**INTERNATIONAL ORGANIZATION FOR STANDARDIZATION**

**ORGANISATION INTERNATIONALE DE NORMALISATION**

**ISO/IEC JTC1/SC29/WG11**

**CODING OF MOVING PICTURES AND AUDIO**

**ISO/IEC JTC1/SC29/WG11 MPEG2014/N16732**

 **Jan. 2017, Geneva, CH**

**Title: Call for Proposals for Point Cloud Compression**

**Source: MPEG 3DG**

**Status: Approved**

# Abstract

This document is a Call for Proposals (CfP) for 3D point cloud compression technology, targeting an efficient representation of static objects and scenes, as well as dynamic objects and real-time acquisition environments.

# Introduction

Advanced 3D representations of the world are enabling more immersive forms of interaction and communication, and also allow machines to understand, interpret and navigate our world. 3D point clouds have emerged as an enabling representation of such information. A number of use cases associated with point cloud data have been identified [1] and corresponding requirements for point cloud representation and compression have been developed [2].

A point cloud is a set of points in a 3D space each with associated attributes, e.g. color, material properties, etc. Point clouds can be used to reconstruct an object or a scene as a composition of such points. They can be captured using multiple cameras and depth sensors in various setups and may be made up of thousands up to billions of points in order to realistically represent reconstructed scenes. Annex A of this document contains the definitions used for a point cloud in this Call for Proposals.

Compression technologies are needed to reduce the amount of data required to represent a point cloud. As such, technologies are needed for lossy compression of point clouds for use in real-time communications. In addition, technology is sought for lossless point cloud compression in the context of dynamic mapping for autonomous driving, six Degrees of Freedom (6 DoF) virtual reality, cultural heritage applications, etc. The standard to be developed will address compression of geometry and attributes such as colors and reflectance, scalable/progressive coding, coding of sequences of point clouds captured over time, and random access to subsets of the point cloud. The acquisition of point clouds is outside of the scope of this standard.

Recently, the investigation of new coding tools for static and dynamic 3D point clouds have shown evidence that improved coding efficiency with respect to existing solutions are possible.

Companies and organizations are invited to submit proposals in response to this Call for Proposals.

Point cloud compression technologies will be evaluated based upon objective metrics. Results of these tests will be made public, taking into account that no direct identification of any of the contributors will be made (unless it is specifically requested or authorized by a contributor to be explicitly identified). Prior to having evaluated the results of the tests, no commitment to any course of action regarding the point cloud compression technology can be made. In addition, subjective evaluation of proposals will be performed by expert viewers.

Descriptions of proposals shall be registered as input documents to the proposal evaluation meeting in October 2017 (see timeline in next section). Proponents are strongly recommended to attend that meeting to present their proposals. For those organizations and individuals that are not accredited members of the MPEG working group, further information about logistical steps to attend the meeting can be obtained from the contact persons listed in section 7.

# Timeline

**Timeline of the calls, deadlines and evaluation of the responses:**

|  |  |  |
| --- | --- | --- |
| **Action** | **Date**  | **Remarks** |
| **Call for proposals** | **2017.01.31** |  |
| **Draft complementary PCC Test Material to be used during the evaluation** | **2017.01.31** |  |
| **Final complementary PCC Test Material to be used during the evaluation** | **2017.04.07** |  |
| **Submission deadline for registration** | **2017.10.02** | **This is equivalent with a declaration of intention and an email should be sent to contact addresses listed in section 7. The ftp account will be provided to proponents.** |
| **Submission of testing material for subjective evaluation to the ftp site** | **2017.10.09** | **Windows decoder and the compressed bistreams must be provided** |
| **Submission of the completed objective evaluation spreadsheets to the ftp site** | **2017.10.09** |  |
| **Compilation of submited data in a unique spreadsheet and submission as an input contribution** | **2017.10.17**  | **Action performed by Marius Preda** |
| **Submission deadline for proposals documentation to be upload to WG11 web site** | **2017.10.18** |  |
| **Evaluation of responses** | **2017.10.22–2017.10.27** | **Action performed during the MPEG meeting week. Proponents are strongly advised to present their proposals in person.** |
| **The first working draft and test model**  | **2017.10.27** |  |

**Preliminary Development Plan:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Month** | **Day** | **MPEG meeting** | **City** | **Country** | **Stage** |
| 2017 | 01 | 20 | 117 | Geneva | CH | Approval of CfP |
| 2017 | 10 | 27 | 120 | Macao | CN | Approval of WD |
| 2018 | 04 | 20 | 122 | San Diego | US | Approval of CD |
| 07 | 20 | 123 | Ljubljana | SI | Approval of DIS |
| 10 |  | 124 | ?? | CA | Approval of FDIS |

# Test Materials, Categories and Conditions

This CfP addresses three categories of point cloud content, as illustrated below.

|  |  |
| --- | --- |
| **Test Category** | **Information to be encoded** |
| Category 1. Static Objects and Scenes | X, Y, Z, R, G, B |
| Category 2. Dynamic Objects | X, Y, Z, R, G, B, t |
| Category 3. Dynamic Acquisition | X, Y, Z, R, G, B, I, t |

Details about test materials, categories and conditions are provided in the document "**Complementary PCC Test Material**", published with the number w**16716** at 117th MPEG meeting. An updated version of this document, providing more complete details, will be produced at 118th MPEG meeting and potential proponents are expected to consult it before submitting their proposals.

# Submission Requirements

Proposals should include submissions to at least one of the three test categories and follow all the relevant test conditions and coding constraints defined in the document "**Complementary PCC Test Material**". In the following sections, details on the coded test material and documentation that form a complete proposal are provided.

## Coded test material

The following material must be made available by proponents of technologies.

1. Bitstreams for all datasets in target test categories which follow the associated test conditions and satisfy rate constraints specified in the document "**Complementary PCC Test Material**".
2. Binary decoder executable (Windows 64 bits), configuration files (if available) and usage documentation allowing to decode the bitstreams specified at previous point.
3. Md5Sum checksum files for files indicated to the previous points.

## Evaluation spreadsheets

Complete submissions shall include the following elements:

* The evaluation spreadsheet provided in Annex A of the document "**Complementary PCC Test Material**" must be completed and submitted together with the proposal.

## Documentation

Complete submissions shall include the following elements:

1. An information form must be submitted within each proposal. This form can be found in Annex B of this document.
2. A technical description for full conceptual understanding and generation of equivalent performance results by experts. This description should include all data processing paths and individual data processing components used to generate the bitstreams. It does not need to include complete bitstream format or implementation details, although as much detail as possible is desired.
3. The technical description shall state how the proposed technology behaves in terms of random access to any frame within the sequence. For example, a description of the GOP (Group of Pictures) like structure and the maximum number of frames that must be decoded to access any frame could be given.
4. The technical description shall specify the expected encoding and decoding delay characteristics of the technology, including structural delay e.g. due to the amount of frame reordering and buffering and the degree by which the delay can be minimized by parallel processing.
5. The technical description shall contain information suitable to assess the complexity of the implementation of the technology, including the following:
* Encoding time[[1]](#footnote-1) for each bit stream of the software implementation. A description of the platform and the methodology used to determine the time is needed. To help interpretation, a description of software and algorithm optimizations undertaken, if any, is welcome.
* Decoding time1 for each bitstream running the software implementation of the proposal, run on the same platform. Proponents shall provide a description of the platform and methodology used to determine the time. To help interpretation, a description of software optimizations undertaken, if any, is encouraged.
* Expected memory usage of encoder and decoder.
* Complexity of encoder and decoder, in terms of number of operations, dependencies that may affect throughput, etc.
* Degree of capability for parallel processing.
* Degree to which bitstreams can be considered progressive

## Source code

* Proponents are encouraged (but not required) to allow other committee participants to have access, on a temporary or permanent basis, to their encoded bit streams and binary executables or source code.
* Proponents are encouraged to submit a statement about the programming language in which the software is written, e.g. C/C++, and the platform(s) on which the binaries were compiled. Note that low-level programming optimizations such as assembly code/intrinsics and external compression libraries are discouraged.

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.

# Evaluation Procedure

The technologies will be evaluated subjectively, in sessions organized during the 120 MPEG meeting with expert viewers, and objectively based on distortion metrics documented in the "**Complementary PCC Test Material**".

Details about the evaluation procedure are provided in the document "**Complementary PCC Test Material**", published with the number w**16716** at 117th MPEG meeting in its draft version. An updated version of this document, providing more complete details, will be produced at 118th MPEG meeting and potential proponents are expected to consult it before submitting their proposals.

The evaluation procedure will be conducted to select a baseline set of technologies. Subsequent core experiments will be used to obtain the best technical solution to fulfill the requirements.

# IPR

Proponents are advised that this call is being made subject to the patent policy of ISO/IEC and other established policies of the standardization organization. The persons named below as contacts can assist potential submitters in identifying the relevant policy information.

# Contacts

Contact persons:

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# References

1. Use Cases for Point Cloud Compression, ISO/IEC JTC1/SC29 WG11 Doc. N16331, Geneva, CH, June 2016.
2. Requirements for Point Cloud Compression, ISO/IEC JTC1/SC29 WG11 Doc. N16330, Geneva, CH, June 2016.
3. **Complementary PCC Test Material** ISO/IEC JTC1/SC29 WG11 Doc. N**16716**, Geneva, CH, January 2017.

# Annex A: MPEG Point Cloud and PCC Definitions

*Point Cloud*. A point cloud is defined as set of (x,y,z) coordinates, where x, y, z have finite precision and dynamic range. Each (x,y,z) can have multiple attributes associated to it (a1 ,a2, a3 …). Typically each point in a cloud has the same number of attributes attached to it. Point clouds with different number of attributes per point will not be considered unless explicitly proven to be useful.

$point v=\left(\left((x,y,z\right),\left[c\right],\left[a\_{0}..a\_{A}\right]\right): x,y,z\in R ,\left[c \in \left(r,g,b\right) \right|r,g,b \in N], [a\_{i} \in \left[0,1\right]])$ (def. 1)

The point cloud is then simply a set of K points without a strict ordering:

$Original Point Cloud V\_{or}=\{\left(v\_{i}\right):i=0…..K-1\}$ (def. 2)

*Lossless Point Cloud Compression*. In the case of lossless compression, the decoder returns exactly the same set of (x,y,z), with exactly the same attributes. This is the same number of points with the same coordinates. An efficient way to canonically order the set and test for equality is to convert to Morton codes [14].

*Lossy Point Cloud Compression*. In this case the number of points in the set and/or the positions x,y,z are not identical to the original.

*Lossy Attributes Compression*. In this case the values of the attributes are not the same compared to the values of the original

# Annex B: Information Form

1. Title of the proposal
2. Organization (i.e., name of proposing company)
3. What does your proposal apply to?

|  |  |
| --- | --- |
| (a) tele-immersive | (b) Interactive parallax |
| (c) Free viewpoint sports | (d) GIS |
| (e) Cultural Heritage | (f) Automotive |
| (g) other |  |

1. What is the main functionality of your proposal?
2. Do you plan to attend the 118th MPEG meeting and make a presentation to explain your proposal and answer questions about it?
3. Will you provide a demonstration to show how your proposal meets the evaluation criteria?

To clearly identify the requirements satisfied by each proposal, proponents should complete the table of requirements provided below.

|  |  |
| --- | --- |
| Requirements on PCC | Addressed functionality(O/X) |
|  |  |
|  |  |
|  |  |
|  |  |

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1. For example, using ntimer for Windows systems. [↑](#footnote-ref-1)