bitstream shall be produced for each input sequence and working point so that the conditions specified for the working point are fulfilled.

## Availability and format of the test data

All test data used for the CfP can be downloaded from the following location:

Server: [ftp.hhi.fraunhofer.de](https://urldefense.com/v3/__http%3A/ftp.hhi.fraunhofer.de__;!!Ab1_Rw!ExOfc-x3p0e9RCmWEdTCbSatvCU5AIjYpC7ovhXAk9GmDH_epQgMsHc6UnSLIewoZqsap0lXQl4o7Z98T51cvaymJphwNcozfzg$)

Login: dicom

Password: yX5GUw.Zn

The files are provided in the European Data Format (EDF).

## Electroencephalography (EEG) signals

Name of dataset: EEG dataset containing interictal epileptiform discharges and seizures

FTP-file: MUSC\_Dataset\_E.zip

Number of input sequences: 41

## Electrocardiography (ECG) signals

Name of dataset: MIT-BIH Arrhythmia Database

FTP-file: MIT\_ECG\_Dataset.zip

Number of input sequences: 48

## Electromyography (EMG) signals

Name of dataset: Dataset for multi-channel surface electromyography (sEMG) signals of hand
 gestures

FTP-file: MENDELEY\_Dataset.zip

Number of input sequences: 40

1. **Requirements on submissions**

Proponents are required to submit a technical description of the proposed technology sufficient for full conceptual understanding and generation of equivalent performance results by experts to the meeting where the evaluation is performed.

Proponents are required to implement their proposed technology in software and include information about the used programming language in their proposal document.

Proponents are required to upload bitstreams for all input sequences and working points of at least one of the three categories specified in sections 5.2 to 5.4 to the ftp server specified in section 5.1 by the date specified in the timeline of section 3. Additionally, they shall indicate their bitstream submission via Email to the CfP coordinators of section 8.

Proponents shall report *PRD* and *CPRD* values for each bitstream along with the number of bits per sample (*BPS*).

For each category and each of the the eight working points WP-1 to WP-8, the average of the *BPS, PRD* and *CPRD* values of all associated bitstreams shall be reported.

For each input sequence, a graph shall be provided that shows the *PRD* values over the *BPS* values for the eight working points WP-1 to WP-8 and connects the working points by linear or some other interpolation method. Moreover, for each input sequence, a second graph shall be provided that shows the *CPRD* values over the *BPS* values for the eight working points WP-1 to WP-8 and connects the working points by linear or some other interpolation method.

Proponents are required to provide the decoder software which is able to create the decoded representations from the uploaded bitstream in the same format as the corresponding input sequence. Provision of source code written in C++17 is encouraged.

1. **Subsequent provision of source code and IPR considerations**

Proponents are advised that, upon acceptance for further evaluation, it will be required that certain parts of any technology proposed be made available in source code format to participants in the core experiments process and for potential inclusion in the prospective standard as reference software. When a particular technology is a candidate for further evaluation, commitment to provide such software is a condition of participation. The software shall produce identical results to those submitted to the test. Additionally, submission of improvements (bug fixes, etc.) is certainly encouraged.

Furthermore, proponents are advised that this Call is being made subject to the common patent policy of ITU-T (see <http://www.itu.int/en/ITU-T/ipr/Pages/policy.aspx>) and the other established policies of the standardization organizations.

1. **Contacts**

To be decided

Coordinator Email: