**INTERNATIONAL ORGANISATION FOR STANDARDISATION**

**ORGANISATION INTERNATIONALE DE NORMALISATION**

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

**CODING OF MOVING PICTURES AND AUDIO**

**ISO/IEC JTC1/SC29/WG11 MPEG2016/n16330**

**February 2016, Geneva, CH**

|  |  |
| --- | --- |
| **Status** | Draft |
| **Title** | Requirements for Point Cloud Compression |
| **Authors** | Rufael Mekuria, Christian Tulvan, Zhu Li |

# Introduction

While so far the most common way of representing the visual component of the world has been to take the output of a camera, compress it for transmission and storage using one of the MPEG video coding standards and eventually decode it and present it on 2D displays, there are now more and more devices that capture and present 3D representations of the world.

A point cloud is a set of points in a 3D space each with associated data relative to the value of the two angles (phi and theta) used in the acquisition, e.g. color, material properties and/or other attributes. Point clouds can be used to reconstruct an object or a scene as a composition of such points. Point clouds 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 represent realistically reconstructed scenes.

As compression technologies are needed to reduce the amount of data required to represent a point cloud, MPEG is planning to develop a Point Cloud Compression standard targeting lossy compression for use in real-time communications, lossless compression for GIS, CAD and cultural heritage applications, with attributes of efficient geometry and attributes compression, 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.

# Requirements for Point Cloud Compression

This document presents the requirements for MPEG Point Cloud Compression. The requirements capture the use cases defined for PCC in MPEG [1], but are not limited to these use cases only.

## 3D Point Cloud Representation

Requirement

MPEG PCC shall provide means for representing 3D point clouds.

Specification

1. The 3D point cloud representation shall include 3D position (X, Y, Z) with a specification of its precision and dynamic range.
2. The 3D point cloud representation shall support multiple attributes being associated with each 3D position including colour, reflectance, normal vectors and transparency or other attributes.
3. The 3D point cloud representation shall support generic attributes being associated with each 3D position.
4. The 3D point cloud representation shall support view-dependent attributes being associated with each 3D position.
5. The representation shall support time-varying point clouds.

## 3D Point Cloud Compression

Requirement

MPEG PCC shall provide means for efficient compression for storage, streaming or downloading of 3D point clouds. The compression shall encompass from lossless to lossy.

Specification

Tools shall be provided for progressive compression of 3D point clouds.

Tools should be provided for error resilient compression of 3D point clouds.

1. Lossy compression: parameter control of the bitrate shall be supported.
2. Lossless compression: the reconstructed data shall be mathematically identical to the original one.
3. Temporal variations of point clouds shall be supported.
4. Progressive and/or scalable coding: it shall be possible to first decode a coarse point cloud and then refine it.
5. View-dependent decoding, spatial random access: it shall be possible to first decode the point-cloud corresponding to a region.
6. Temporal random access shall be possible.
7. Error resilience: it should be possible to cope with packet loss without having to retransmit the entire point cloud.
8. Compression shall support encoding and decoding with low complexity, low latency and/or real-time implementation
9. Compression should enable parallel encoding and decoding.
10. Compression shall target compression rates of 10 times for lossy coding and upto 40 times for lossy coding.
11. Output bitrates of 5 Mbps, 10 Mbps, 20 Mbps and 40 Mbps shall be supported

# Appendix 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.

*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

# References

[1] n16331 Use Cases for Point Cloud Compression ISO/JCT SC29 WG11 Geneva June 2016