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| **Email of acting convenor** | ostermann@tnt.uni-hannover.de |
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# Introduction

This document provides the status on addressing the PCC requirements [w17353] using V-PCC.

# PCC requirements

## Point cloud representation requirements

This section lists the PCC requirements for point cloud representation as stated in [w17353] and provides information whether each requirement is satisfied by the current version (DIS) of the V-PCC specification [[w19329](http://wg11.sc29.org/doc_end_user/documents/130_Alpbach/wg11/w19329.zip)] (in italics after each requirement statement).

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 V-PCC*

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

*Supported in V-PCC*

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

*Supported in V-PCC (ai\_attribute\_type\_id may be unspecified)*

1. View-dependent attributes per 3D position

*According to [*[*m52755*](http://wg11.sc29.org/doc_end_user/current_document.php?id=73197&id_meeting=181)*],* *this feature may be addressed in V-PCC thanks to tiling, volumetric SEI and viewport SEI messages. A patch may be viewed according to the viewer angle. It is noted that up to 127 attributes may be carried in the V-PCC stream. It is remarked that the usual 3D graphics definition of view-dependent covers the modulation of colour for an arbitrary angle of view, which can be addressed in a post-decoding rendering stage.*

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

*V-PCC can code dynamic point clouds*

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

(‘🗸’ = Supported)

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| Requirements | V-PCC |
| a) 3D positions | 🗸 |
| b) Pre-defined attributes | 🗸 |
| c) Generic attributes | 🗸 |
| d) View-dependent attributes | 🗸 |
| e) Time-varying | 🗸 |

Table 1 Status of supported requirements of V-PCC

## Point cloud compression requirements per test model

This section lists of the PCC requirements for point cloud compression as stated in [w17353] and provides information whether each requirement is satisfied by the current version (DIS) of the V-PCC specification [[w19329](http://wg11.sc29.org/doc_end_user/documents/130_Alpbach/wg11/w19329.zip)]. (in italics after each requirement statement).

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 V-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.

*V-PCC supports lossless coding of geometry through the underlying 2D video codec used to code the geometry video. Besides, V-PCC comprises tools to code or represent geometry losslessly (e.g. using RAW and EOM).*

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.

*V-PCC supports lossless coding of attributes through the underlying 2D video codec used to code the attribute video.*

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.

*V-PCC supports near-lossless coding of geometry through the underlying 2D video codec used to code the geometry video.*

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.

*V-PCC supports near-lossless coding of attributes through the underlying 2D video codec used to code the attribute video.*

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

*Supported by V-PCC (dynamic point cloud and interframes).*

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.

*V-PCC supports subframe low-latency thanks to tile groups and possibly RAW points.*

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 V-PCC. Complexity is part of the decision-making process in MPEG: trade-off between gains and complexity.* *Implementations of V-PCC real-time decoding are demonstrated in several trade fairs.*

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

*V-PCC could support temporal scalability through 2D video codec (see [*[*m52755*](http://wg11.sc29.org/doc_end_user/current_document.php?id=73197&id_meeting=181)*]). However, it is noted that atlas temporal scalability is disabled in the current version of V-PCC.*

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.

*According to [*[*m52755*](http://wg11.sc29.org/doc_end_user/current_document.php?id=73197&id_meeting=181)*], spatial scalability in V-PCC may be supported by maps (delta coding), level of detail (LoD), RAW points, video codec scalability (depends on usage of such codec). However, there is no inter-layer prediction set per V-PCC.*

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).

*According to [*[*m52755*](http://wg11.sc29.org/doc_end_user/current_document.php?id=73197&id_meeting=181)*], region-based spatial scalability such as defined here may be enabled by combination of tiling and LoD mechanism in V-PCC. However, there is no prediction of the additional layer.*

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.

*According to [*[*m52755*](http://wg11.sc29.org/doc_end_user/current_document.php?id=73197&id_meeting=181)*], in V-PCC, quality scalability may be supported by using a 2D video codec supporting quality scalability.*

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

*This feature is supported in V-PCC by the tiling mechanism.*

1. Temporal random access shall be possible.

*V-PCC supports temporal random access.*

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

*In V-PCC, this feature is supported by using a 2D video codec with error resilience mechanism and possibly with packing strategy, maps, etc..*

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

*In V-PCC, atlas tiling enables this feature. In addition, the geometry, attribute, occupancy maps may be decoded/encoded in parallel. Finally, the 2D video codec used for encoding video bitstreams may support parallelism features.*

(‘🗸’ = Supported, ‘(🗸)’ = Partly supported)

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| Requirements | V-PCC |
| a) Lossy compression | 🗸 |
| b) Lossless geometry compression | 🗸[[1]](#footnote-1) |
| c) Lossless attribute compression | 🗸1 |
| d) Near-lossless geometry compression | 🗸1 |
| e) Near-lossless attribute compression | 🗸 |
| f) Temporal variations | 🗸 |
| g) Low latency | 🗸 |
| h) Low complexity | 🗸 |
| i) Temporal scalability | (🗸1) |
| j) Spatial scalability | 🗸1 |
| k) Region-based scalability | 🗸 |
| l) Quality scalability | 🗸1 |
| m) Spatial random access | 🗸 |
| n) Temporal random access | 🗸 |
| o) Error resilience | 🗸1,[[2]](#footnote-2) |
| p) Parallel encoding and decoding | 🗸1 |

Table 2 Status of supported requirements of V-PCC

# Conclusion

This document provides information on whether the PCC requirements for point cloud representation as stated in [w17353] and are satisfied by the current version (DIS) of the V-PCC specification [[w19329](http://wg11.sc29.org/doc_end_user/documents/130_Alpbach/wg11/w19329.zip)].

# References

[[w19376](http://wg11.sc29.org/doc_end_user/documents/130_Alpbach/wg11/w19376.zip)] Draft Status on addressing the V-PCC and G-PCC requirements, Alpbach, Austria, April 2020.

[[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.

[[m52755](http://wg11.sc29.org/doc_end_user/current_document.php?id=73197&id_meeting=181)] Scalability support in V-PCC, A.M. Tourapis et al, Brussels, Belgium, January 2020.

[[w19329](http://wg11.sc29.org/doc_end_user/documents/130_Alpbach/wg11/w19329.zip)] Text of ISO/IEC 23090-5 DIS Video-based Point Cloud Compression, Alpbach, Austria, April 2020.

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1. V-PCC leverages existing video codecs for coding atlases (projection of 3D pieces on planes). Feature may be enabled thanks to underlying video codec. [↑](#footnote-ref-1)
2. A covered feature or requirement may be dependent upon external means e.g. systems layer providing required metadata... [↑](#footnote-ref-2)