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**CODING OF MOVING PICTURES AND AUDIO**

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# Introduction

This document aims at providing an informative update of the status of G-PCC (TMC13) provided in output document [w17889] (July 2018) with respect to PCC requirements [w17353].

# G-PCC requirements

## G-PCC point cloud representation requirements

It is noted that phrasing of requirements may lead to different interpretation.

For convenience purposes, the list of requirements for point cloud representation as stated in [w17353] and completed with G-PCC related piece of information is provided below:

Requirement

MPEG PCC shall provide means for encoding and decoding 3D point clouds.

Specification

The 3D point cloud representation shall support:

1. 3D positions: the (X, Y, Z) coordinates with a specification of its precision and dynamic range.

*Supported in G-PCC*

1. Pre-defined attributes: the attributes associated with each 3D position including colour, reflectance, normal vectors and transparency.

*Supported in G-PCC; the type of each attribute is identified by a label*

1. Generic (i.e., user-defined) attributes per 3D position

*Supported by G-PCC (attribute labels may be user-defined).*

1. View-dependent attributes per 3D position

*In G-PCC the value of the attribute\_instance\_id differentiates attributes with identical attribute labels. For example, it is useful for the point clouds having multiple colour attributes from the different view point. An external mapping of attribute\_instance\_id to view point is required. No inter-instance compression is performed.*

1. Time-varying point clouds: point clouds captured or represented with timed information.

*The G-PCC elementary stream does not contain frame-based timing information beyond a frame counter. Frame level timing information must be provided by a systems layer. Points from multiple frames may be merged and compressed as a single frame; a per-point fame index attribute permits the merged frame to be decomposed into individual frames. Per-point timing information may be represented as a point attribute. G-PCC does not otherwise address temporal correlation.*

The following table updates the table 1 given in [w17889]

(‘🗸’ = Supported, ‘🗸’ = Newly supported wrt w17889,

‘(🗸)’ = Partial support wrt w17889, ‘🗴’ = Not supported)

|  |  |
| --- | --- |
| Requirements | G-PCC |
| a) 3D positions | 🗸 |
| b) Pre-defined attributes | 🗸 |
| c) Generic attributes | 🗸 |
| d) View-dependent attributes | 🗸[[1]](#footnote-1) |
| e) Time-varying | 🗸1 |

Table 1 Updated (green) status of supported requirements of G-PCC

## G-PCC point cloud compression requirements

For convenience purposes, the list of requirements for point cloud compression as stated in [w17353] and completed with G-PCC related piece of information is provided below:

Requirement

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

Specification

MPEG PCC shall support:

1. Lossy compression: parameter control of the bitrate shall be supported.

*Supported by G-PCC*

1. Lossless geometry compression: the reconstructed position shall be mathematically identical to the original. The number of points reconstructed from the compressed point cloud is the same as the original. The reordering of points during compression is permissible.

*Supported by G-PCC*

1. Lossless attribute compression: the reconstructed attributes shall be mathematically identical to the original. The number of points reconstructed from the compressed point cloud is the same as the original. The reordering of points during compression is permissible.

*Supported by G-PCC*

1. Near-lossless geometry compression: The number of points after compression remains the same as the original, but the point locations after compression may not be mathematically identical, but the error between the original and compressed points is always less than the given error margin.

*Supported by G-PCC. Geometry may be either pre-quantized and losslessly coded, or in-tree geometry quantization may be applied on a per-point basis. The error in either case is bounded.*

1. Near-lossless attribute compression: The number of points after compression remains the same as the original, but the point attributes after compression may not be mathematically identical, but the error between the original and compressed attributes is always less than the given error margin.*.*

*Supported by G-PCC. Attribute compression may be configured to guarantee an error bound.*

1. Temporal variations (e.g., dependency among temporal frames) of point clouds shall be supported.

*G-PCC supports intra coding with a temporal notion but without "dependency among temporal frames". There is no consideration of temporal compression in current G-PCC specification.*

1. Low latency: Encode plus decode as low as one point cloud frame duration shall be supported. For some applications, an even lower latency should be supported.

*It is remarked that this requirement section may be split in "single frame latency" and "sub-frame latency". The smallest decoding unit in G-PCC is the slice (a set of points); a point cloud frame is defined by one or more slices.*

1. Low complexity: The complexity shall allow for feasible implementation of encoding and decoding within the constraints of the available technology at the expected time of usage.

*Supported by G-PCC. Complexity is part of the decision-making process in MPEG: trade-off between gains and complexity.*

1. Temporal scalability: The dependency of frames shall be structured such that some frames can be dropped from the bitstream.

*G-PCC supports only intra frames and some may be dropped to enable some sort of temporal scalability but appropriate signaling seems currently missing in the bitstream syntax. It is remarked that such signaling may occur at the transport layer.*

1. Spatial scalability: The compressed bitstream shall be structured with more than one layer to decode the points of the current layer predicted from the points from the lower layer(s) which provides a coarse approximation (i.e., a lower number of points) of the entire point cloud.

*G-PCC enables partial decoding of geometry and corresponding attributes (this might relate to progressive refinement or partial decoding) however there is no prediction from a lower layer and combination with a refinement layer.*

1. Region-based spatial scalability: The compressed bitstream shall be structured with more than one layer such that certain regions of interest may have a higher density with additional layers; where the layers may be predicted from the lower layer(s).

*In G-PCC, the stream may be sliced into regions. This mechanism may be combined with spatial scalability to offer a region-based scalability.*

1. Quality scalability: A point cloud shall be coded at a single spatial resolution but at different qualities (or bit depths). The data and decoded samples of lower qualities may be used to predict data or samples of higher qualities to reduce the bit rate to code the higher qualities.

*G-PCC may enable multiple streams, one stream with lower resolution and another with higher one, however there is no so-called refinement layer.*

1. Spatial random access: it shall be possible to decode the point-cloud corresponding to a region without having to decode the entire bitstream.

*Supported by G-PCC. The smallest decodable unit is the slice; each slice may belong to a tile. Each tile provides metadata for spatial random access.*

1. Temporal random access shall be possible.

*G-PCC (all intra) supports temporal random access.*

1. Error resilience: it shall be possible to cope with packet loss without having to retransmit the entire point cloud.

*The smallest decodable unit is the slice; the loss of a slice does not affect the decoding of any other slices. Codec parameters are signalled in parameter sets that may be afforded protection by a transport/system layer.*

1. Parallel encoding and decoding: The design should support parallel processing implementation with low cost in terms of bitrate overhead.

*Individual slices may be encoded and decoded in parallel. Parallel geometry decoding within a single slice is supported.*

*NOTE: PCC requirement document may be updated with progressive streaming and the two possible low latency categories such as discussed above. Possibly, clarify quality scalability requirement definition.*

The following table updates the table 2 given in [w17889]

(‘🗸’ = Supported, ‘🗸’ = Newly supported wrt w17889,

‘(🗸)’ = Partial support wrt w17889, ‘🗴’ = Not supported wrt w17889)

|  |  |
| --- | --- |
| Requirements | G-PCC |
| a) Lossy compression | 🗸 |
| b) Lossless geometry compression | 🗸 |
| c) Lossless attribute compression | 🗸 |
| d) Near-lossless geometry compression | 🗸 |
| e) Near-lossless attribute compression | 🗸 |
| f) Temporal variations | 🗴 |
| g) Low latency | 🗸 |
| h) Low complexity | 🗸 |
| i) Temporal scalability | (🗸1) |
| j) Spatial scalability | (🗸) |
| k) Region-based scalability | 🗸 |
| l) Quality scalability | (🗸) |
| m) Spatial random access | 🗸 |
| n) Temporal random access | 🗸 |
| o) Error resilience | 🗸1 |
| p) Parallel encoding and decoding | 🗸 |

Table 2 Updated (green) status of supported requirements of G-PCC

# References

[[w17353](http://wg11.sc29.org/doc_end_user/current_document.php?id=61231&id_meeting=173)] PCC Requirements, ISO/IEC JTC1/SC29 WG11, Gwangju, Korea, January 2018.

[[w17889](http://wg11.sc29.org/doc_end_user/current_document.php?id=63428&id_meeting=175)] Current Status of covering PCC requirements, Ljubljana, Slovenia, July 2018.

1. A covered feature or requirement may be dependent upon external means e.g. systems layer providing required metadata... [↑](#footnote-ref-1)