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# Abstract

In this document we provide descriptions for the core experiment 13.22 on the study of improvements to the octree coding for the geometry of Geometry-based PCC.

The octree representation of the geometry may suffer from some non-optimal compression performance in case the local geometry of the point cloud shows some specific priors like planarity or non-homogeneous directionality. In addition, when a bounding box is not a cube, regular octree partition may become infeasible or not optimal. In this case, alternative tree partition such as quadtree partition or binary tree partition can be utilized.

The goals of this Core Experiment are now focused on:

* extend the octree representation of the geometry by introducing new representations at the node level of the octree
* while maintaining the underlying octree structure used by other tools, in particular neighbour information
* extend the octree partition to quadtree or binary tree partition without explicit signalling.

# CE 13.22 on Improvements to Octree coding

## Mandates

* study the impact on compression performance of the proposed new representations of the geometry
* evaluate the trade-off compression performance vs complexity
* report the change of the new representations to the octree-related tools like occupancy bit entropy coding and neighbouring node determination

Related changes to the G-PCC Improvements [2] shall be reported.

## Participants, description of tools, and implementation notes

The following people are participating in this CE. Their specific roles are detailed in the next section. Proposals are based on the input contributions

1. m48906, *Planar mode in octree-based geometry coding,* BlackBerry
2. m49231, *Implicit geometry partition for point cloud coding*, Tencent

Proponents and cross checkers are

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## Information on proposed tools

### Planar mode in octree-based geometry coding from m48906

Contribution m48906 [4] introduces planar modes, in the three directions xyz, as new representations of the geometry. Planar modes are activated at eligible node level through a planar mode activation flag coded in the bitstream. Also, an extra syntax is added to the bitstream to indicate the position of the plane associated with activated planar modes.

The predication of both the flag and the plane position are also introduced to ensure good compression of the new syntax element.

Finally, local eligibility criteria are used to avoid using planar modes in adverse regions of the point cloud and thus avoiding worse compression performance, particularly on dense point clouds.

It has been observed that turning IDCM on/off has a strong impact on the compression performance as well as the running time.

### Implicit geometry partition for point cloud coding from m49231

In contribution m49231 [5], the bounding box B is not restricted to be a cube, instead it can be an arbitrary-size rectangular cuboid to better fit for the shape of the 3D scene or objects. In the implementation, the size of B is represented as a power of two, i.e., . Note that are not assumed to be equal, they are signaled separately in the slice header of the bitstream.

As B may not be a perfect cube, in some cases the node may not be (or unable to be) partitioned along all directions. If a partition is performed on all three directions, it is a typical octree (OT) partition. If performed on two directions out of three, it is a quadtree (QT) partition in 3D. If performed on one direction only, it is then a binary tree (BT) partition in 3D. Examples of QT and BT in 3D are shown in Fig. 1 and Fig, 2, respectively.

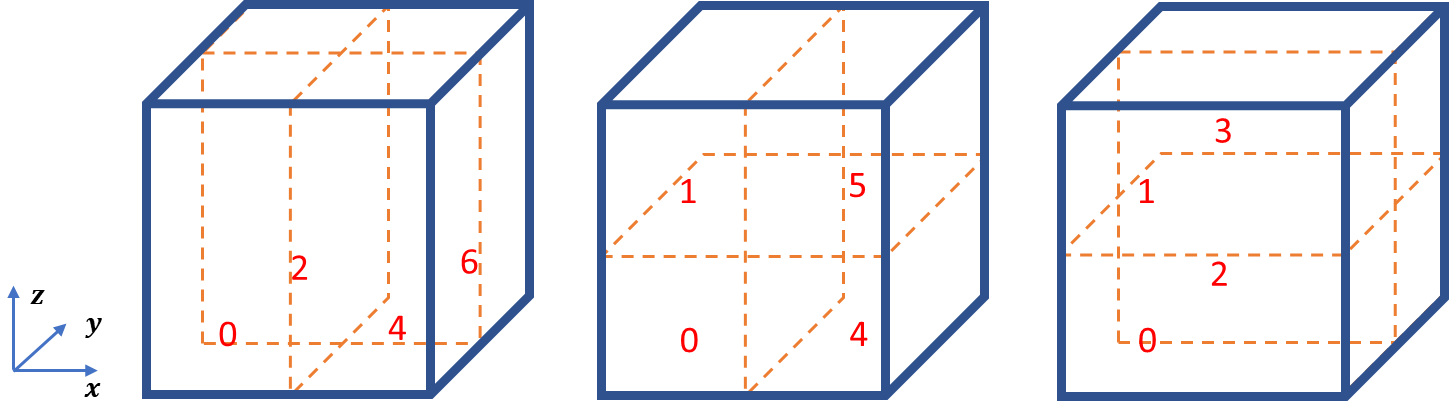
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Figure 1: Quad-tree partition of a 3D cube, along x-y, x-z, y-z axes, respectively.

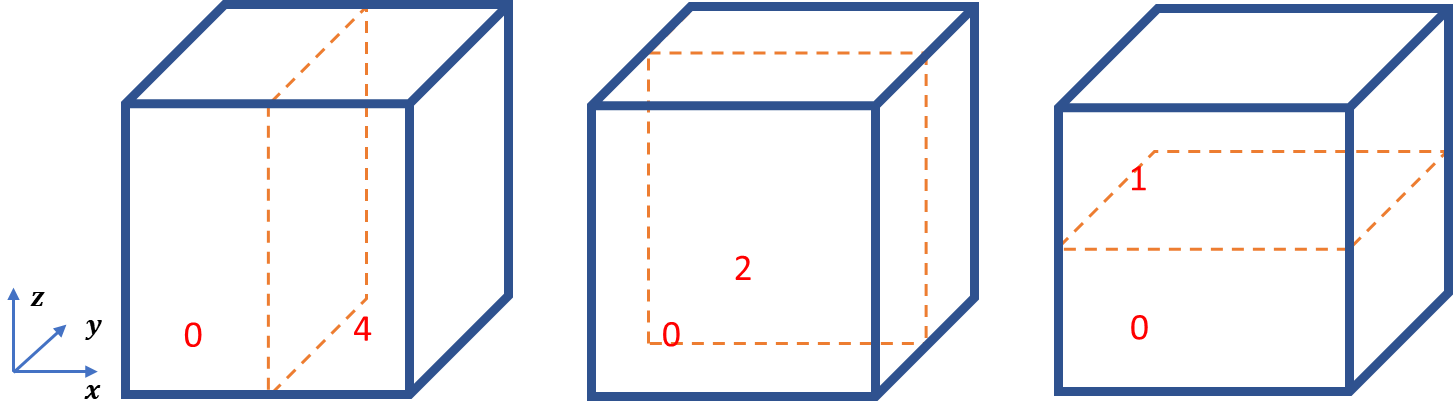
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Figure 2: Binary-tree partition of a 3D cube, along x, y, z axis, respectively.

When conditions are met, QT and BT partitions can be performed implicitly. “Implicitly” implies that no additional signaling bits are needed to indicate that a QT or BT partition, instead of an OT partition, is used. Determining the type and direction of the partition is based on the pre-defined conditions. Moreover, bits can be saved from an implicit QT or BT partition compared to an OT partition when signaling the occupancy information of each sub-node. A QT requires four bits, reducing from eight, to represent the occupancy status of four sub-nodes, while a BT only requires two bits.

In addition, since the implicit partition may lead to sub-nodes with unequal sizes in dimensions, the direct coding mode (DM) should be changed accordingly. For example, if a sub-node with the size of is to be coded in DM mode, the relative positions of each point in the sub-nodes are coded by fixed-length coding with bits, respectively.

## Information for conducting tests

Adoption of the tool should be based on the discussion of the compression gains and the complexity of said tools.

The two proposed tools will be tested individually. However, it is encouraged to study the compatibility of the tools and report the results of a subsequent combination.

### Software

TMC13v7 shall be used for these experiments. The proposed tools shall be implemented on top of TMC13v7.

### Test configurations

Parameters and configurations for the modified TMC13v7 software will be provided by the proponent.

### Evaluation Method

The point cloud test material will be tested for the test sequences of category

* (1) Static Objects and Scenes
* (3) Dynamic Acquisition

as defined by the CTC [3]. The following test conditions will be under evaluation

1. *CW AI lossless geometry – (lossless attribute)*
2. *C2 AI, lossy geometry – (lossy attribute)*

Note that the tested technologies should have an impact on geometry compression only and that attribute compression performance are reported informatively.

## CE 13.22 Coordinators

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# Timeline:

* **2019-08-12**: Expected date for TMC13v7 release;
* **2019-09-02 [TMC13v7 + 3 weeks]**: Deliver source code and results for cross check;
* **2019-09-16**: **[TMC13v7 + 5 weeks]** Report of preliminary cross check results;
* **2019-10-02**: MPEG document upload deadline.

# References

1. “*G-PCC Test Model 7*”, ISO/IEC JTC1/SC29/WG11 MPEG2019 Doc. w18664, Goteborg, Sweden, July 2019
2. “*G-PCC Improvements*”, ISO/IEC JTC1/SC29/WG11 MPEG2019 Doc. w18669, Goteborg, Sweden, July 2019
3. “Common Test Conditions for PCC” ISO/IEC JTC1/SC29 WG11 MPEG2018”, ISO/IEC JTC1/SC29/WG11 MPEG2019 Doc. w18665, Goteborg, Sweden, July 2019
4. m48906, *Planar mode in octree-based geometry coding,* Goteborg, Sweden, July 2019
5. m49231, *Implicit geometry partition for point cloud coding,* Goteborg, Sweden, July 2019