**INTERNATIONAL ORGANISATION FOR STANDARDISATION**

**ORGANISATION INTERNATIONALE DE NORMALISATION**

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

**CODING OF MOVING PICTURES AND AUDIO**

**ISO/IEC JTC1/SC29/WG11 m54463**

**June-July 2020, Electronic Meeting**

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| **Source** | **InterDigital Communications, Inc.** |
| **Status** | **Input** |
| **Title** | **[PCC Systems] On DASH signalling for G-PCC content** |
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| **Agenda** | 37.1 |

# Introduction

The 3DG workgroup, in MPEG is currently working on developing a standard for geometry-based point cloud compression with a draft international standard (DIS) version released in the MPEG#129 meeting [1]. In parallel, MPEG is also developing a system standard for carriage of geometry-based point cloud data (ISO/IEC 23090-18) [2]. One important aspect that is still missing in the DIS is MPEG-DASH signalling of G-PCC media to support adaptive streaming.

Practical point cloud applications will require streaming point cloud data over the network. Such applications may perform either live or on-demand streaming of point cloud content depending on how the content was generated. Moreover, due to the large amount of information required for representing point clouds, such applications need to support adaptive streaming techniques to avoid overloading the network and provide the optimal viewing experience at any given moment with respect to the network capacity at that moment.

In this contribution, we propose various MPEG DASH based signaling methods for adaptive streaming of G-PCC streams.

# Proposed Solution

G-PCC media content is composed of a number of components such as geometry and attributes. Each component is separately encoded as a sub-stream of the G-PCC bitstream. Component sub-streams need to be collectively decoded along with additional metadata in order to render a point cloud.

A number of XML elements and attributes are defined. These XML elements are defined in a separate namespace "urn:mpeg:mpegI:gpcc:2020". The namespace designator "gpcc:" is used to refer to this name space.

## GPCCComponent Descriptor

Each G-PCC component can be represented in the DASH manifest (MPD) file as a separate Adaptation Set with a Main Adaptation Set serving as the access point for the G-PCC content. The G-PCC component present in an Adaptation Set and Representation Set is referred as Component Adaptation Set and Component Representation Set respectively.

To identify the type of the G-PCC component in an Adaptation Set, an EssentialProperty descriptor can be used with the @schemeIdUri attribute equal to "urn:mpeg:mpegI:gpcc:2020:component". This descriptor is referred to as a **GPCCComponent** descriptor. At adaptation set level, one **GPCCComponent** descriptor shall be signaled for each point cloud component that is present in the Representations of the adaptation set. The **GPCCComponent** descriptor shall include the attributes defined in Table 1.

Table 1 Elements and attributes for the GPCCComponent descriptor

|  |  |  |  |
| --- | --- | --- | --- |
| **Elements and Attributes for GPCCComponent descriptor** | **Use** | **Data type** | **Description** |
| **component** | 0..N | gpcc:gpccComponentType | An element whose attributes specify information for one of the Geometry point cloud components present in the representation(s) of the adaptation set. |
| **component**@component\_type | M | xs:string | Indicates the type of the point cloud component. Value ‘geom’ indicates a geometry component, and ‘attr’ indicates an attribute component. |
| **component**@attribute\_type | CM | xs:unsignedByte | Indicates the type of the attribute (refer to Table 8 in the G-PCC DIS 23090-9 [1]). Only values between 0 and 255, inclusive, are allowed. Shall be present only if the component is a geometry point cloud attribute (i.e., component\_type has the value ‘attr’).  Attribute type & value  0: Colour 1: Reflectance 2: Frame index 3: Material ID 4: Transparency 5: Normals 6 .. 255: Reserved |
| Legend:  For attributes: M=Mandatory, O=Optional, OD=Optional with Default Value, CM=Conditionally Mandatory.  For elements: <minOccurs>..<maxOccurs> (N=unbounded)  Elements are bold; attributes are non-bold and preceded with an @. | | | |

The Main Adaptation Set shall contain either a single Initialization Segment at adaptation set level or multiple Initialization Segments at representation level (one for each Representation). Initialization Segments should contain the G-PCC parameter sets as defined in [1], which are needed to initialize the G-PCC decoder.

When more than one Representation is signaled in the Main Adaptation Set, the initialization segment of each Representation shall contain the G-PCC parameter sets for that Representation. The Representation(s) of a Component Adaptation Set may list the corresponding Representation identifier from the Main Adaptation Set using the @dependencyId attribute defined in ISO/IEC 23009-1 [3].

## GPCC Descriptor

A streaming client can identify the type of point cloud component in an Adaptation Set or Representation by checking the **GPCCComponent** descriptor within the corresponding element. However, a streaming client also needs to distinguish between different geometry point cloud streams present in the MPD file and identify their respective component streams.

A **SupplementalProperty** element with a @schemeIdUri attribute equal to "urn:mpeg:mpegI:gpcc:2020:gpc" is referred to as a GPCC descriptor. The attributes of **GPCC** descriptor is shown in Table 2. At most one **GPCC** descriptor may be present at the adaptation set level for the Main Adaptation Set of the G-PCC media or at the preselection level.

Table 2 Attributes for the GPCC descriptor

|  |  |  |  |
| --- | --- | --- | --- |
| **Attributes for GPCC descriptor** | **Use** | **Data type** | **Description** |
| gpcc:@gpcId | CM | xs:string | An id for the volumetric media. This attribute shall be present if multiple versions of the same volumetric media are signaled in separate AdapatationSets. |
| Legend:  For attributes: M=Mandatory, O=Optional, OD=Optional with Default Value, CM=Conditionally Mandatory.  For elements: <minOccurs>..<maxOccurs> (N=unbounded)  Elements are **bold**; attributes are non-bold and preceded with an @. | | | |

## Grouping of G-PCC Components

### GPCC Preselection

A G-PCC preselection is signaled in the MPD using a PreSelection element (as defined in ISO/IEC 23009-1[3]) with an id list for the @preselectionComponents attribute including the id of the Main Adaptation Set for the G-PCC media followed by the ids of Component Adaptation Sets. The @codecs attribute for the PreSelection shall be set to ‘gpc1’, indicating that the PreSelection media is a geometry-based point cloud. The PreSelection may either be signaled using a PreSelection element within the Period element or a Preselection descriptor at the adaptation set level in the Main Adaptation Set.

### Example

Figure 1 illustrates an exemplary DASH configuration for grouping of G-PCC components belonging to a single point cloud media within an MPEG-DASH MPD file.



**Figure 1 Grouping GPCC components in an MPD using Preselection**

## Supporting multiple versions of GPCC media

Multiple versions of the same point cloud media shall be signaled using separate Preselections. Preselections that represent alternative versions of the same geometry-based point cloud media shall contain a GPCC descriptor with the same @gpcId value. At most one GPCC descriptor shall be present at the preselection level. These Preselections are alternatives to each other. The id of the Main Adaptation Set is the first id in the list of Adaptation Set ids for the Preselection followed by the ids of Component Adaptation Sets. Figure 2 illustrates an exemplary DASH configuration for grouping multiple versions of G-PCC components belonging to the same point cloud within an MPEG-DASH MPD file.

In this example, two versions of the G-PCC components bitstreams are available. For each version of G-PCC component (geometry and attributes), two different bitstreams are available (encoded at different qualities). Each version of the geometry and attribute components can be signaled by separate Adaptation Sets, with two Representations one for each quality level in the Adaptation Set.

The Main Adaptation Set shall contain the Initialization Segment for the complete experience (G-PCC parameter sets, etc.). Compatible Component Adaptation Sets, along with the respective Main Adaptation Set, are grouped together in two Preselections in the MPD. To indicate that these Adaptation Sets are referenced in at least one Preselection, a Preselection descriptor without the @value attribute is signaled in each Adaptation Set. Each Preselection shall include a GPCC descriptor that indicates at least the mandatory @gpcId attribute. The values assigned to the @gpcId attributes of the two Preselections are identical, indicating that both Preselections belong to the same point cloud content. When the Preselections represent different point clouds, the @gpcId attribute for each Preselection shall be different.



**Figure 2 Grouping of multiple versions of GPCC components in an MPD using PreSelections**

A skeleton for the complete MPD file that signals the point cloud content described in the above example is given below.

|  |
| --- |
| <?xml version="1.0" encoding="UTF-8"?>  <MPD  <Period>   <!-- Main GPCC AdaptationSet -->   <AdaptationSet id="1" codecs="gpc1">   <EssentialProperty schemeIdUri="urn:mpeg:dash:preselection:2016" />   <Representation>   ...  </Representation>   </AdaptationSet>  <AdaptationSet id="2" codecs="gpc1">   <EssentialProperty schemeIdUri="urn:mpeg:dash:preselection:2016" />   <Representation>   ...  </Representation>   </AdaptationSet>  <!-- Geometry -->  <AdaptationSet id="3" codecs="gpc1">   <EssentialProperty schemeIdUri="urn:mpeg:dash:preselection:2016" />   <EssentialProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2020:component">   <gpcc:component component\_type="geom" />   </EssentialProperty>   <Representation>   ...   </Representation>   </AdaptationSet>    <AdaptationSet id="4" codecs="gpc1">   <EssentialProperty schemeIdUri="urn:mpeg:dash:preselection:2016" />   <EssentialProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2020:component">   <gpcc:component component\_type="geom" />   </EssentialProperty>   <Representation>   ...   </Representation>   </AdaptationSet>  <!-- Attribute -->  <AdaptationSet id="5" codecs="gpc1">   <EssentialProperty schemeIdUri="urn:mpeg:dash:preselection:2016" />   <EssentialProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2020:component">   <gpcc:component component\_type="attr" attribute\_type="0"/>   </EssentialProperty>   <Representation>   ...   </Representation>   </AdaptationSet>    <AdaptationSet id="6" codecs="gpc1">   <EssentialProperty schemeIdUri="urn:mpeg:dash:preselection:2016" />   <EssentialProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2020:component">   <gpcc:component component\_type="attr" attribute\_type="0"/>   </EssentialProperty>   <Representation>   ...   </Representation>   </AdaptationSet>    <AdaptationSet id="7" codecs="gpc1">   <EssentialProperty schemeIdUri="urn:mpeg:dash:preselection:2016" />   <EssentialProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2020:component">   <gpcc:component component\_type="attr" attribute\_type="1"/>   </EssentialProperty>   <Representation>   ...   </Representation>   </AdaptationSet>    <AdaptationSet id="8" codecs="gpc1">   <EssentialProperty schemeIdUri="urn:mpeg:dash:preselection:2016" />   <EssentialProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2020:component">   <gpcc:component component\_type="attr" attribute\_type="1"/> />   </EssentialProperty>   <Representation>   ...   </Representation>   </AdaptationSet>    <!-- Preselections -->   <Preselection id="1" tag="1" preselectionComponents="1 3 5 7" codecs="gpc1">   <!—GPCC Descriptor -->   <EssentialProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2020:gpc" gpcId="1" />   </Preselection>    <Preselection id="2" tag="2" preselectionComponents="2 4 6 8" codecs="gpc1">  <!—GPCC Descriptor -->   <EssentialProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2020:gpc" gpcId="1" />   </Preselection>   </Period>  </MPD> |

# Recommendation

We recommend the proposed MPEG-DASH signaling methods for streaming the geometry-based point cloud content be included in the working draft of ISO/IEC 23090-18.

# References

1. N19328, “G-PCC Future Enhancements”, MPEG 130, April 2020
2. N19286, “WD of ISO/IEC 23090-18 Carriage of G-PCC Data”, MPEG 130, April 2020
3. N18312, “Revised text of ISO/IEC FDIS 23009-1 3rd edition”, MPEG 125, January 2019