**A black and white logo

Description automatically generated** **ISO/IEC JTC 1/SC 29/WG 7 N1215**

**ISO/IEC JTC 1/SC 29/WG 7  
MPEG 3D Graphics and Haptics Coding   
Convenorship: AFNOR (France)**

**Document type:** Output Document

**Title:** CRM5.1 Reference software

**Status:** Approved

**Date of document:** 2025-04-07

**Source:** ISO/IEC JTC 1/SC 29/WG 7

**Expected action:** None

**Action due date:** None

**No. of pages:** 4 (with cover page)

**Email of Convenor:** marius.preda @ imt . fr

**Committee URL:** [https://isotc.iso.org/livelink/livelink/open/jtc1sc29wg7](https://isotc.iso.org/livelink/livelink/open/jtc1sc29wg3)

**INTERNATIONAL ORGANIZATION FOR STANDARDIZATION**

**ORGANISATION INTERNATIONALE DE NORMALISATION**

**ISO/IEC JTC 1/SC 29/WG 7 MPEG Coding for 3D Graphics and haptics**

**ISO/IEC JTC 1/SC 29/WG 7 N** **1215**

**April 2025, Virtual**

|  |  |
| --- | --- |
| **Title** | **CRM5.1 Reference software** |
| **Source** | **WG 7, MPEG Coding for 3D Graphics and Haptics** |
| **Status** | **Approved** |
| **Serial Number** | **25222** |

**Contents**

[1. Introduction 1](#_Toc194917960)

[2. RM5 Baseline and new features 2](#_Toc194917961)

[3. Reference software evaluation 2](#_Toc194917962)

[3.1. PSNR comparison 2](#_Toc194917963)

[3.2. Bitrate Comparison 2](#_Toc194917964)

[4. Conformance software evaluation 2](#_Toc194917965)

[4.1. HJIF Schema conformance 3](#_Toc194917966)

[4.2. HJIF Semantic conformance 3](#_Toc194917967)

[4.3. HJIF compatibility with MIHS 3](#_Toc194917968)

[4.4. MIHS Conformance 3](#_Toc194917969)

[4.5. Conversion checks 3](#_Toc194917970)

[5. Conclusion 3](#_Toc194917971)

# Introduction

The reference software of the reference model 0 (RM0) for the coded representation of Haptics was presented and released at MPEG 137 (m58749). The CRM1 version of the codec including multiple bug fixes was then presented at MPEG 138 (m59356, m59357). The CRM2 version of the codec was introduced at MPEG 139 after fixing bug issues identified (m60563). At MPEG 140, the last Core Experiments have been presented (m60390, m60759, m60891, m61141). At MPEG 141, the new version of the Reference Software (CRM3) was approved and the AHG received the result of the balloting stage on the CD. After MPEG 141, the ballot comments were analyzed and the modifications required to address some of the technical comments were addressed. The version CRM3.1 was released at MPEG 142. Following the publication of the DIS, a version CRM3.2 was released after MPEG 144. At MPEG 145, based on the ballot comments on the DIS, the version CRM4.0 of the reference software matching the FDIS specification was released at MPEG 146. At MPEG 147, the conformance software was merged with the reference software and the version CRM5 of the software was released. Finally, we now release the version CRM5.1 of the reference software that includes additional bug fixes.

# RM5 Baseline and new features

The reference and conformance software previous version, CRM5.0, can be accessed from the MPEG GitLab. It is identified by the **CRM5** tag in the MPEG Haptics repository. This specific version can be accessed directly from here:

<https://git.mpeg.expert/MPEG/3dgh/haptics/software/ReferenceSoftwarePhase1/-/tags/CRM5>

The new released version CRM5.1 of the reference software fixed a number of identified issues, and an optimization of the synthesizer was added as an optional feature. The CRM5.1 version includes executables for the encoder, decoder, synthesizer, and a conformance executable.

# Reference software evaluation

Before the release of the CRM5.1, a thorough evaluation of this version was completed to ensure that there was no degradation of the codec compared to previous version.

# PSNR comparison

The comparison of the results after encoding with the CRM5.0 and the CRM5.1 versions showed no modification of the PSNR for any of the test files. The detailed results are provided in the companion file “bitratePSNRComparison.xlsx”.

# Bitrate Comparison

The comparison of the bitrate results after encoding with the CRM5 version and the CRM5.1 version showed very small changes on the bitrates. This is due to the bug fix on the date checks for the MIHS streams. Dates were not encoded with proper format in the previous version. The changes either reduced or increased the size of the date string resulting in slight changes in bitrate. These changes are only really noticeable for some of the short files and remain under 5%. The changes result in an average improvement of the bitrate of 0.2% on the whole dataset.

The detailed results are provided in the companion file bitratePSNRComparison.xlsx.

# Conformance software evaluation

The final conformance tests were implemented for the release of CRM5.1. The conformance test files were also updated following the latest bug fixes of the reference software. The reference and conformance software now offers complete testing for HJIF schema conformance, HJIF semantic conformance, HJIF compatibility checks with MIHS, MIHS conformance and HJIF/MIHS conversion checks.

# HJIF Schema conformance

Tests are made on a set of 66 HJIF files, not conforming to the JSON schemas of the HJIF format defined in ISO/IEC 23090-31. A conformance test is run on each of them, and the output of the test is compared with the expected output.

# HJIF Semantic conformance

Tests are made on a set of 29 HJIF files, not conforming to the semantic rules of the HJIF format specified in ISO/IEC 23090-31. A conformance test is performed on each of them, and the output of the test is compared with the expected output.

# HJIF compatibility with MIHS

Tests are made on a set of 40 HJIF files, conformant with the HJIF format specified in ISO/IEC 23090-31 but containing values that may not be encoded in the binary format. A conformance test is performed on each of them, and the output of the test is compared with the expected output.

# MIHS Conformance

Tests are made on a set of 17 non-conformant MIHS files (.hmpg). A conformance test is performed on each of them, and the output of the test is compared with the expected output.

# Conversion checks

Tests are made on a set of 22 conformant HJIF reference files that are first encoded in MIHS and then decoded back to the HJIF format. A one-by-one comparison of each reference file and its associated decoded file is then performed to check that the data in the decoded file has not been altered.

# Conclusion

Based on the results of the evaluation of the reference software, the new version CRM5.1 is released. It can be accessed from the MPEG GitLab identified by the **CRM5.1** tag in the MPEG Haptics repository. The software can be accessed directly from here:

<https://git.mpeg.expert/MPEG/3dgh/haptics/software/ReferenceSoftwarePhase1/-/tags/CRM5.1>