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# Scope

The ISO/IEC 23090-10 2nd edition [1] contains a section 9 dedicated to partial access. Partial access relates to making available only a subset of V3C content. The V3C Carriage specification defines data structures like V3CSpatialRegion that provides information of a spatial region or object-based subdivision of the volumetric media and their mapping information to atlas tiles. It may include the x, y, z offset of the spatial region and the width, height, and depth of the region in 3D space, 3D bounding box information of the volumetric media or object-based subdivision details. Static and dynamic spatial regions are supported, respectively as a V3CSpatialRegionCollectionBox in sample entry of a volumetric track and as V3CVolumetricMetadataSample in a timed-metadata track with a sample entry type 'dyvm'.

This exploration proposes an encapsulation mode dedicated to spatial access, based on “spatial” tracks.

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# 1 Introduction

This exploration proposes an encapsulation mode dedicated to spatial access, based on “spatial” tracks proposed in the following contributions:

* MPEG#151, [m73489](https://dms.mpeg.expert/doc_end_user/current_document.php?id=100090&id_meeting=0) - On V3C spatial tracks, discussed in [MPEG GitLab Issue#245](https://git.mpeg.expert/MPEG/Systems/PCC-SYS/V-PCC/-/issues/245)
  + the benefit of spatial track against partial access method, which is mainly the reduction of number of tracks and also the gathering in a single track of the independently decodable data for a given region. This avoids parsers to look for different tracks corresponding to a same region (for example atlas tile track(s) and submesh track(s) corresponding to a same region).
  + It has been discussed that this solution would save delivery bandwidth if the viewport is static but this benefit would be disappeared if the viewport changes dynamically.
  + It has been commented that this contribution does not consider the case that the region configuration is dynamically changing.
* MPEG#152, [m74541](https://dms.mpeg.expert/doc_end_user/current_document.php?id=101420&id_meeting=0) - On Dynamic V3C spatial tracks, discussed in [GitLab Issue#254](https://git.mpeg.expert/MPEG/Systems/PCC-SYS/V-PCC/-/issues/254) addressed the latter aspect (region dynamically changing). The following comments were received:
  + This contribution seems somehow lose a benefit of previous proposal as the region can move around different tracks so the clients may need to look at multiple tracks.
  + It would be beneficial if there is a static separation of bitstream into multiple tracks based on either spatial region or particular objects so that according to the use case a client only needs to parse and decode a specific track.
* Finally, from these initial proposals and discussion, the following questions remained open:
  + what if a V3CUnit contains two independently decodable tiles supposed to belong two different tracks based on this *(dynamic)* configuration. In addition, mapping of atlas to tile is dynamic normally to achieve best coding efficiency, which means that the association of atlas to tile can change at each frame.
  + If we can already place SpatialRegionCollectionBox in V3CBitstreamSampleEntry, why do we need the Spatial base track? V3C content in single-track encapsulation is supposed to be self-contained and independently decodable, so it would have to store all necessary parameter sets in the track? Are we willing to compromise this design and making single-track encapsulated content decoding depending on the new proposed base track? It is in my opinion a cleaner design to keep these tracks independently decodable and store the SpatialRegionCollectionBox in the V3CBitstreamSampleEntry instead.

To support spatial tracks for V3C Carriage, the following sections are proposed:

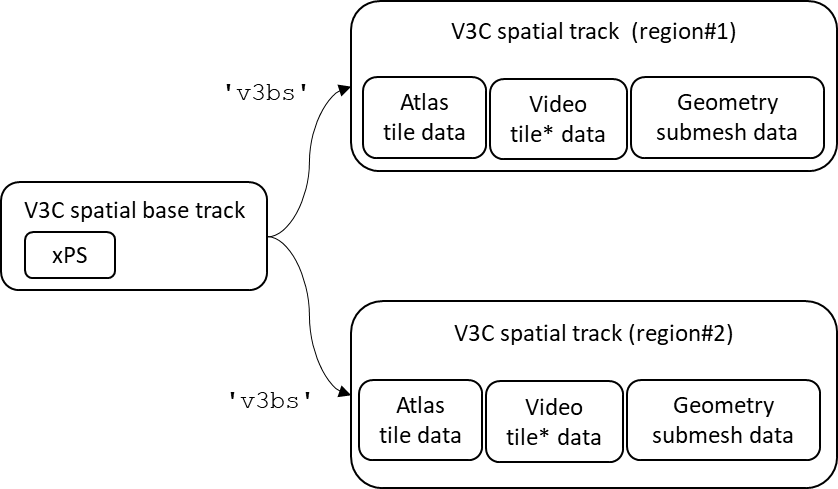
* Section 2 for static spatial tracks (from ISO/IEC 23090-10 TuC [1])
* Section 3 for dynamic spatial tracks (from contribution m74541)

# 2 Static spatial tracks

***2.1 Motivation***

ISO/IEC 23090-10 allows the sample entries of an atlas track to declare a collection of 3D regions, using the V3CSpatialRegionCollectionBox. This box provides a mapping between 3D regions and atlas tiles. Then, for region-based access, it makes sense to organize tracks according to these regions:

* The atlas can be split in atlas tiles, with one or more tiles per region, as indicated in the TileMapping structure of the V3CSpatialRegionCollectionBox.
* Along with each set of atlas tiles for a region, the corresponding data for the other components can be multiplexed in a single track as illustrated below.

****

**Figure 1: V3C spatial tracks**

There may be cases where some V3C units are not specific to a single region, or sub-bitstreams for which there is no split into regions (for example a displacement sub-bitstream).

First, we recall that the tiling and independent encoding of regions is an encoder choice. As well, the granularity of spatial track is decided by the encapsulation module: it can match one atlas tile, correspond to a combination of tiles, correspond to an identified region of interest or correspond to an object of interest.

About V3C units that are not specific to a single region, they can correspond to

- parameter sets (V3C\_VPS, parameter sets of the different sub-bitstreams) or

- data units that are not independently decodable for the region. This may be due to no tiling or no independent encoding available or to a granularity that is broader than the single region.

When V3C units that are not specific to a single region are present, they should be encapsulated in a “shared” ‘(or common) track. The content of the “shared” track can be described in the base track, to limit the number of tracks and track references.

***2.2 Proposal***

**Add a section** 9.X.X V3C spatial base track

A V3C spatial base track references one or more spatial tracks using track reference with a track reference type equal to ‘v3bs’ (**V3**C **b**ase track to **s**patial track). It contains the parameter sets or SEI messages for one or more referenced spatial tracks. It may contain data units for the sub-bitstreams that do not provide independently decodable parts. V3C spatial base track uses V3CSpatialBaseSampleEntry which extends VolumetricVisualSampleEntry with a sample entry type of 'v3b1’.

**Add a section** 9.X.X.1 V3C spatial base sample entry

9.X.X.1.1 Definition

|  |  |
| --- | --- |
| Sample Entry Type: | 'v3b1' |
| Container: | SampleDescriptionBox |
| Mandatory: | Yes, when spatial tracks are present |
| Quantity: | Zero or more (in a file) |

9.X.X.1.2 Syntax

aligned class V3CSpatialBaseSampleEntry extends VolumetricVisualSampleEntry('v3b1') {

V3CConfigurationBox config; // v3cC with full decoder configurations

V3CSpatialRegionCollectionBox regions; // optional

+config box for sub-bitstreams without spatial access!!

}

9.X.X.1.3 Semantics

compressorname in the base class VolumetricVisualSampleEntry indicates the name of the compressor used with the value "\012V3C Coding" being recommended; the first byte is a count of the remaining bytes, here represented by \012, which (being octal 12) is 10 (decimal), the number of bytes in the rest of the string.

config contains a single instance of V3CConfigurationBox providing the exhaustive list of decoder configurations.

regions describes the regions covered by the spatial tracks referenced from the spatial base track with this sample entry. When the number of regions declared in the V3CSpatialRegionCollectionBox is equal to 0, it means that spatial tracks correspond to one or more atlas tiles and not to an identified region.

**Add a section** 9.X.X.1.4 V3C spatial base track sync sample

A sync sample in a V3C spatial base track is a sample that provides random access point for the spatial tracks it references.

**Add a section** 9.X.X.2 V3C spatial track

**Add a section** 9.X.X.2.1 V3C spatial sample entry

9.X.X.2.1.1 Definition

|  |  |
| --- | --- |
| Sample Entry Type: | 'vss1' |
| Container: | SampleDescriptionBox |
| Mandatory: | Yes, in spatial tracks |
| Quantity: | One or more |

A spatial track contains data units corresponding to one or more 3D regions that are independently decodable. A sample of a spatial track sample shall contain at least one V3C unit.

The parent spatial base track is indicated by a track reference of type 'v3bs' from the spatial base track to the spatial track.

For V-DMC, V-PCC and MIV, the following statements shall be verified:

* each sample shall comprise at least one atlas V3C unit;
* all the data units of a spatial track belong to a same set of atlas tiles. The set of atlas tiles may be described in the sample entry of the spatial track.

9.X.X.2.1.2 Syntax

aligned class V3CSpatialSampleEntry extends VolumetricVisualSampleEntry('vss1') {

V3CSpatialConfigurationBox config; // optional

}

class V3CSpatialConfigurationBox extends FullBox('vssC', version = 0, 0) {

V3CSpatialRegionCollectionBox regions; // optional

}

9.X.X.2.1.3 Semantics

compressorname in the base class VolumetricVisualSampleEntry indicates the name of the compressor used with the value "\012V3C Coding" being recommended; the first byte is a count of the remaining bytes, here represented by \012, which (being octal 12) is 10 (decimal), the number of bytes in the rest of the string.

config contains a single instance of V3CSpatialConfigurationBox. When present, it contains at least a V3CSpatialConfigurationBox that describes the set of atlas tiles contained in the spatial track, for example as a V3CSpatialRegionCollectionBox.

regions describe the regions covered by the spatial track. These regions shall be a subset of the regions declared in a V3CSpatialRegionCollectionBox in the parent spatial base track.

**Add a section** 9.X.X.2.2 V3C spatial track sample format

9.X.X.2.2.1 Definition

9.X.X.2.2.2 Syntax

aligned(8) class V3CSpatialSample {

// sample\_size size of sample from SampleSizeBox

for (int i=0; i < sample\_size; ) {

unsigned int(v3c\_config.unit\_size\_precision\_bytes\_minus1 + 1)\*8) v3c\_unit\_size;

bit(8) ss\_v3c\_unit[v3c\_unit\_size];

i += v3c\_unit\_size + v3c\_config.unit\_size\_precision\_bytes\_minus1 + 1;

}

}

9.X.X.2.2.3 Semantics

v3c\_unit\_size specifies the size, in bytes, of the ss\_v3c\_unit array. The size is equivalent to the sample stream v3c unit size ssvu\_v3c\_unit\_size as defined in ISO/IEC 23090-5, Annex C.

ss\_v3c\_unit contains a single V3C unit in V3C unit sample stream format as defined in ISO/IEC 23090-5:2021 in Annex C.

**Add a section** 9.X.X.2.3 V3C spatial track sync sample

A sync sample in a V3C spatial track is a sample for which all sub-bitstream composition units are sub-bitstream IRAP composition units as defined in ISO/IEC 23090-5.

**Add a section** 9.X.X.2.4 V3C spatial track subsample

A V3C spatial track sub-sample is a V3C unit which is contained in a V3C spatial track sample.

A V3C spatial track may contain one SubSampleInformationBox in its SampleTableBox, or in the TrackFragmentBox of each of its MovieFragmentBoxes, which lists the V3C spatial track sub-samples.

The 32-bit unit header of the V3C unit which represents the sub-sample shall be copied to the 32-bit codec\_specific\_parameters field of the sub-sample entry in the SubSampleInformationBox. The V3C unit type of each sub-sample shall be identified by parsing the codec\_specific\_parameters field of the sub-sample entry in the SubSampleInformationBox.

# 3 Dynamic spatial tracks

In ISO/IEC 23090-10, if the V3C atlas track has an associated timed-metadata track with a sample entry type 'dyvm', 3D spatial regions defined for the volumetric media stream carried by the V3C atlas track are considered as dynamic regions (i.e., the spatial region information may dynamically change over time) and V3CSpatialRegionCollectionBox shall be present in the sample entry of the timed-metadata track, and not in the sample entry of the V3C track.

***3.1 Motivation***

The proposal from section 2, introducing V3C spatial base track and V3C spatial track, is updated to support dynamic regions by using a sample group approach. Indeed, sample group can handle both static and dynamic spatial regions by setting the flags of the SampleGroupDescriptionBox appropriately. The entries of the SampleGroupDescriptionBox list the regions covered by the samples of a V3C spatial track mapped to this entry. The sample group description entry for spatial region description reuses the already defined V3C structure: V3CSpatialRegionCollectionBox. When ***3D spatial regions*** *defined for the volumetric media stream* ***are considered as dynamic regions,*** the collection of regions within a spatial track shall be a subset of these 3D spatial regions, meaning that the scope for region\_id is unique for a spatial base track, its related spatial track and a timed\_metadata track when present; this timed\_metadata track may be associated to the V3C spatial base track with a ‘cdsc’ track reference.

***3.2 Proposed definition of V3C Spatial Base track***

**Renumber section 7.3.4 into 7.3.5**

**Rename section** 7.3.4 into V3C spatial tracks

**Add a section** 7.3.4.1 V3C spatial base track

A V3C spatial base track references one or more spatial tracks using track reference with a track reference type equal to ‘v3bs’ (from **V3**C **b**ase track to **s**patial track). It contains the parameter sets or SEI messages for one or more referenced spatial tracks. It may contain coding layer data units (e.g. ACL NAL units, VCL NAL units for video sub-bitstreams, BMC NAL units or DCL NAL units within V3C units) for the sub-bitstreams that do not provide independently decodable parts. **When the V3C spatial base track contains coding layer data units, it shall contain the corresponding decoder configuration boxes in its sample entry.** V3C spatial base track uses V3CSpatialBaseSampleEntry which extends VolumetricVisualSampleEntry with a sample entry type of 'v3b1’. **The sample entry may contain a** V3CSpatialRegionCollectionBox **to indicate the set of regions covered by the V3C spatial base track and its related V3C spatial tracks.**

**Add a section** 7.3.4.1.1 V3C spatial base sample entry

7.3.4.1.1.1 Definition

|  |  |
| --- | --- |
| Sample Entry Type: | 'v3b1' |
| Container: | SampleDescriptionBox |
| Mandatory: | Yes, when spatial tracks are present |
| Quantity: | Zero or more (in a file) |

7.3.4.1.1.2 Syntax

aligned class V3CSpatialBaseSampleEntry extends VolumetricVisualSampleEntry('v3b1') {

V3CConfigurationBox config; // v3cC with full decoder configurations

V3CSpatialRegionCollectionBox regions; // optional

// optional configuration boxes for sub-bitstreams without spatial access

}

7.3.4.1.1.3 Semantics

compressorname in the base class VolumetricVisualSampleEntry indicates the name of the compressor used with the value "\012V3C Coding" being recommended; the first byte is a count of the remaining bytes, here represented by \012, which (being octal 12) is 10 (decimal), the number of bytes in the rest of the string.

config contains V3C bitstream’s decoding specific information, as defined in subclause 7.2.1.

regions, when present, describes the collection of regions covered by all the spatial tracks referenced from the spatial base track with this sample entry. The number of regions declared in the V3CSpatialRegionCollectionBox shall not be equal to 0 and shall be greater than (when some regions overlap) or equal to the sum of the number of regions carried in each V3C spatial track associated to this base track.

**Add a section** 7.3.4.1.2 V3C spatial base track sync sample

A sync sample in a V3C spatial base track is a sample that provides random access point for the V3C spatial tracks it references.

***3.3 Proposed definition of V3C Spatial track***

**Add a section** 7.3.4.2. V3C spatial track

**Add a section** 7.3.4.2.1 V3C spatial sample entry

7.3.4.2.1.1 Definition

|  |  |
| --- | --- |
| Sample Entry Type: | 'vss1' |
| Container: | SampleDescriptionBox |
| Mandatory: | Yes, in spatial tracks |
| Quantity: | One or more |

A spatial track contains data units corresponding to one or more 3D regions that are independently decodable. A sample of a spatial track shall contain at least one V3C unit.

The parent spatial base track is indicated by a track reference of type 'v3bs' from the spatial base track to the spatial track.

For V-DMC, V-PCC and MIV, the following statements shall be verified:

* each sample shall comprise at least one atlas V3C unit;
* all the data units of a spatial track belong to a same set of atlas tiles. The set of atlas tiles may be described in the sample entry of the spatial track.

7.3.4.2.1.2 Syntax

aligned class V3CSpatialSampleEntry extends VolumetricVisualSampleEntry('vss1') {

V3CSpatialConfigurationBox config; // optional

}

class V3CSpatialConfigurationBox extends FullBox('vssC', version = 0, 0) {

V3CSpatialRegionCollectionBox regions; // optional

}

7.3.4.2.1.3 Semantics

compressorname in the base class VolumetricVisualSampleEntry indicates the name of the compressor used with the value "\012V3C Coding" being recommended; the first byte is a count of the remaining bytes, here represented by \012, which (being octal 12) is 10 (decimal), the number of bytes in the rest of the string.

config contains a single instance of V3CSpatialConfigurationBox. When present, it contains at least a V3CSpatialConfigurationBox that describes the set of atlas tiles contained in the spatial track, for example as a V3CSpatialRegionCollectionBox.

regions defines a collection of regions present in a spatial track.

**Add a section** 7.3.4.2.2 V3C spatial track sample format

7.3.4.2.2.1 Definition

7.3.4.2.2.2 Syntax

aligned(8) class V3CSpatialSample {

// sample\_size size of sample from SampleSizeBox

for (int i=0; i < sample\_size; ) {

unsigned int(v3c\_config.unit\_size\_precision\_bytes\_minus1 + 1)\*8) v3c\_unit\_size;

bit(8) ss\_v3c\_unit[v3c\_unit\_size];

i += v3c\_unit\_size + v3c\_config.unit\_size\_precision\_bytes\_minus1 + 1;

}

}

7.3.4.2.2.3 Semantics

v3c\_unit\_size specifies the size, in bytes, of the ss\_v3c\_unit array. The size is equivalent to the sample stream v3c unit size ssvu\_v3c\_unit\_size as defined in ISO/IEC 23090-5, Annex C.

ss\_v3c\_unit contains a single V3C unit in V3C unit sample stream format as defined in ISO/IEC 23090-5:2021 in Annex C.

**Add a section** 7.3.4.2.3 V3C spatial track sync sample

A sync sample in a V3C spatial track is a sample for which all sub-bitstream composition units are sub-bitstream IRAP composition units as defined in ISO/IEC 23090-5.

**Add a section** 7.3.4.2.4 V3C spatial track subsample

A V3C spatial track sub-sample is a V3C unit which is contained in a V3C spatial track sample.

A V3C spatial track may contain one SubSampleInformationBox in its SampleTableBox, or in the TrackFragmentBox of each of its MovieFragmentBoxes, which lists the V3C spatial track sub-samples.

The 32-bit unit header of the V3C unit which represents the sub-sample shall be copied to the 32-bit codec\_specific\_parameters field of the sub-sample entry in the SubSampleInformationBox. The V3C unit type of each sub-sample shall be identified by parsing the codec\_specific\_parameters field of the sub-sample entry in the SubSampleInformationBox.

**Add a section** 7.3.4.2.5 Sample group for spatial region description

**7.3.4.2.5.1 Definition**

Group Type: '3dri'   
Container: SampleGroupDescriptionBox ('sgpd')  
Mandatory: No (yes in dynamic spatial tracks)  
Quantity: Zero or more

The 3DSpatialRegionInformationGroupEntry may be used to describe one or more 3D spatial regions present in a V3C spatial track.

The grouping\_type\_parameter is not defined for the SampleToGroupBox with grouping type '3dri'.

**7.3.4.2.5.2 Syntax**

class 3DSpatialRegionInformationGroupEntry() extends VolumetricVisualSampleGroupEntry ('3dri')  
{  
 V3CSpatialRegionCollectionBox spatial\_regions;  
}

**7.3.4.2.5.3 Semantics**

spatial\_regions describe the regions covered by the spatial track. These regions shall be a subset of the regions declared in a V3CSpatialRegionCollectionBox in the timed metadata track associated to its parent base track if any.

***3.4 Proposed changes for spatial region description in V3C Carriage***

In section 9.6.1., update the Container line with the yellow-highlighted part:

|  |  |
| --- | --- |
| Container: | V3CBitstreamSampleEntry, V3CAtlasSampleEntry, V3CSpatialSampleEntry (‘vss1’), or DynamicVolumetricMetadataSampleEntry ('dyvm') or  3DSpatialRegionInformationGroupEntry (‘3dri’) |

# 4 Open questions

[Ballot comment -038](https://git.mpeg.expert/MPEG/Systems/PCC-SYS/V-PCC/-/issues/262) on clause 7.4.1 indicated that:

*The single-track encapsulation does not support partial access*

Discussions at MPEG#152 indicated the following:

* *allowing this would require additional brand*
* *accepted in general but this to be further studied in the context of enhanced partial access.*

[MPEG GitLab comment](https://git.mpeg.expert/MPEG/Systems/PCC-SYS/V-PCC/-/issues/254#note_130521) raised the following points:

*There are some open questions requiring careful review. For example, what if a V3CUnit contains two independently decodable tiles supposed to belong two different tracks based on this configuration. In addition, mapping of atlas to tile is dynamic normally to achieve best coding efficiency, which means that the association of atlas to tile can change at each frame.*

This other [MPEG GitLab comment](https://git.mpeg.expert/MPEG/Systems/PCC-SYS/V-PCC/-/issues/254#note_130523) raised the following points:

*If we can already place SpatialRegionCollectionBox in V3CBitstreamSampleEntry, why do we need the Spatial base track? V3C content in single-track encapsulation is supposed to be self-contained and independently decodable, so it would have to store all necessary parameter sets in the track? Are we willing to compromise this design and making single-track encapsulated content decoding depending on the new proposed base track? It is in my opinion a cleaner design to keep these tracks independently decodable and store the SpatialRegionCollectionBox in the V3CBitstreamSampleEntry instead*.

It has been answered that the intention was not to change the design for single track and spatial tracks result from the split of a V3C bitstream for spatial access. As discussed at the beginning of section 2.2 of this document, the spatial base track is needed to carry the parameter sets and data units that are common to all spatial tracks.

# 5 References

[1] MDS25595\_WG03\_N01621, “*Technologies under consideration for ISO/IEC 23090-10*”, MPEG#152, October 2025

[2] MDS25293\_WG03\_N01546, “Text of ISO/IEC CD 23090-10 2nd edition Carriage of visual volumetric video-based coding data”, MPEG#151, July 2025