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AMENDMENT 1
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Information technology — Coded representation of immersive media —

Part 18: Carriage of geometry-based point cloud compression data

AMENDMENT 1: Support for temporal scalability

Technologies de l'information — Représentation codée de média immersifs —

Partie 18: Transport des données de compression des nuages de points basée sur la géométrie

AMENDEMENT 1: Prise en charge de l'échelonnabilité temporelle

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Information technology — Coded representation of immersive media —

Part 18: Carriage of geometry-based point cloud compression data

AMENDMENT 1: Support for temporal scalability

Clause 3

Add the following terms:

3.12
temporal level track
volumetric visual track which carries a subset of point cloud frames in the G-PCC bitstream that constitute a temporal sub-sequence of the actual G-PCC bitstream

3.13
temporal level tile track
volumetric visual track which carries one or more G-PCC tiles of a subset of point cloud frames in the G-PCC bitstream that constitute a temporal sub-sequence of the actual G-PCC bitstream

7.2.1.2

Replace the content of the subclause with the following:

```
aligned(8) class GPCCDecoderConfigurationRecord {
   unsigned int(8)      configurationVersion = 1;
   unsigned int(2)      reserved = 0;
   unsigned int(1)      simple_profile_compliant;
   unsigned int(1)      dense_profile_compliant;
   unsigned int(1)      predictive_profile_compliant;
   unsigned int(1)      main_profile_compliant;
   unsigned int(18)     reserved_profile_18bits
   unsigned int(8)      level_idc;
   unsigned int(7)      num_setup_unit_arrays;
   unsigned int(1)      array_completeness;
   for (i=0; i<num_setup_unit_arrays; i++) {
      unsigned int(8)      setup_unit_type;
      unsigned int(8)      num_setup_units;
      for (j=0; j<num_setup_units; j++) {
         tlv_encapsulation   setup_unit;   //as defined in ISO/IEC 23090-9, Annex B
      }
   }
   // additional fields
}
```

7.2.1.3

Replace

— `numOfSetupUnits` specifies the number of following `setupUnit` present in the decoder configuration record.

— `setupUnit` contains one data unit carrying one of SPS, GPS, and APS as defined in ISO/IEC 23090-9.

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with

— num_setup_unit_arrays indicates the number of arrays of setup units of the given type(s).

— array_completeness when equal to 1 indicates all parameter sets of all types are in the following array and none are in the stream; when equal to 0 indicates that parameter set(s) of one or more types may be in the stream; the default and permitted values are constrained by the sample entry type. When the sample entry type of the track is 'gpe1' or 'gpc1', the value of array_completeness shall be equal to 1.

— setup_unit_type indicates the type of G-PCC setup units as defined in Annex B of ISO/IEC 23090-9.

— num_setup_units specifies the number of following setup_unit present in the decoder configuration record.

— setup_unit contains one data unit carrying one of SPS, GPS, and APS as defined in ISO/IEC 23090-9.

7.2.5, 7.26 and 7.2.7

Add the following subclauses after 7.2.4.

7.2.5 G-PCC parameter set sample group

7.2.5.1 Definition

Group Types:	'gpsg'
Container:	Sample Group Description Box ('sgpd')
Mandatory:	No
Quantity:	Zero or more

A G-PCC parameter set sample group entry contains the parameter set information for samples that mapped to it from SampleToGroupBox. Multiple SampleToGroupBox with grouping_type equal to 'gpsg' but with a different grouping_type_parameter may be present. When multiple instances of the SampleToGroupBox with grouping_type equal to 'gpsg' are present, the version of all the SampleToGroupBox boxes shall be set to 1.

A G-PCC parameter set sample group may be present in G-PCC tracks with track type 'gpcg', 'gpeg', 'gpcb' and 'gpeb'. A G-PCC parameter set sample group shall not be present in G-PCC tracks with track type 'gpc1', 'gpe1' and 'gpt1'.

A SampleToGroupBox with grouping_type equal to 'gpsg' with a particular grouping_type_parameter provides the mapping between samples with G-PCC parameter set sample group entries that contains all parameter sets of that particular type.

NOTE When a particular G-PCC parameter set sample group entry is referred to / mapped to a sample in a SampleToGroupBox with grouping_type equal to 'gpsg' with a particular grouping_type_parameter, the G-PCC parameter set sample group entry contains all the parameter sets of that particular type for decoding the sample while it can also contain other parameter sets as well.

Within a SampleToGroupBox with grouping_type equal to 'gpsg' with a particular grouping_type_parameter, a sample shall be mapped to group_description_index value 0 when one of the following case is satisfied:

— The sample contains parameter set of that particular type.

— The sample does not contain the parameter set of that type but other parameter sets are present in the sample entry.

For tracks with types 'gpeg', 'gpcb' and 'gpeb', if only one SampleToGroupBox with grouping_type equal to 'gpsg' is present in the track then grouping_type_parameter shall be set to zero. When a sample is mapped to a G-PCC parameter set sample group entry in a SampleToGroupBox with grouping_type equal to

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'gpsg' and grouping_type_parameter equal to zero, the G-PCC parameter set sample group entry contains the information to all the required parameter sets for the sample.

Annex L describes how the file player supports the random access.

7.2.5.2 Syntax

```
aligned(8) class GPCCParameterSetInfoEntry()
      extends VolumetricVisualSampleGroupEntry ('gpsg') {
      unsigned int(1) gpcc_unit_offset_flag;
      unsigned int(7) num_parameter_sets_minus1;
      for(int i = 0; i <= num_parameter_sets_minus1; i++) {
            unsigned int(4) parameter_set_type;
            unsigned int(4) parameter_set_id;
            unsigned int(16)sample_offset;
            if(gpcc_unit_offset_flag)
                  unsigned int(8) gpcc_unit_offset;
      }
}
```

7.2.5.3 Semantics

gpcc_unit_offset_flag indicates whether the gpcc_unit offset information is present in the sample description entry or not.

num_parameter_sets_minus1 plus one indicates the number of parameter sets described in the sample description entry.

parameter_set_type indicates the type of the i-th parameter set as indicated in Table B.1 of ISO/IEC 23090-9.
parameter_set_id indicates the identifier of parameter set carried in the indicated sample. In case of geometry parameter set, this value is equal to gps_geom_parameter_set_id present in the GPS. In case of attribute parameter set, this field value is equal to aps_attr_parameter_set_id present in the APS. In case of sequence parameter set, this field value is equal to sps_seq_parameter_set_id present in the SPS.

sample_offset specifies the sample offset from the immediately preceding sync sample where the indicated parameter set is contained. The value of sample_offset shall be equal to or greater than 0.

NOTE When sample_offset is equal to 0, the sample that contains the parameter set is the immediately preceding sync sample.

gpcc_unit_offset specifies that the i-th parameter set is the (gpcc_unit_offset + 1)-th GPCC unit in the sample that contains the parameter set. The value of gpcc_unit_offset shall be equal to or greater than 0.

NOTE When gpcc_unit_offset is equal to 0, the parameter set is the 1st GPCC unit in the sample that contains the parameter set.

7.2.6 Sub-frame timing sample group

7.2.6.1 Definition

This sample group provides sub-frame timing information which indicates a time offset to the composition time of the G-PCC sample containing the sub-frame. When the track containing this sample group has no CompositionOffsetBox, the composition time of the G-PCC sample corresponds to the decoding time of this sample. The composition times for G-PCC sub-frames contained in a G-PCC sample is derived after the composition time of the containing G-PCC sample is resolved.

— When the difference between sub-frame time offsets is constant (constant_time_offset_delta equals 1) for a group of G-PCC samples, the time offset of the i-th G-PCC sub-frame in a sample is equal to subframe_time_offset_delta * *i* and the composition timestamp of the i-th G-PCC sub-frame in a sample is computed as CTS[i] = CT + subframe_time_offset_delta * i, where CT is the composition time of the sample containing the G-PCC sub-frame and i is varying from 0 to subframe_count – 1, included.

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— When the difference between sub-frame time offsets is not constant (`constant_time_offset_delta` equals 0) for a group of G-PCC samples, the time offset of the i-th G-PCC sub-frame in a sample is equal to `subframe_time_offset[i]` and the composition timestamp of the i-th G-PCC sub-frame in a sample is computed as `CTS[i] = CT + subframe_time_offset[i]`, where `CT` is the composition time of the sample containing the sub-frame and `i` is varying from 0 to `subframe_count - 1`, included.

The loop on `subframe_time_offset[i]` is implicitly ordered in the order of sub-frames present in the samples mapped to this entry with increasing frame index or frame number attribute values.

When a G-PCC bitstream contains sub-frames, i.e. frame number or frame index attribute, the following constraints are applied:

— For single track encapsulation, when the G-PCC bitstream is carried using G-PCC tracks with `'gpe1'` or `'gpeg'` sample entry type, the subframe timing sample group may be present in the G-PCC track.

— For multi-track encapsulation, when the G-PCC bitstream is carried in multiple G-PCC tracks with `'gpc1'` or `'gpcg'` sample entry type, the subframe timing sample group may be present only in the G-PCC attribute track carrying the frame number or frame index attribute data units. The subframe timing sample group shall not be present in G-PCC geometry track or G-PCC attribute track which does not carry the frame number or frame index attribute data units.

— For encapsulation with G-PCC tile tracks, the sub-frame timing sample group may be present only in the G-PCC tile track (`'gpt1'`) carrying all components or in G-PCC attribute tile track carrying the frame number or frame index attribute data units. The subframe timing sample group shall not be present in a tile base track. The subframe timing sample group shall not be present in the following G-PCC tile tracks:

  — G-PCC tile track carrying all components which are not comprised of the frame number or frame index attribute data units;

  — G-PCC geometry tile track;

  — G-PCC attribute tile track which are not comprised of frame number or frame index attribute data units.

— The sub-frame timing sample group may be present in temporal level tracks or temporal level tile tracks with the same constraints as for single track or multi-track encapsulations described in this clause.

NOTE The sub-frame timing sample group, when present, allows file readers to access to precise timing information (e.g. corresponding to a capture time by a 3D sensor). When the G-PCC bitstream contains the frame number attribute data units potentially leading to sub-frame reordering across samples, the subframe timing sample group can be present in the appropriate G-PCC tracks to help file readers in reordering the sub-frames.

7.2.6.2 Syntax

```
aligned(8) class SubFrameTimingGroupEntry()
      extends VolumetricVisualSampleGroupEntry ('sfcf') {
      unsigned int (1)  constant_time_offset_delta;
      unsigned int (7)  reserved = 0;
      unsigned int(32)  subframe_count;
      if (constant_time_offset_delta == 1) {
            unsigned int(32) subframe_time_offset_delta;
      }
      else {
            for (int i=0; i < subframe_count; i++) {
                  signed int(32) subframe_time_offset[i];
            }
      }
}
```

7.2.6.3 Semantics

`constant_time_offset_delta` indicates whether all G-PCC sub-frames contained in the G-PCC samples mapped to this entry have a constant time offset delta with the previous G-PCC sub-frame in the increasing order of their frame index or frame number attribute values. Value 1 indicates that the time offset delta is constant.

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`subframe_count` is an unsigned integer that counts the number of G-PCC sub-frames in the G-PCC samples mapped to this entry. The value 0 is reserved.

`subframe_time_offset_delta` is an unsigned integer that gives the difference, in the timescale of the media, between composition timestamps of two successive G-PCC sub-frames present in a G-PCC sample mapped to this entry.

`subframe_time_offset[i]` is a signed integer that indicates the time offset of the i-th G-PCC sub-frame present in the G-PCC samples mapped to this entry, in the timescale of the media. This time offset is relative to the composition timestamp of the sample containing the sub-frame.

7.2.7 TLV sample group

7.2.7.1 Definition

Group Types: `'tlvs'`

Container: Sample Group Description Box (`'sgpd'`)

Mandatory: No

Quantity: Zero or more

The use of `'tlvs'` for the `grouping_type` in sample grouping indicates the number of slices and the number of TLVs per slice of the samples associated with this sample group. When a `SampleGroupDescriptionBox` with `grouping_type` equal to `'tlvs'` is present, an accompanying `SampleToGroupBox` with the same grouping type may be present (when default sample grouping cannot apply). The `grouping_type_parameter` in this `SampleToGroupBox` is undefined.

The `'tlvs'` sample group may be present in `'gpc1'` or `'gpcg'` or `'gpt1'` geometry tracks referenced by a `'gpcb'` tile base track. The `'tlvs'` sample group shall not be present in `'gpc1'` or `'gpcg'` attribute tracks, `'gpe1'`, `'gpeg'`, `'gpeb'`, `'gpcb'`, or `'gpt1'` track carrying DUs of all components.

Annex M describes how a G-PCC frame is reconstructed from multiple tracks. The reconstruction process is applied to the following cases containing more than one slice:

— one geometry track and its associated attribute tracks;

— each set of geometry tile track and its associated attribute tile tracks;

— when temporal scalability is in use:

  — each set of geometry temporal level track and its associated attribute temporal level tracks;

  — each set of geometry temporal tile track and its associated attribute temporal tile tracks.

7.2.7.2 Syntax

```
aligned(8) class GPCC_TLVToSliceGroupEntry() extends
VolumetricVisualSampleGroupEntry ('tlvs')
{
      unsigned int nb_referenced_tracks;
      unsigned int (16) num_slices;
      for (int I = 0; i < num_slices; i++){
       unsigned int (8) num_tlvs[1 + nb_referenced_tracks]
      }
}
```

7.2.7.3 Semantics

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nb_referenced_tracks is equal to the number of tracks referenced by the 'gpca' track references from the geometry track containing this sample group to attribute tracks.

num_slices indicates the number of slices present in the samples associated with this sample group.

num_tlvs is an array of integers providing the number of consecutive TLV units of the geometry track containing this sample group and the referenced tracks of a given slice in the samples associated with this sample group.-The array is ordered starting by the number of TLV units for the geometry track containing this sample group, followed by the number of TLV units for each attribute track referenced by the 'gpca' track reference, in the order of tracks within the track reference.

7.6

Add the following subclause after 7.5.

7.6 Sync sample box

SyncSampleBox may be present in the following tracks:

— Track with sample entry type 'gpeg'

— Track with sample entry type 'gpcg'

— Track with sample entry type 'gpeb' or'gpcb'

NOTE SyncSampleBox is not present in track with sample entry type 'gpe1' and in track with sample entry type 'gpc1' since all samples have intra coded frame and all parameter sets are carried in the sample entry.

NOTE SyncSampleBox is not present in the tile base track when all parameter sets that are needed to decode any samples in the associated tile tracks are carried in the tile base track sample entry.

A sync sample with sample entry type 'gpcg' and 'gpcg' shall satisfy all the following conditions:

— It shall be independently decodable.

— None of the samples that come after the sync sample (in decoding order) have any decoding dependency on any sample prior to the sync sample.

— All samples that come after the sync sample (in decoding order) and until the next sync samples are successfully decodable.

— The parameter set(s) required to decode the sample shall be included either in the sample itself or in the sample entry.

When it is present in the track with sample entry type 'gpcg', SyncSampleBox shall be present in the geometry track and the associated attribute tracks. The sync samples in the geometry track and its associated attribute tracks that are indicated in SyncSampleBox shall be aligned.

When it is present in the track with sample entry type 'gpeb' or 'gpcb', the following applies:

a) If the sample is a sync sample, all parameter sets needed for decoding the associated G-PCC tile track samples shall be included either in the sample entry or in the sample itself.

b) Otherwise (the sample is not a sync sample), all parameter sets needed for decoding the associated G-PCC tile track samples shall be included either in the sample entry or in any of the samples since the previous sync sample to the sample itself, inclusive.

When both SyncSampleBox and G-PCC parameter sets sample group are not present in a track with sample entry type 'gpeg', gpcg', 'gpeb' or'gpcb', the method to perform random access playback is not specified.

When temporal scalability is supported and the G-PCC bitstream is stored in multiple temporal level tracks, SyncSampleBox may be present in all the tracks.

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9.2.3.1

Replace the last paragraph with:

Static viewport information is signalled in `GPCCViewportInfoConfigutationBox` present in the sample entry of one of G-PCC bitstream track, G-PCC geometry track, or G-PCC tile base track. `GPCCViewportInfoConfigutationBox` shall not be present in any G-PCC attribute tracks and G-PCC tile tracks.

When `GPCCViewportInfoConfigutationBox` present in the sample entry of one of G-PCC bitstream track, G-PCC geometry track, or G-PCC tile base track, both of `dynamic_int_camera_flag` and `dynamic_ext_camera_flag` shall be set to 0.

9.2.4.2

Add the following:

Both of `dynamic_int_camera_flag` and `dynamic_ext_camera_flag` in `GPCCViewportInfoConfigutationBox` shall not be set to 0.

9.2.4.3.3

Replace the content of the subclause with:

— `num_viewports` indicate the number of viewports signalled in the sample.

— `viewport_id` is an identifier that is used to identify the viewport.

— When `viewport_cancel_flag` is equals to 1, it indicates that the viewport with the `viewport_id` is cancelled. When `viewport_cancel_flag` is equals to 0, it indicates that either camera extrinsic information structure or camera intrinsic information structure shall be present in the current sample.

— When `camera_ext_flag` is equal to 1, it indicates that the extrinsic camera information structure of this viewport is present in the current sample. It shall be equal to 0 when `dynamic_ext_camera_flag` in the sample entry is equal to 0.

— When `camera_int_flag` equal to 1 indicates that the intrinsic camera information structure of this viewport is present in the current sample. It shall be equal to 0 when `dynamic_int_camera_flag` in the sample entry is equal to 0.

Clause 12

Add the following new clause after Clause 11.

12 Temporal scalability support

12.1 General

A G-PCC temporal level is a subset of the point cloud frames that constitute a temporal sub-sequence of the actual G-PCC bitstream. Each point cloud frame may be associated with a particular temporal level. Each temporal level is identified by a unique temporal level identifier with the first temporal level having the id 0.

A G-PCC bitstream may be carried/stored in one or more temporal level tracks. Necessary information to describe the temporal level tracks and the mapping between a sample and its temporal level may be available in the file. A G-PCC sample belonging to a certain temporal level shall not have any decoding dependency

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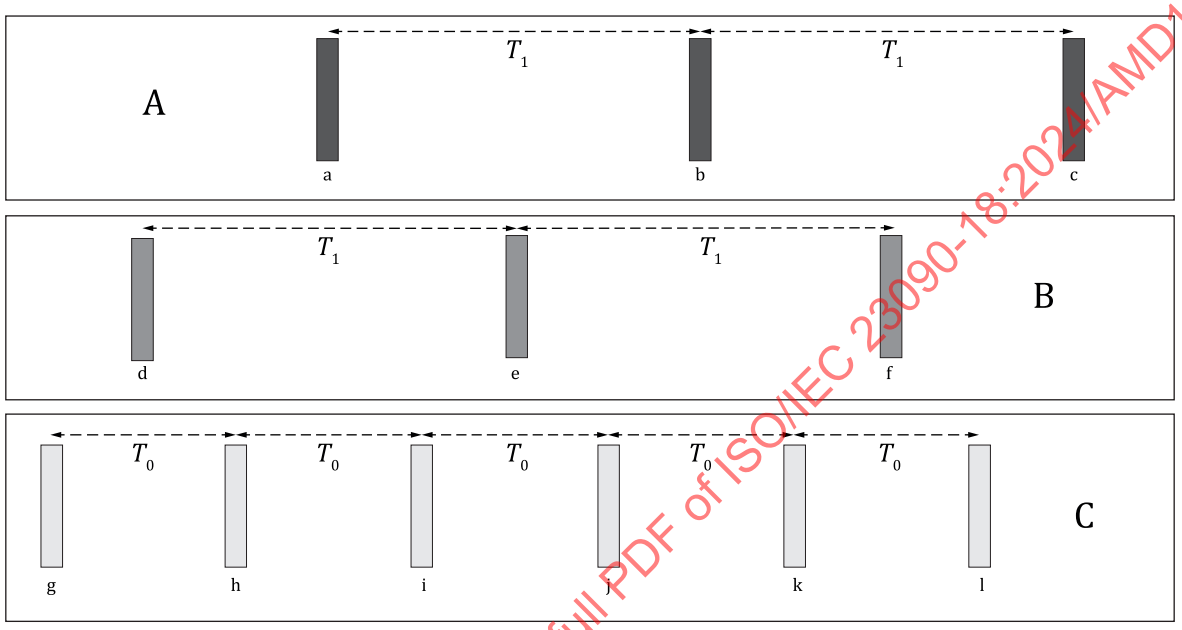
on any G-PCC samples present in higher temporal levels. Prior to decoding process, necessary samples are extracted from the temporal level track(s) and combined into a single conforming G-PCC bitstream. When extracting a G-PCC bitstream for a target temporal level with an id greater than 0 and target tile ids, data from all lower temporal level samples are also included in the resulting output bitstream, and the required G-PCC tracks are selected accordingly during the extraction process.

Figure 4 shows an example of enabling the playback of a G-PCC bitstream at 30 fps, 45 fps, and 60 fps when the G-PCC bitstream are encapsulated into three temporal levels; temporal level 0 represents a 30 fps subsequence, and temporal levels 1 and 2 represent a 15 fps subsequence, respectively. A combination of temporal level 0 and temporal level 1 enables the playback of G-PCC bitstream as a 45 fps in average and the combination of all three temporal levels enables the playback of G-PCC bitstream as 60 fps in average.



Key

←----→	The presentation time difference between two consecutive frames
A	temporal level 2
B	temporal level 1
C	temporal level 0
a	Frame 4.
b	Frame 8.
c	Frame 12.
d	Frame 2.
e	Frame 6.
f	Frame 10.
g	Frame 1.
h	Frame 3.
i	Frame 5.
j	Frame 7.
k	Frame 9.
l	Frame 11.

Figure 4 — Temporal levels in a G-PCC sequence

When the temporal scalability is used, either any alternatives of same G-PCC content or any alternatives of same point cloud bitstream shall not be carried in a same file.

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12.2 Common data structures

12.2.1 Temporal level sample group

The temporal level sample grouping (`'tele'`) defined in ISO/IEC 14496-12 provides a codec-independent sample grouping that can be used to group G-PCC samples in a G-PCC track (and potential track fragments) according to temporal level, where samples of one temporal level have no coding dependencies on samples of higher temporal levels. This sample group may be present in temporal level tracks or in temporal level tile tracks.

When present in a G-PCC track, temporal level sample group provides mechanism to indicate the temporal level identifier value for each sample in that track.

Annex J contains examples of how temporal level sample group is indicated according to different track encapsulations.

12.2.2 Temporal level sample group in temporal level track

When the G-PCC bitstream is carried using multiple temporal level tracks, the `'tele'` sample group shall only be present in a temporal level track that contains geometry component when the number of temporal levels in the track is greater than one. When the `'tele'` sample group is present in a temporal level track, the samples belonging to a temporal level identifier shall be mapped to the sample group description index equal to temporal level identifier plus 1. The list of temporal level identifier is available in the `GPCCScalabilityInfoBox` that is present in the sample entry of the track.

When sample group description box with `grouping_type` equal to `'tele'` is present in temporal level track, the value of `entry_count` shall be equal to the highest temporal level identifier value contained in the track plus one. The highest temporal level identifier value is the highest value in the list of temporal level identifiers present in the `GPCCScalabilityInfoBox` of that temporal level track.

When each temporal level track carries a single component data, the temporal level of a sample in a track containing attribute component is identical to the temporal level of the corresponding sample, i.e. the sample with the same composition time stamp, in the associated track containing geometry component.

12.2.3 Temporal level sample group in temporal level tile track

When the G-PCC bitstream is carried using multiple temporal level tile tracks, the `'tele'` sample group shall only be present in a temporal level tile track that contains geometry component when the number of temporal levels in the track is greater than one. When the `'tele'` sample group is present in a temporal level tile track, the samples belonging to a temporal level identifier shall be mapped to the sample group description index equal to temporal level identifier plus 1. The list of temporal level identifier is available in the `GPCCTileScalabilityInfoBox` if it is present in the sample entry of the temporal level tile track or in the `GPCCScalabilityInfoBox` that is present in the sample entry of the associated tile base track.

When sample group description box with `grouping_type` equal to `'tele'` is present in a temporal level tile track, the value of `entry_count` shall be equal to the highest temporal level identifier value contained in the track plus one. The highest temporal level identifier value contained in the temporal level tile track is derived as follows:

— If `GPCCTileScalabilityInfoBox` is present in the temporal level tile track, the highest temporal level identifier is the highest value in the list of temporal level identifiers present in that track's `GPCCTileScalabilityInfoBox` box.

— Otherwise (i.e., `GPCCTileScalabilityInfoBox` is not present in the temporal level tile track), the highest temporal level identifier is the highest value in the list of temporal level identifiers present in the `GPCCScalabilityInfoBox` in the associated tile base track of that temporal level tile track.

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When each temporal level tile track carries a single component data, the temporal level of a sample in a tile track containing attribute component is identical to the temporal level of the corresponding sample, i.e. the sample with the same composition time stamp, in the associated tile track containing geometry component.

12.3 Temporal level track

12.3.1 General

A G-PCC track containing `GPCCScalabilityInfoBox` in the sample entry is referred as temporal level track carrying a temporal subset of the G-PCC bitstream. When the G-PCC bitstream is carried in multiple temporal level tracks, all temporal level tracks carrying a subset of same G-PCC bitstream shall use the same sample entry type.

In each sample entry, the value of `simple_profile_compatibility_flag`, `dense_profile_compatibility_flag`, `predictive_profile_compatibility_flag`, and `main_profile_compatibility_flag` shall indicate a profile to conform to samples in temporal level tracks with current and lower temporal level ids. The value of `level_idc` shall indicate a level of capability equal to or greater than the highest level required for samples in temporal level tracks with current and lower temporal level ids.

Temporal level tracks with temporal level id greater than 0 shall have their `track_in_movie flags` set to 0.

12.3.2 G-PCC scalability information box

12.3.2.1 Definition

Box Types: `'gsci'`

Container: `GPCCSampleEntry` (`'gpe1'`, `'gpeg'`, `'gpc1'`, `'gpcg'`, `'gpcb'`, or `'gpeb'`)

Mandatory: No

Quantity: Zero or one

This box signals scalability information for a G-PCC track. When this box is present in a G-PCC track with sample entries of type `'gpe1'`, `'gpeg'`, `'gpc1'`, `'gpcg'`, `'gpcb'`, or `'gpeb'`, it indicates that temporal scalability is supported and provides information about the temporal levels present in this G-PCC track. This box shall not be present in a G-PCC track when the temporal scalability is not used.

This box shall not be present in G-PCC tile track with a sample entry of type `'gpt1'`.

For tracks with sample entry type `'gpc1'` or `'gpcg'`, the `GPCCScalabilityInfoBox` may be present only in the tracks that carry G-PCC geometry component. For the tracks with sample entry type `'gpc1'` or `'gpcg'` which carry attribute component, the `GPCCScalabilityInfoBox` shall not be present but should be inferred from the `GPCCScalabilityInfoBox` in the sample entry of the corresponding G-PCC geometry track.

12.3.2.2 Syntax

```
aligned(8) class GPCCScalabilityInfoBox
      extends FullBox('gsci', version = 0, 0) {
      unsigned int(1)          multiple_temporal_level_tracks_flag;
      unsigned int(1)          frame_rate_present_flag;
      bit(3)                   reserved = 0;
      unsigned int(3)          num_temporal_levels;
      for(i=0; i < num_temporal_levels; i++){
         bit(5)                reserved;
         unsigned int(3)       temporal_level_id;
```

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```
        if (frame_rate_present_flag){
           unsigned int(16)       frame_rate;
        }
    }
}
```

12.3.2.3 Semantics

`multiple_temporal_level_tracks_flag` indicates the presence of multiple temporal level tracks in the file. When the sample entry type is '`gpe1`', '`gpeg`', '`gpc1`', or '`gpcg`', the following applies:

— If the value of `multiple_temporal_level_tracks_flag` is equal to 0, it specifies that there is no other temporal level track for the G-PCC bitstream.

— Otherwise, it specifies that there may be other temporal level track(s) for the G-PCC bitstream.

When one of the following applies, the value of `multiple_temporal_level_tracks_flag` shall be equal to 1:

— There are more than one temporal level tracks with sample entry type '`gpe1`' or '`gpeg`'.

— There are more than one temporal level tracks with sample entry type '`gpc1`' or '`gpcg`' containing the same component type.

When the sample entry type is '`gpcb`' or '`gpeb`', the following applies:

— If the value of `multiple_temporal_level_tracks_flag` is equal to 0, it specifies that each tile track referred to by the tile base track contains samples from all temporal levels for the G-PCC bitstream.

— Otherwise, it specifies that there may be one or more temporal tile tracks that do not contain samples from all temporal levels for the G-PCC bitstream.

When one of the following applies, the value of `multiple_temporal_level_tracks_flag` shall be equal to 1:

— The track is a tile base track with sample entry type '`gpeb`' and it refers to tile tracks in which there are more than one temporal level tile tracks of the same tile(s).

— The track is a tile base track with sample entry type '`gpcb`' and it refers to tile tracks in which there are more than one temporal level tile tracks of the same tile(s) of the same component type.

How the value of `multiple_temporal_level_tracks_flag` is handled is described in Annex K.

`frame_rate_present_flag` indicates the presence of average frame rate information. Value 1 indicates the average frame rate information is present. Value 0 indicates the average frame rate information is not present.

`num_temporal_levels` indicate the number of temporal levels present in the samples of the respective track. For '`gpcb`' or '`gpeb`' G-PCC track, this field value indicates the maximum number of temporal levels present in the samples of this G-PCC track. The minimum value of num_temporal_levels shall be 1.

`temporal_level_id` indicates temporal level identifier of a G-PCC sample in the respective track. The following applies to the value of `temporal_level_id`:

— The value of `temporal_level_id` shall be in increment of 1. For a temporal level with temporal id *x*, the immediate next temporal level shall have temporal id equal to *x + 1*.

— When a *TrackB* is said to be the next temporal level track of another *TrackA, TrackB* shall contain samples with temporal id equal to the highest temporal id in *TrackA* plus 1.

`frame_rate` gives the average frame rate of a temporal level in units of frames / (256 seconds). Value 0 indicates an unspecified average frame rate.

12.3.3 Temporal level track samples

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12.3.3.1 General

The smallest composition time difference between two consecutive samples in a temporal level track with a maximum `temporal_level_id` Y shall be equal to or greater than the smallest composition time difference between two consecutive samples in a temporal level track with a maximum `temporal_level_id` X when Y is greater than X.

The presentation time of samples present in different temporal level tracks belonging to the same point cloud component shall be different. For example, the presentation time of geometry component samples present in temporal level 0 and temporal level 1 geometry component tracks shall be different.

The syntax and semantics of samples in a temporal level track carrying more than one G-PCC component as defined in 7.3.3, shall be applied. The syntax and semantics of samples in a temporal level track carrying only one G-PCC component as defined in 7.4.3, shall be applied.

12.3.3.2 sub-sample

The syntax and semantics of the sub-sample as defined in 7.3.3.4, is applied.

For temporal level track carrying multiple G-PCC components, when sub-samples are present, the `SubSampleInformationBox` with `flags` equal to 0 in `SampleTableBox`, or in the `TrackFragmentBox` of each of its `MovieFragmentBoxes` shall be present.

For temporal level track carrying only one G-PCC component, when sub-samples are present, `SubSampleInformationBox` with `flags` equal to 1 in `SampleTableBox`, or in the `TrackFragmentBox` of each of its `MovieFragmentBoxes` shall be present.

12.3.4 Temporal scalability track grouping

12.3.4.1 Definition

The temporal level tracks carrying the G-PCC geometry component may be grouped into a G-PCC temporal scalability track group.

A `GPCCTemporalScalabilityGroupBox` may be present in a track with sample entry type `'gpe1'`, `'gpeg'`, `'gpc1'`, or `'gpcg'`. When `GPCCTemporalScalabilityGroupBox` is present, to get a bitstream with more temporal levels, only the tracks with the same `track_group_id` of a `GPCCTemporalScalabilityGroupBox` shall be combined. A `GPCCTemporalScalabilityGroupBox` may be present in a track that contains the geometry component. A `GPCCTemporalScalabilityGroupBox` shall not be present in a track with sample entry type `'gpc1'` or `'gpcg'` that contains the attribute component. When `GPCCTemporalScalabilityGroupBox` is present in tracks with sample entry `'gpc1'` or `'gpcg'`, the combination of G-PCC geometry tracks within the same temporal scalability track group implies the combination of G-PCC attribute tracks which are referenced by the G-PCC geometry tracks.

12.3.4.2 Syntax

```
aligned(8) class GPCCTemporalScalabilityGroupBox
                extends TrackGroupTypeBox('gtsg') {
    // track_group_id is inherited from TrackGroupTypeBox;
}
```

12.4 Temporal level tile track

12.4.1 General

A G-PCC tile track containing `GPCCTileScalabilityInfoBox` in its sample entry is referred as G-PCC temporal level tile track and it carries one or more G-PCC tiles of a temporal subset of the G-PCC bitstream. When the

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G-PCC bitstream is carried in multiple temporal level tile tracks, all temporal level tile tracks shall use the sample entry type 'gpt1'.

12.4.2 G-PCC tile track scalability information box

12.4.2.1 Definition

Box Types: 'gtsi'

Container: SampleEntry ('gpt1')

Mandatory: No

Quantity: Zero or one

This box contains the scalability information for a G-PCC tile track with sample entry type 'gpt1'. This box may only be present in a tile track when the sample entry of the associated G-PCC tile base track contains a GPCCScalabilityInfoBox. When GPCCTileScalabilityInfoBox presents, it shall only be present in a G-PCC temporal level tile track that contains geometry component.

When temporal scalability is not supported, this box shall not be present in any of G-PCC tile tracks. This box shall not be present in the G-PCC tile track when the GPCCScalabilityInfoBox is not present in the sample entry of the associated G-PCC tile base track.

The following applies:

— If this box is present in the sample entry of a G-PCC tile track, it indicates that temporal scalability is supported and the number of temporal levels in the G-PCC tile track is less than the number of temporal levels signalled in GPCCScalabilityInfoBox present in the associated G-PCC tile base track.

— Otherwise, if this box is not present in the sample entry of a G-PCC tile track and GPCCScalabilityInfoBox is present in the associated G-PCC tile base track, the temporal scalability is supported and the temporal scalability information for the G-PCC tile track is derived from the GPCCScalabilityInfoBox in the associated G-PCC tile base track. The number of temporal levels and temporal level identifiers for the G-PCC tile track are inferred to be equal to the number of temporal levels and temporal level identifiers signalled in GPCCScalabilityInfoBox, respectively.

— Otherwise (this box is not present in a G-PCC tile track and GPCCScalabilityInfoBox is not present in the associated G-PCC tile base track), temporal scalability is not supported.

This box may only be present in the G-PCC temporal level tile tracks carrying geometry component and shall not be present in the G-PCC temporal level tile tracks carrying attribute component only, but the temporal level information is inferred from the GPCCTileScalabilityInfoBox present in the sample entry of the corresponding G-PCC temporal level tile track carrying the geometry component or from the GPCCScalabilityInfoBox present in the sample entry of the associated G-PCC tile base track.

12.4.2.2 Syntax

```
aligned(8) class GPCCTileScalabilityInfoBox
      extends FullBox('gtsi', version = 0, 0) {
      bit(5)                  reserved;
      unsigned int(3)         num_temporal_levels;
      for(i=0; i < num_temporal_levels; i++){
            bit(5)            reserved;
            unsigned int(3)   temporal_level_id;
      }
}
```

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12.4.2.3 Semantics

`num_temporal_levels` indicates the number of temporal levels present in the samples of the respective tile track.

`temporal_level_id` indicates a temporal level identifier of the samples signalled in the respective tile track.

12.4.3 Temporal level tile track samples

12.4.3.1 General

The syntax and semantics of samples in a temporal level tile track as defined in 7.5.3.2, shall be applied.

12.4.3.2 sub-sample

The syntax and semantics of the sub-sample as defined in 7.5.3.2.2, shall be applied.

12.5 Player behavior with temporal scalability support

For handling G-PCC bitstream stored in an ISOBMFF file with temporal level tracks, the G-PCC player is provided with a target temporal level and optionally target tile ids, if the file contains G-PCC tile tracks. When extracting a G-PCC bitstream for a target temporal level with an id greater than 0 and target tile ids, data from all lower temporal level samples are also included in the resulting bitstream, and the required tracks are selected accordingly during the extraction process. The extracted G-PCC samples are used to form the output bitstream. The extracted G-PCC samples in the output bitstream are in increasing order of the decoding time.

The extraction process may extract samples from one or more temporal level tracks, and it combines the extracted samples into one single output bitstream. Encoder may split a single G-PCC bitstream and store it into multiple temporal level tracks or multiple temporal level tile tracks and transmits the file over the network. Prior to decoding process, G-PCC player extracts samples from the temporal level tracks, combines them into an output bitstream, and feeds it to a single G-PCC decoder.

NOTE The player feeds the output bitstream to a single decoder as there is no scalability concept in G-PCC codec. However, implementation with multiple decoders can be possible but out of the scope of this document.

NOTE Example of temporal level extraction process is given in Annex I.

12.6 Signaling temporal level information in DASH

A `SupplementalProperty` element with a `@schemeIdUri` attribute equal to `"urn:mpeg:mpegI:gpcc:2022:temporallevelId"` is referred to as `GPCCTemporalLevelId` descriptor. A `GPCCTemporalLevelId` descriptor is used to identify the different temporal levels present in a Representation of a G-PCC content. At most one `GPCCTemporalLevelId` descriptor shall be present at the Representation level for the G-PCC media when the G-PCC media is stored in multiple temporal level tracks.

At most one `GPCCTemporalLevelId` descriptor may be present at the Representation level for the G-PCC media when the G-PCC component media samples are divided into multiple temporal levels and all temporal level samples are stored in a single temporal level track. The `GPCCTemporalLevelId` descriptor shall not be present at the Representation level when the G-PCC media samples are not divided based on temporal levels.

The `GPCCTemporalLevelId` descriptor shall include an `@value` attribute which specifies a list of space-separated temporal level identifiers for the temporal levels present in the G-PCC track of the Representation. The example of DASH signalling is explained in Clause H.4.

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Annex A

Add following clauses after Clause A.3.

A.4 Encapsulation with temporal scalability support

A.4.1 General

This brand specifies temporal scalability-related requirements on files and file readers.

The brand `'gpts'` may be present among the `compatible_brands` list of the `FileTypeBox`. File readers conforming to the `'gpst'` brand shall support the track encapsulation in multiple tracks as specified in A.2.2. and A.2.3.

A.4.2 Requirements on files

Files containing the brands `'gpts'` among the `compatible_brands` list of the `FileTypeBox` shall conform to the constraints defined in this subclause.

The boxes listed in Table A.1 are required in a file under the `'gpts'` brands. The Version column in Table A.1 lists the versions of the boxes allowed by this brand. Other versions of the boxes shall not be present.

Table A.1 — Required boxes in a file under the `'gpts'` brand

Hierarchy of boxes							Version	Box description
ftyp							-	file type and compatibility
moov								movie presentation
	trak							track
	mdia							media declaration
		hdlr						handler, declares the handler type for the track
		minf						media information
			vvhd				0	volumetric visual media header
			stbl					sample table
				stsd				sample description table
					–			sample entry
						gpcC	0	G-PCC decoder configuration
						ginf	0	G-PCC component information
						gsci	0	G-PCC scalability information
						gptC	0	G-PCC tile configuration
						gtsi	0	G-PCC tile scalability information
NOTE A '-' in the Version column indicates that the box is a container box.								

A.4.3 Requirements on readers

Support for the boxes listed in Table A.2 is required under the `'gpts'` and `'v3mp'` brands. The version column in Table A.2 specifies the versions of the boxes that shall be supported by the readers of the `'gpts'` brands.

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Table A.2 — Boxes to be supported in a file under the 'gpts' brand

Hierarchy of boxes							Version	Box description
ftyp							-	file type and compatibility
mdat								media data
moov								movie presentation
	trak							track
	mdia							media declaration
		hdlr						handler, declares the handler type for the track
		minf						media information
			vvhd				0	volumetric visual media header
			stbl					sample table
				stsd				sample description table
					–			sample entry
						gpcC	0	G-PCC decoder configuration
						ginf	0	G-PCC component information
						gsci	0	G-PCC scalability information
						gptC	0	G-PCC tile configuration
						gtsi	0	G-PCC tile scalability information
NOTE A '-' in the Version column indicates that the box is a container box.								

Readers shall recognize the sample entries in Table A.3 under the 'gpts' brand:

Table A.3 — Sample entries to be recognized under the 'gpts' brand

Four-character code	Name of the sample entry
gpe1	Temporal level track carrying all component data units of a temporal subset of G-PCC bitstream, and all parameter set data units carrying SPS, GPS, and APS in G-PCC decoder configuration record
gpeg	Temporal level track carrying all component data units of a temporal subset of G-PCC bitstream, and all parameter set data units carrying SPS, GPS, and APS in G-PCC decoder configuration record or samples
gpc1	Temporal level track carrying a particular component data units of a temporal subset of G-PCC bitstream, and all parameter set data units carrying SPS, GPS, and APS in G-PCC decoder configuration record
gpcg	Temporal level track carrying a particular component data units of a temporal subset of G-PCC bitstream, and all parameter set data units carrying SPS, GPS, and APS in G-PCC decoder configuration record or samples
gpeb	G-PCC tile base track with temporal level tile tracks carrying all component data units corresponding to G-PCC tiles of a temporal subset of G-PCC bitstream,
gpcb	G-PCC tile base track with temporal level tile tracks carrying a particular component data units corresponding to G-PCC tiles of a temporal subset of G-PCC bitstream,
gpt1	Temporal tile tracks carrying data units corresponding to G-PCC tiles of a temporal subset of G-PCC bitstream,

Readers shall recognize the sample group in Table A.4 under the 'gpts' brand:

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Table A.4 — Sample group to be recognized under the 'gpts' brand

Four-character code	Name of the sample group
gtii	Tile inventory sample group
tele	Tile level sample group

Readers shall recognize the track reference in Table A.5 under the 'gpts' brand:

Table A.5 — Track reference to be recognized under the 'gpts' brand

Four-character code	Name of the sample group
gpca	Reference to G-PCC attribute track
gpbt	Reference to G-PCC tile track

Readers shall recognize the track group in Table A.6 under the 'gpts' brand:

Table A.6 — Track group to be recognized under the 'gpts' brand

Four-character code	Name of the sample group
gtsg	Temporal scalability track group

Annex B

Replace the content of the annex with the following.

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="https://www.w3.org/2001/XMLSchema"
    targetNamespace="urn:mpeg:mpegI:gpcc:2022"
    xmlns:gpcc="urn:mpeg:mpegI:gpcc:2022"
    elementFormDefault="qualified">

    <xs:attribute name="gpcId" type="xs:string" use="optional" />
    <xs:attribute name="tile_Ids" type="xs:UIntVectorType" use="required" />
    <xs:attribute name="temporal_level_Ids" type="xs:UIntVectorType" use="required" />


    <xs:element name="component" type="gpcc:gpccComponentType"/>

    <xs:complexType name="gpccComponentType">
        <xs:attribute name="type" type="xs:string" use="required" />
        <xs:attribute name="attr_type" type="xs:unsignedByte" use="optional" />
        <xs:attribute name="attr_index" type="xs:unsignedByte" use="optional" />
        <xs:attribute name="tile_ids" type="xs:UIntVectorType" use="optional" />
    </xs:complexType>

    <xs:element name="gpsr" type="gpcc:spatialRegionMapType" />

    <xs:complexType name="spatialRegionMapType">
        <xs:element name="spatialRegion" type="gpcc:spatialRegionType" minOccurs="1"/>
    </xs:complexType>

    <xs:complexType name="spatialRegionType">
```

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```
        <xs:attribute name="id" type="xs:unsignedShort" use="required" />
        <xs:attribute name="x" type="xs:int" use="optional" default="0" />
        <xs:attribute name="y" type="xs:int" use="optional" default="0" />
        <xs:attribute name="z" type="xs:int" use="optional" default="0" />
        <xs:attribute name="dx" type="xs:int" use="required" />
        <xs:attribute name="dy" type="xs:int" use="required" />
        <xs:attribute name="dz" type="xs:int" use="required" />
        <xs:attribute name="tileIds" type="xs:UIntVectorType" use="optional" />
    </xs:complexType>

    <xs:attribute name="viewport_id" type="xs:integer" use="optional" />
    <xs:element name="ViewportInfo" type=" gpcc:ViewportInfoType"/>

    <!-- viewport -->
    <xs:complexType name="ViewportInfoType">
        <xs:attribute name="vp_pos" type="FloatVectorType" use="required"
            minLength="3" maxLength="3"/>
        <xs:attribute name="vp_quat" type="IntVectorType" use="required"
            minLength="3" maxLength="3"/>
        <xs:attribute name="vp_center_view_flag" type="xs:boolean" use="optional"/>
        <xs:attribute name="vp_left_view_flag" type="xs:boolean" use="optional"/>
        <xs:attribute name="viewport_description" type="xs:string" use="optional"/>
        <xs:attribute name="viewport_type" type="xs:integer" use="optional" default="0"/>
        <xs:anyAttribute processContents="skip"/>
    </xs:complexType>

</xs:schema>
```

Annex H

Add the following new clause after Clause H.3.

H.4 Temporal level indication

An example of a DASH MPD file signaling a G-PCC content with three temporal levels encapsulated into two temporal level and component tracks, each described in a Representation, is shown here.

```
<?xml version="1.0" encoding="UTF-8"?>
<MPD
    xmlns="urn:mpeg:dash:schema:mpd:2011"
    xmlns:gpcc="urn:mpeg:mpegI:gpcc:2022"
    type="static"
    mediaPresentationDuration="PT10S"
    minBufferTime="PT1S"
    profiles="urn:mpeg:dash:profile:isoff-on-demand:2011">

<Period>
    <!-- GPCC Geometry AdaptationSet -->
    <AdaptationSet id="1" codecs="gpc1">
            <Representation id="1">
```

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```
            <SupplementalProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2022:GPCCTemporalLevelId"
temporal_level_Ids="0 1"/>
                ...
            </Representation>
            <Representation id="2">
            <SupplementalProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2022:GPCCTemporalLevelId"
temporal_level_Ids="2"/>
                ...
            </Representation>
    </AdaptationSet>

    <!—Attribute 0 Component AdaptationSet -->
    <AdaptationSet id="2" codecs="gpc1">
            <EssentialProperty schemeIdUri="urn:mpeg:dash:preselection:2016" />
            <EssentialProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2022:component">
                <gpcc:component component_type="attr" attribute_type="0" attr_index="0"/>
            </EssentialProperty>
            <Representation id="3">
            <SupplementalProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2022:GPCCTemporalLevelId"
temporal_level_Ids="0 1"/>
                ...
            </Representation>
            <Representation id="4">
            <SupplementalProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2022:GPCCTemporalLevelId"
temporal_level_Ids="2"/>
                ...
            </Representation>
    </AdaptationSet>

    <!-- Attribute 1 Component AdaptationSet -->
    <AdaptationSet id="3" codecs="gpc1">
            <EssentialProperty schemeIdUri="urn:mpeg:dash:preselection:2016" />
            <EssentialProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2022:component">
                <gpcc:component component_type="attr" attribute_type="1" attr_index="1"/>
            </EssentialProperty>
            <Representation id="5">
            <SupplementalProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2022:GPCCTemporalLevelId"
temporal_level_Ids="0 1"/>
                ...
            </Representation>
            <Representation id="6">
            <SupplementalProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2022:GPCCTemporalLevelId"
temporal_level_Ids="2"/>
                ...
            </Representation>
    </AdaptationSet>

    <!-- Attribute 2 Component AdaptationSet -->
    <AdaptationSet id="4" codecs="gpc1">
            <EssentialProperty schemeIdUri="urn:mpeg:dash:preselection:2016" />
            <EssentialProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2022:component">
                <gpcc:component component_type="attr" attribute_type="4" attr_index="2"/>
            </EssentialProperty>
```

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```
            <Representation id="7">
            <SupplementalProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2022:GPCCTemporalLevelId"
temporal_level_Ids="0 1"/>
               ...
            </Representation>
            <Representation id="8">
            <SupplementalProperty schemeIdUri="urn:mpeg:mpegI:gpcc:2022:GPCCTemporalLevelId"
temporal_level_Ids=""2"/>
               ...
            </Representation>
    </AdaptationSet>



    <!—G-PCC Preselections -->
    <Preselection id="1" tag="1" preselectionComponents="1 2 3 4" codecs="gpc1">
    </Preselection>
</Period>
</MPD>
```

Annex I, J, K, L and M

Add the following new annexes after Annex H.

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Annex I
(informative)

Temporal level extraction process

I.1 Temporal level extraction from temporal level tracks

To extract samples from temporal level tracks, the G-PCC player is provided with a given target temporal level and a variable *lastPresentationTime*. The process is as follows:

a) The G-PCC player identifies the set of tracks in which each of the identified track contains temporal level that is less than or equal to the given target temporal level.

b) From the set of tracks, the player extracts samples that belong to temporal level that is less than or equal to the given target temporal level and have presentation time greater than the value of *lastPresentationTime*.

c) The extracted samples are delivered to the decoder according to their decoding time.

d) Once decoded, the decoded samples are delivered for rendering according to their presentation / composition time.

I.2 Temporal level extraction from temporal level tile tracks

To extract samples from temporal level tile tracks, the G-PCC player is provided with a given target temporal level, target tile ids, and a variable *lastPresentationTime*. The process is as follows:

a) The G-PCC player identifies a set of temporal level tile tracks in which each of the identified tile track contains a tile id which is one of target tile ids.

b) The player refines the selection criteria of the tile tracks in step 1 by selecting the set of tile tracks in which each of the identified track contains temporal level that is less than or equal to the given target temporal level.

c) From the set of selected tile tracks, the player extracts samples that belong to temporal level that is less than or equal to the given target temporal level, contain tile id which is one of the target tile ids, and have presentation time greater than the value of *lastPresentationTime*.

d) The extracted samples are delivered to the decoder according to their decoding time.

e) Once decoded, the decoded samples are delivered for presentation according to their presentation / composition time.

When the extraction process is invoked for the first time, the value of *lastPresentationTime* is set equal to the least possible presentation time.

Figure I.1 presents an example of how point cloud frames are encapsulated into multiple temporal level tile tracks during encapsulation and how the G-PCC samples are extracted from the temporal level tile tracks. In this example, each point cloud frame is composed of eight tiles and all the point cloud frames in the G-PCC bitstream are grouped into three temporal levels. The G-PCC samples are encapsulated into an ISOBMFF file using temporal level tile tracks. Each temporal level tile track represents G-PCC samples of a specific tile belonging to a specific temporal level. Each tile track carries all the G-PCC components data.

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The G-PCC player selects the corresponding temporal level tile tracks based on the given target temporal level and target tile ids which are based on the user's viewing orientation. The player may initially select tile tracks with a target temporal level id equal to 0 and enhance the temporal resolution by selecting additional tile tracks with temporal level 1 and higher at later stage. In this example, the G-PCC player initially receives tile tracks 1, 2, 5 and 6 with a target temporal level id 0. The player extracts the G-PCC samples of tiles 1, 2, 5 and 6 for a specific presentation time from those tile tracks. To enhance the user's quality of experience, the player may receive additional tile tracks with temporal level id 1 and 2 for tiles 1, 2, 5 and 6 and extract the G-PCC samples of those tiles for a specific presentation time from the tile tracks.

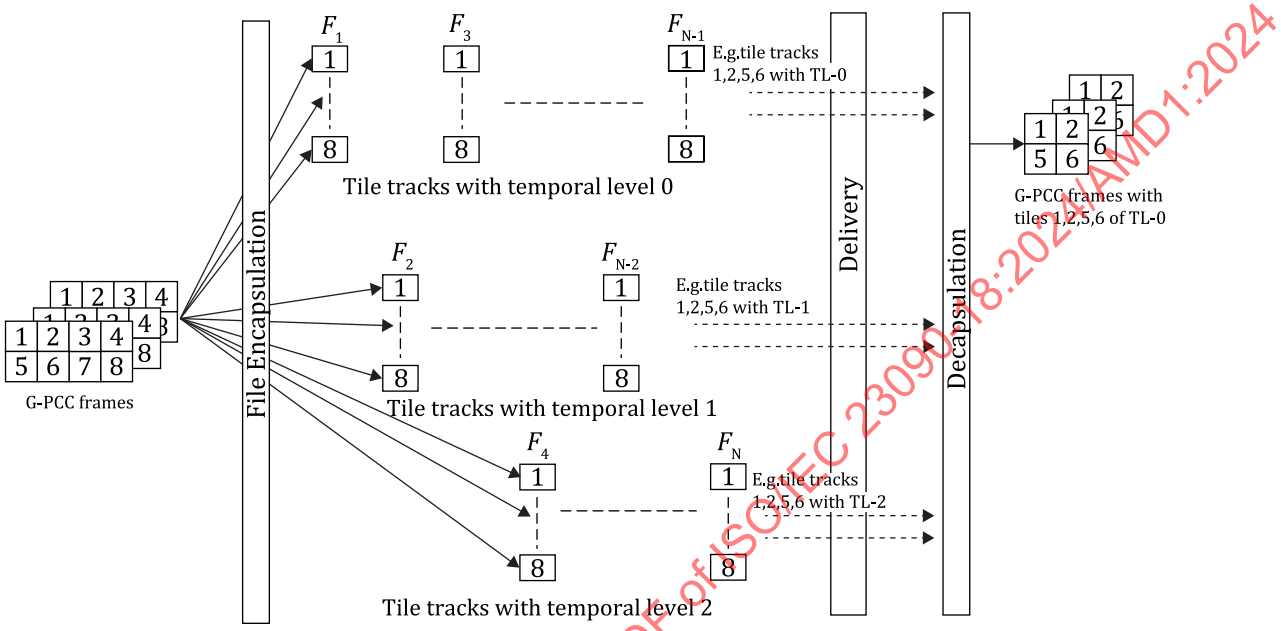

Figure I.1 — Example of G-PCC samples extraction from temporal level tile tracks

I.3 Change of parameters

When the target parameters (i.e., target temporal level and / or target tile ids) change, the players invoke the following process:

a) Set the value of *targetChangeTime* equal to the time of the new target parameters plus a fixed amount of offset time. The fixed amount of offset time can be set externally. For example, this can be a one of configuration parameter for the player operation.

b) Discard:

   1) samples that have been extracted but not yet decoded and that have presentation time less than the value of *targetChangeTime*;

   2) samples that have been decoded but not yet presented and that have presentation time less than the value of *targetChangeTime*.

c) Deliver the remaining extracted samples to the decoder according to their decoding time and then deliver the decoded samples for presentation according to their presentation time.

d) Set the value of *lastPresentationTime* to be equal to the presentation time of the last presented sample and invoke the extraction process based on the new target parameter(s).

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Annex J
(informative)

Indication of temporal level sample group

Figure J.1 illustrates an example of G-PCC file structure with two temporal level tracks. Each track contains samples from two temporal levels. For each track, sample group description box and sample to group box with grouping type `'tele'` are present. In the first track (Track 1), the sample group description box contains two `'tele'` sample group description entries as the highest temporal level identifier in that track is one. In the second track (Track 2), the sample group description box contains four `'tele'` sample group description entries as the highest temporal level identifier in that track is three.

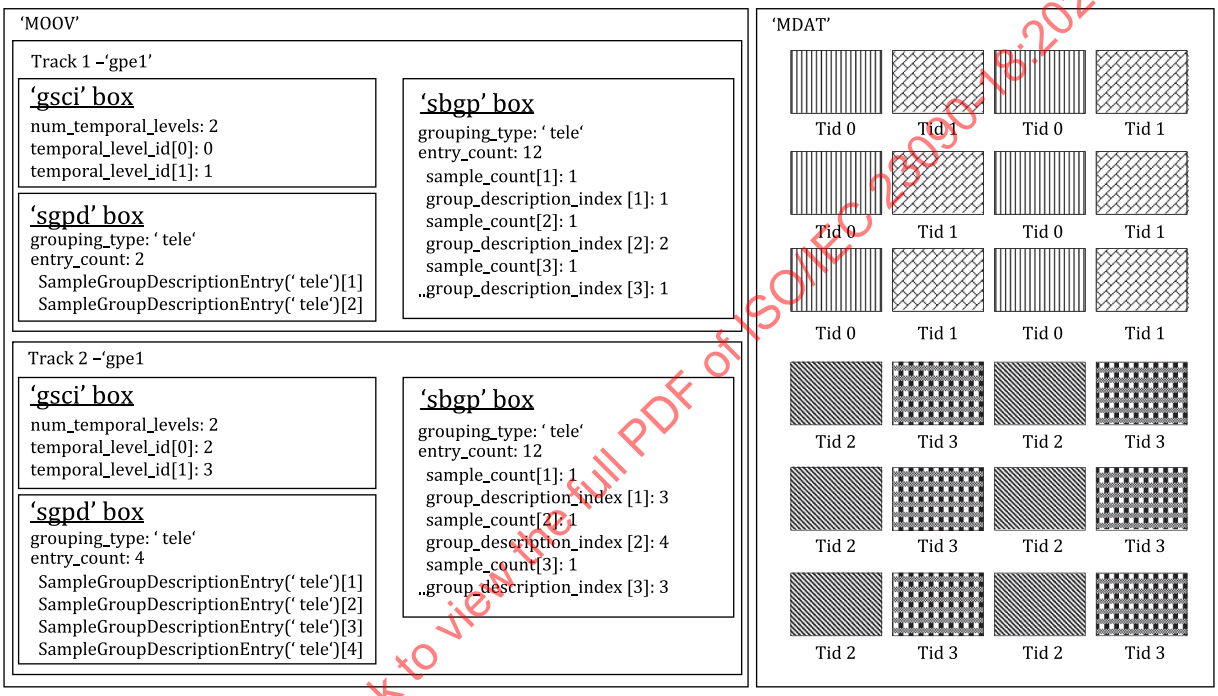

Figure J.1 — Example of using `'tele'` sample group in temporal level tracks

Figure J.2 illustrates an example of a G=PCC file structure that contains a tile base track (Track 1) and two temporal level tile tracks (Track 2 and Track 3). In each temporal level tile track, the number of `'tele'` sample group description entries in the sample group description box is equal to the max value of `temporal_level_id` plus 1 in the `GPCCTileScalabilityInfoBox` that is present in each of the temporal level tile track.

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