

m49629:

*[G-PCC] Modification on LoD generation
process in TMC13*

- In current G-PCC specification, we found that there is an inconsistent process in generating LoD
- In detail, the assignment order of each 3D point to each LoD layer is different between top LoD layer and others
 - Top LoD layer → Descending order of Morton code
 - Others → Ascending order of Morton code
- We propose either order to remove the inconsistent

- In current CD text, section 8.3.2.1 defines level of Detail Generation as following,

```
for (lod = 0; unprocessedPointCount > 0 && lod <= levelDetailCount; lod++) {  
    ...  
    if (lod == levelDetailCount) { #top LoD layer  
        for ( i = unprocessedPointCount - 1; i >= 0; i-- ) { #descending order  
            assignedPointIndexes[assignedPointCount++] = unprocessedPointIndexes[i];  
        }  
    } else { #other layer  
        for ( i=0; i< unprocessedPointCount; i++) { #ascending order  
            ...  
            assignedPointIndexes[assignedPointCount++] = unprocessedPointIndexes[i]  
        }  
    }
```

- As the result, the coding order of 3D points also become opposite between top LoD layer and others
- To make the specification be consistent, it would be desired to use either way
→ Ascending order or descending order

Experimental result compared to TMC13v6

- Ascending order based LoD generation

lossless geometry, lossy attributes [all intra]						
C1_ai	End-to-End BD-AttrRate [%]					
	Luma	Chroma Cb	Chroma Cr	Reflectanc		
Cat1-A average	0.0%	0.0%	0.0%			
Cat3-fused average	0.0%	0.0%	0.0%	0.0%		
Cat3-frame average				0.0%		
Overall average	0.0%	0.0%	0.0%	0.0%		
Avg. Enc Time [%]		99%				
Avg. Dec Time [%]		99%				
lossy geometry, lossy attributes [all intra]						
C2_ai	End-to-End BD-AttrRate [%]				Geom. BD-TotGeomRate	
	Luma	Chroma Cb	Chroma Cr	Reflectanc	D1	D2
Cat1-A average	0.0%	0.0%	0.0%		0.0%	0.0%
Cat1-B average	#VALUE!	#VALUE!	#VALUE!		0.0%	0.0%
Cat3-fused average	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cat3-frame average				0.0%	0.0%	0.0%
Overall average	#VALUE!	#VALUE!	#VALUE!	0.0%	0.0%	0.0%
Avg. Enc Time [%]			96%			
Avg. Dec Time [%]			#NUM!			
lossless geometry, lossless attributes [all intra]						
CW_ai	bpip ratio [%]					
	Geometry	Colour	Reflectance	Total		
Cat1-A average	100.0%	100.0%		100.0%		
Cat1-B average	100.0%	#VALUE!		100.0%		
Cat3-fused average	100.0%	100.0%	100.0%	100.0%		
Cat3-frame average	100.0%		100.0%	100.0%		
Overall average	100.0%	#VALUE!	100.0%	100.0%		
Avg. Enc Time [%]		95%				
Avg. Dec Time [%]		96%				
lossless geometry, near-lossless attributes [all intra]						
CY_ai	EtE Hausdorff BD-AttrRate [%]					
	Luma	Chroma Cb	Chroma Cr	Reflectanc		
Cat1-A average	0.0%	0.0%	0.0%			
Cat3-fused average	-0.1%	-0.1%	-0.1%	0.0%		
Cat3-frame average				-0.3%		
Overall average	0.0%	0.0%	0.0%	-0.2%		
Avg. Enc Time [%]		100%				
Avg. Dec Time [%]		100%				

No obvious difference

Experimental result compared to TMC13v6

- Descending order based LoD generation

lossless geometry, lossy attributes [all intra]						
C1_ai	End-to-End BD-AttrRate [%]					
	Luma	Chroma Cb	Chroma Cr	Reflectance		
Cat1-A average	0.0%	-0.2%	0.1%			
Cat3-fused average	0.1%	0.0%	0.1%	0.0%		
Cat3-frame average				0.0%		
Overall average	0.0%	-0.1%	0.1%	0.0%		
Avg. Enc Time [%]			99%			
Avg. Dec Time [%]			99%			
lossy geometry, lossy attributes [all intra]						
C2_ai	End-to-End BD-AttrRate [%]				Geom. BD-TotGeomRate	
	Luma	Chroma Cb	Chroma Cr	Reflectance	D1	D2
Cat1-A average	0.4%	-0.1%	0.6%		0.0%	0.0%
Cat1-B average	#VALUE!	#VALUE!	#VALUE!		0.0%	0.0%
Cat3-fused average	-0.7%	-0.1%	-0.2%	0.1%	0.0%	0.0%
Cat3-frame average				-0.1%	0.0%	0.0%
Overall average	#VALUE!	#VALUE!	#VALUE!	-0.1%	0.0%	0.0%
Avg. Enc Time [%]			96%			
Avg. Dec Time [%]			#NUM!			
lossless geometry, lossless attributes [all intra]						
CW_ai	bpip ratio [%]					
	Geometry	Colour	Reflectance	Total		
Cat1-A average	100.0%	100.7%		100.5%		
Cat1-B average	100.0%	#VALUE!		100.0%		
Cat3-fused average	100.0%	100.0%	100.0%	100.0%		
Cat3-frame average	100.0%		100.0%	100.0%		
Overall average	100.0%	#VALUE!	100.0%	100.1%		
Avg. Enc Time [%]			94%			
Avg. Dec Time [%]			96%			
lossless geometry, near-lossless attributes [all intra]						
CY_ai	EtE Hausdorff BD-AttrRate [%]					
	Luma	Chroma Cb	Chroma Cr	Reflectance		
Cat1-A average	2.2%	2.2%	2.2%			
Cat3-fused average	0.0%	0.0%	0.0%	0.0%		
Cat3-frame average				0.0%		
Overall average	1.9%	1.9%	1.9%	0.0%		
Avg. Enc Time [%]			101%			
Avg. Dec Time [%]			101%			

Some loss in CY

- The inconsistent process on LoD generation was reported
- Two methods were tested
 - Ascending order based LoD generation method
 - Descending order based one
- The results showed no significant difference compared to TMC13v6 in case of ascending order based method
- We suggest including the ascending order based modification in next CD text and software

8.3.2.1 Level of Detail Generation

```
...
for (lod = 0; unprocessedPointCount > 0 && lod <= levelDetailCount; lod++) {
    ...
    if (lod == levelDetailCount) { #top LoD layer
        for ( i = unprocessedPointCount - 1; i >= 0; i-- ) { #descending order
            for ( i=0; i< unprocessedPointCount; i++ ) { #ascending order
                assignedPointIndexes[assignedPointCount++] = unprocessedPointIndexes[i];
            }
        } else { #other layer
            for ( i=0; i< unprocessedPointCount; i++) { #ascending order
                ...
                assignedPointIndexes[assignedPointCount++] = unprocessedPointIndexes[i]
```