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| **ITU – Telecommunications Standardization Sector**  STUDY GROUP 21 Question 6  **Video Coding Experts Group (VCEG)**  77th Meeting: 26 June – 4 July 2025, Daejeon, Korea | Document VCEG-BY01-v1 |

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| Question: | 6/21 (VCEG) | | |
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| Title: | **AHG report on coding of medical and general waveform data** | | |
| Purpose: | AHG report | | |

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# Abstract

This document contains the AHG report on the coding of medical and general waveform data

# Introduction

The mandates of the AHG are as follows:

* Update and improve the draft specification of H.BWC and the H.BWC algorithm description document
* Update the H.BWC reference software in coordination with the H.BWC reference software coordinators
* Identify additional candidate test data for experimentation, including additional types (PPG, multimodal, seismic data, etc.)
* Communicate informally with DICOM on the status and plans of H.BWC
* Coordinate with DICOM to engage medical experts in evaluations of H.BWC's compression performance
* Produce anchor encoding results using the latest version of reference software and the CTC configurations
* Study performance vs. complexity trade-off and encoder optimization algorithms, and define associated configurations of the test model in support of envisioned use cases

Experts from Q6/SG21 participated in the meetings of DICOM WG32 and provided information about the progress of the H.BWC development. Also, experts from DICOM WG32 started to investigate the functionalities of the provided H.BWC reference software.

The following documents contain updates on the draft specification, CTC and software:

* <https://www.itu.int/wftp3/av-arch/video-site/2503_Tel/VCEG-BX21-v1-H.BWC_Specification_Draft2.docx>
* <https://www.itu.int/wftp3/av-arch/video-site/2503_Tel/VCEG-BX23-v1-CTC.docx>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY06-Software-Status-v1.docx>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY06-Plots_PSNR2-v1.zip>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY06-Plots_PSNR1-v1.zip>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY06-CTC-BWC-1.0-CTC_vs_BWC-2.1-CTC-v1.xlsm>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY06-CTC-BWC-1.0-CTC-ICC_vs_BWC-2.1-CTC-ICC-v1.xlsm>

The following documents related to core experiments for H.BWC have been registered:

Ongoing CEs:

* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY02-CE2.1-Deblock-v1.docx>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY03-CE3-CABAC-Mods-v1.docx>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY04-CE4-LMS-CABAC-v1.docx>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY05-CE5-LMS-CABAC-Quantization-v1.docx>

New CEs:

* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY07-LMS-Harmonization-v1.docx>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY09-ChannelGrouping-v1.docx>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY10-ChannelRereferencing-v1.docx>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY12-Lossless-Prop-v1.docx>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY12-Lossless-Software-v1.zip>

The following documents related to the mandates of the AHG have been registered:

* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY08-LMS-Limitation-v1.docx>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY11-HLS-Prop-v1.docx>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY11-HLS-Text-v1.docx>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY13-Quantization-Prop-v1.docx>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY13-Quantization-Excel-v1.zip>
* <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY13-Quantization-Excel-v1.zip>

# AhG Meetings

There was one virtual meeting of the VCEG AhG on H.BWC, held on 2025-06-20, 0500 – 0700 UTC. The agenda and related notes can be found in the Annex to this document.

# Summary

The AhG recommends to:

* Update CTC according to the discussion related to VCEG-BX21-v1 (see details in the Annex).
* Consider adding an overview of performance to VCEG-BY06-Software-Status-v1 that also includes the audio-anchor, to show H.BWC performance vs. what’s available on the market (see details in the Annex).
* Discuss and agree on adding a PPG dataset and which dataset that would be.
* Discuss standardization of (parts of) the encoder normatively and creating a plan on next steps regarding this topic (see details in the Annex).
* Adopt the proposal in VCEG-BY13-Quantization-Prop-v1.
* Adopt the proposal in VCEG-BY11-HLS-Prop-v1.
* Review all remaining input contributions (see details in the Annex).

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**Annex - VCEG AhG on H.BWC Agenda and Notes**

2025-06-20, 0700 – 0900 CEST

**Participants**

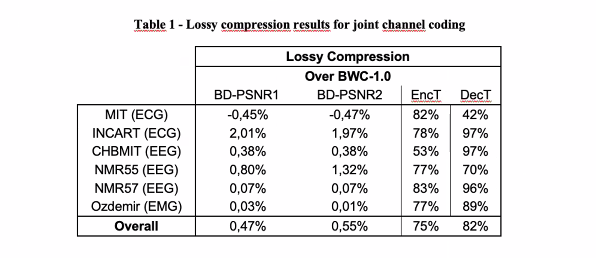
* Yan Ye (Alibaba)
* Sam Jelfs, Werner Oomen, Ray Krasinski (Philips)
* Jongmo Sung, SooYoung Park, Seungkwon Beack, Byeongho Jo (ETRI)
* Christian Helmrich, Heiko Schwarz, Heiner Kirchhoffer, Jonathan Pfaff, Tung Nguyen, Paul Haase, Sophie Pientka (Fraunhofer HHI)
* Gary Sullivan, Mark Vinton, Panji Setiawan, Christof Fersch (Dolby Laboratories)

**Agenda and Notes**

**#0 Discussion and approval of agenda (5min)**

**#1 Status updates on (15min):**

* Update and improve the draft specification of H.BWC and the H.BWC algorithm description document
  + Verbal status update.
  + <https://www.itu.int/wftp3/av-arch/video-site/2503_Tel/VCEG-BX21-v1-H.BWC_Specification_Draft2.docx>
  + No update on algorithm description.
    - Is there a mismatch between Draft specification and algorithm description?
      * No, algorithmic description is not affected by “bugfixes” and improvements to draft specification.
* Updated CTC:
  + <https://www.itu.int/wftp3/av-arch/video-site/2503_Tel/VCEG-BX23-v1-CTC.docx>
    - Added one additional dataset (12-lead ECG)
    - Did split up very large EEG datasets (files to be used for development and files to be used for training listed in Annex)
    - Also recommended to reduce number of working-points, but this has not been included in the CTC.
      * AhG recommends updating the CTC accordingly.
* Update the H.BWC reference software in coordination with the H.BWC reference software coordinators
  + <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY06-Software-Status-v1.docx>
  + Paul Haase presented.
  + Attached xls needs update due to incompatibility of used function. Will not change content.
  + Should we also include the audio-anchor that we had in the CfP?
    - H.BWC 1.0 already showed significant gain over this audio-anchor.



* + - Would be nice to have an overview of performance that also includes the audio-anchor, to show H.BWC performance vs. what’s available on the market.
    - AhG should consider doing this in the next AhG-period.
* Identify additional candidate test data for experimentation, including additional types (PPG, multimodal, seismic data, etc.)
  + Talking about PPG-data at DICOM meeting yesterday.
  + DICOM is supportive of adding PPG to the dataset to test.
  + AhG recommends discussing adding a PPG dataset and which dataset that would be.
  + Not yet clear if adding 32-bit data is a requirement of DICOM and how relevant that is. We will continue to investigate.
    - More urgent to include a 24-bit dataset. Philips proposed something to DICOM, but they were critical because there are not clinical features in it.

**#2 Communication with DICOM and resulting actions (30min):**

* Communicate informally with DICOM on the status and plans of H.BWC
* Coordinate with DICOM to engage medical experts in evaluations of H.BWC's compression performance
  + Related to those mandates, there has been a discussion in DICOM about reproducibility of results for what they call “Transfer Syntax” (which is basically a configuration of an encoder). We should take some time to talk about if/how we can achieve this and cater for DICOM’s needs.
  + DICOM is planning a “verification test” with 10+ institutions involved. They assume that the output of the encoder is reproducible.
    - Will start with the lossless-operation point of the H.BWC.
  + Discussion:
    - In biomedical systems, the number of deployed encoders (on devices) will likely far outnumber the number of deployed decoders, whereas in professional streamed media (e.g., audio/video), it’s often the reverse: many decoders and few encoders (e.g., streaming services produce, users consume).
    - Normative encoders help meet regulatory requirements (e.g., from FDA or EU MDR), ensuring patient safety and data integrity by providing clear guidelines on how signals should be encoded and handled. Many regulations require traceable, verifiable conformity in data production. Medical regulators (e.g., FDA, EMA) can verify that a biomedical device’s encoder conforms to a known, predictable quality output, which simplifies certification and therefore eventually reduces risks for patients.
    - Manufacturers can save time and money by re-using a normatively specified conformant encoder in their devices rather than developing their own encoder and seeking required approvals for the same, thus speeding up development and deployment. We expect this will significantly help the adoption of the H.BWC standard.
    - We wish to limit the variability and guarantee a quality of service. However, we do not know all the use-cases and relevant configuration points at this stage. Hence, we should consider specifying the tools themselves normatively but leave if for application standards to specify the exact normative configurations for the tools for a specific use-case as needed.
    - There is precedence of normatively standardizing (part of) the encoder in ITU-T.
  + AhG recommends discussing standardization of (parts of) the encoder normatively in VCEG and creating a plan on next steps regarding this topic.

**#3 Discussion of VCEG input documents**

* Work related to unification of CfP proposals and maintenance
  + Harmonization of quantization methods in H.BWC
    - <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY13-Quantization-Prop-v1.docx>
    - AhG recommends adopting the proposal.
  + Further Updates and Corrections to H.BWC High Level Syntax
    - <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY11-HLS-Prop-v1.docx>
    - AhG recommends adopting the proposal.

**#4 Next VCEG Session on H.BWC**

3h on Saturday, 3pm local time Daejeon, starting with CE-reports.

Documents which have not been discussed or need further discussion:

* Work related to unification of CfP proposals and maintenance
  + Improvement of the LMS Predictor Implementation in H.BWC
    - <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY08-LMS-Limitation-v1.docx>
    - AhG recommends adopting a solution for this topic. We will review an updated proposal later in the week.
  + New CE proposals (just a suggestion, since I believe we may not have the CE-crosschecks available in time)
    - Harmonization of H.BWC for LMS prediction in the transform domain (ETRI)
      * <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY07-LMS-Harmonization-v1.docx>
      * Jongmo presented.
    - Signal re-referencing for reduced entropy (Philips)
      * <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY10-ChannelRereferencing-v1.docx>
    - Enabling automated channel grouping (Philips)
      * <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY09-ChannelGrouping-v1.docx>
    - Unification of lossless coding methods in H.BWC (HHI, Dolby)
      * <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY12-Lossless-Prop-v1.docx>
  + CE Reports and Cross checks (if we have time and cross-checks are available)
    - <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY02-CE2.1-Deblock-v1.docx>
    - <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY03-CE3-CABAC-Mods-v1.docx>
    - <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY04-CE4-LMS-CABAC-v1.docx>
    - <https://www.itu.int/wftp3/av-arch/video-site/2506_Dae/VCEG-BY05-CE5-LMS-CABAC-Quantization-v1.docx>