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| **ITU – Telecommunications Standardization Sector**  STUDY GROUP 21 Question 6  **Video Coding Experts Group (VCEG)**  77th Meeting: 27 June – 4 July 2025, Daejeon | Document VCEG-BY16-v1 |

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| Question: | 6/21 (VCEG) | | |
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| Title: | **Cross check report for CE-3 and CE-5 as outlined in VCEG-BX24** | | |
| Purpose: | Information | | |

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# Abstract

This document reports on the cross-checking work Dolby has carried out to verify the Core Experiments CE-3 and CE-5 as outlined in VCEG-BX24-v1 output document [1] from the 76th VCEG meeting on 27 March – 4 April 2025. The results presented here are generated based on our best effort, given the available time and resources.

In the first version of the document, the results of the cross-check of two Core Experiments are presented. In CE-3, CABAC modifications are investigated specifically in the context of long blocks. CE-5 unifies the current two coding modes in the H.BWC codec v2.1 by combining the LMS and block-based predictors. In CE-4, that was also to be cross-checked, unification of entropy coding is proposed by testing LMS prediction in combination with CABAC instead of Huffman coding. Despite our best efforts, we were not able to run the experiments needed for CE-4, because of lack of clarity in how to correctly configure the codec for the experiments. However, since CE-4 can be seen as a subset of CE-5, we deem that the results of CE-5 are sufficient to support the validity of CE-4.

The technology proposed in the CEs essentially unifies the two operation modes in the current version (v2.1) of the H.BWC, providing a conceptually simpler structure without duplicating tools (such as entropy coding) and reducing redundant processing. The results show that, depending on the test case, either improved coding gain or drastically reduced encoding time is achieved. In some cases, both improved coding gain and reduced encoding time are obtained. Hence, the CEs present useful trade-offs between encoder runtime and compression efficiency.

The CTC datasets (in some cases subsets of the datasets, or a subset of items in a dataset) were processed using the respective candidate technologies as outlined in the corresponding CE descriptions to validate the results reported in VCEG-BY03 [2] and VCEG-BY03 [4]. The outcome of the cross-check indicates results that corroborate what is reported by the CE proponent. Some issues were found in the results presented in VCEG-BY03 [2] and VCEG-BY03 [4], however, these are related reporting rather than the validity of the hypothesis that is being tested. These issues were not significant and are not deemed to affect the validity of the conclusions of the CE. The proponent has been informed.

We note that there are small differences in the BD rates reported in this document compared to what is reported in [2] and [4]. The following explanations for the discrepancies can be found. First, some of the test sets were truncated to speed up the cross-checking process. This was necessary to meet the deadline for this document. Second, the rate-distortion curves obtained as a part of the cross-checking match very well with what is presented by the CE proponent and differ by the convention of handling very high PSNR values.

Furthermore, the encoding and decoding times presented in this document may not be accurate, because the infrastructure that was used to carry out the experiments had other simultaneous workloads, however, the trend observed in the encoding and decoding times is similar to what is presented in [2] and [4].

Based on the results of the cross-checking effort, it is proposed to accept the Core Experiments CE-3 and CE-5. It is further recommended that the proposed changes be integrated into the next version of the H.BWC test model.

# Description of the verification experiments

The sections below describe the experiments done to verify the core experiments proposed in VCEG-BX24 [1]. The verification tests for CE-3 were carried out on the following CTC datasets, or a subset of the items in the respective datasets: MIT (ECG), INCART (ECG), and Ozdemir (EMG). The verification tests for CE-5 were carried out on the MIT (ECG) dataset.

Only non-independent channel coding configuration was tested. Note that the encoding and decoding times may not be representative, because the tests were run on infrastructure that had other simultaneous jobs.

## CE-3: CABAC adaptations for large block sizes

This CE proposes modifications to the context modeling in H.BWC, as described in VCEG-BX15 [5]. The software containing the proposed changes was compared to the H.BWC v2.1 reference software with the CTC configuration (CE-3.1) and another configuration (CE-3.2): LOG2\_MAX\_BLOCK\_SIZE=11, --MAX\_SPLIT\_DEPTH=0, --MIN\_SPLIT\_DEPTH\_FULL\_TEST=0.

### CE-3.1 Results

CTC (Joint Channel Coding Configuration)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Lossy Compression** | | | |
|  | **Over BWC-2.1** | | | |
|  | BD-PSNR1 | BD-PSNR2 | EncT | DecT |
| MIT (ECG) | -0.29% | -0.29% | 162% | 157% |
| INCART (ECG) | 0.09% | 0.09% | 102% | 93% |
| Ozdemir (EMG) | 0.26% | 0.26% | 101% | 101% |
|  | |  | | | |
|  | | **Lossless Compression** | | |  |
|  | | **Over BWC-2.1** | | |  |
|  | | BR-R | EncT | DecT |  |
| MIT (ECG) | | 0.00% | 119% | 143% |  |
| INCART (ECG) | | -0.01% | 113% | 166% |  |
| Ozdemir (EMG) | | 0.00% | 97% | 161% |  |

### CE-3.2 Results

CTC (Joint Channel Coding Configuration)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Lossy Compression** | | | |
|  | **Over BWC-2.1** | | | |
|  | BD-PSNR1 | BD-PSNR2 | EncT | DecT |
| MIT (ECG) | -1.68% | -1.68% | 108% | 103% |
| INCART (ECG) | -0.04% | -0.04% | 106% | 101% |
| Ozdemir (EMG) | -2.15% | -2.15% | 103% | 109% |

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Lossless Compression** | | |
|  | **Over BWC-2.0** | | |
|  | BR-R | EncT | DecT |
| MIT (ECG) | -0.01% | 102% | 97% |
| INCART (ECG) | 0.00% | 107% | 100% |
| Ozdemir (EMG) | -0.04% | 104% | 105% |

## CE-5: Combination of LMS and block-based prediction

This CE investigates combining LMS prediction with block-based prediction, when the residual resulting from the block-based prediction is CABAC entropy coded and processed by the LMS predictor. In this experiment, the proposed technology is compared against the CTC configuration of H.BWC.

For this CE, only the MIT dataset with non-independent channel coding was tested.

### CE-5-1-1 Results

CTC (Joint Channel Coding Configuration)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Lossy Compression** | | | |
|  | **Over BWC-2.1** | | | |
|  | BD-PSNR1 | BD-PSNR2 | EncT | DecT |
| MIT (ECG) | 6.13% | 6.13% | 23% | 82% |

### CE-5-1-2 Results

CTC (Joint Channel Coding Configuration)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Lossy Compression** | | | |
|  | **Over BWC-2.1** | | | |
|  | BD-PSNR1 | BD-PSNR2 | EncT | DecT |
| MIT (ECG) | 4.35% | 4.35% | 30% | 92% |

### CE-5-2-1 Results

CTC (Joint Channel Coding Configuration)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Lossy Compression** | | | |
|  | **Over BWC-2.1** | | | |
|  | BD-PSNR1 | BD-PSNR2 | EncT | DecT |
| MIT (ECG) | 4.62% | 4.62% | 30% | 106% |

### CE-5-2-2 Results

CTC (Joint Channel Coding Configuration)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Lossy Compression** | | | |
|  | **Over BWC-2.1** | | | |
|  | BD-PSNR1 | BD-PSNR2 | EncT | DecT |
| MIT (ECG) | 4.35% | 4.35% | 36% | 62% |

### CE-5-3-1 Results

CTC (Joint Channel Coding Configuration)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Lossy Compression** | | | |
|  | **Over BWC-2.1** | | | |
|  | BD-PSNR1 | BD-PSNR2 | EncT | DecT |
| MIT (ECG) | 2.85% | 2.85% | 36% | 62% |

### CE-5-3-2 Results

CTC (Joint Channel Coding Configuration)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Lossy Compression** | | | |
|  | **Over BWC-2.1** | | | |
|  | BD-PSNR1 | BD-PSNR2 | EncT | DecT |
| MIT (ECG) | 0.88% | 0.88% | 26% | 53% |

# Conclusion

This document describes the cross check experiments to verify CE-3 and CE-5 as outlined in VCEG-BX24 [1]. The proposed modifications harmonize the codec and remove redundant and duplicative processing. The results show a useful tradeoff between coding gain and encoding time, which is most likely desirable considering potential future use cases. Based on the experiments carried out, it is concluded that the results are reasonable and in line with what is described in [2] and [4]. It is proposed to accept CE-3 and CE-5 and include the proposed technology in the next version of H.BWC.

# References

[1] Rapp, Q6/21. (March 27 - April 4, 2025) *CE description for H.BWC, doc VCEG-BX24-v1.*

[2] Fraunhofer HHI. (June 26 - July 4, 2025) *Report of CE-3, doc VCEG-BY03-v1.*

[3] Fraunhofer HHI. (June 26 - July 4, 2025) *Report of CE-4, doc VCEG-BY04-v1.*

[4] Fraunhofer HHI. (June 26 - July 4, 2025) *Report of CE-5, doc VCEG-BY05-v1.*

[5] Fraunhofer HHI. (March 27 - April 4, 2025) *Entropy coding modifications for H.BWC, doc VCEG-BX15-v1.*

[6] Fraunhofer HHI. (March 27 - April 4, 2025) *Harmonization of* e*ntropy coding methods in H.BWC, doc VCEG-BX14-v1.*

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