
**Information technology — Coded
representation of immersive media —**
Part 10:
**Carriage of visual volumetric video-
based coding data**

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

*Partie 10: Transport de données de codage basé sur la vidéo
volumétrique*



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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

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A list of all parts in the ISO/IEC 23090 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

This document addresses the storage of visual volumetric video-based coding data in files based on ISO/IEC 14496-12, reusing existing tools for storage of video-coded components. Another important aspect considered by this document is supporting flexible extraction of component streams at delivery or decoding time, or both.

The International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) draw attention to the fact that it is claimed that compliance with this document may involve the use of a patent.

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Information technology — Coded representation of immersive media —

Part 10: Carriage of visual volumetric video-based coding data

1 Scope

This document specifies carriage of coded media representations which comply with visual volumetric video-based coding and video-based point cloud compression (specified in ISO/IEC 23090-5).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEEE 754-2019, *IEEE Standard for Floating-Point Arithmetic*

IETF RFC 6381, *The 'Codecs' and 'Profiles' Parameters for "Bucket" Media Types*

ISO/IEC 14496-12, *Information technology — Coding of audio-visual objects — Part 12: ISO base media file format*

ISO/IEC 14496-15, *Information technology — Coding of audio-visual objects — Part 15: Carriage of network abstraction layer (NAL) unit structured video in the ISO based media file format*

ISO/IEC 23008-1:2017, *Information technology — High efficiency coding and media delivery in heterogeneous environments — Part 1: MPEG media transport (MMT)*

ISO/IEC 23009-1:2019, *Information technology — Dynamic adaptive streaming over HTTP (DASH) — Part 1: Media presentation description and segment formats*

ISO/IEC 23090-5:2021, *Information technology — Coded representation of immersive media — Part 5: Visual Volumetric Video-based Coding (V3C) and Video-based Point Cloud Compression (V-PCC)*

W3C Recommendation, *XML schema part 1: Structures*

W3C Recommendation, *XML schema part 2: Datatypes*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 23090-5 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

atlas parameter sets

non-ACL NAL units that have nal_unit_type equal to NAL_ASPS, NAL_AAPS, or NAL_AFPS

3.2

V3C content

volumetric media that is encoded

Note 1 to entry: For the purposes of this document, the media shall be encoded using ISO/IEC 23090-5.

3.3

volumetric visual track

track with a handler type reserved to describe volumetric visual track

3.4

V3C track

V3C bitstream track, V3C atlas track or V3C atlas tile track

3.5

V3C bitstream track

volumetric visual track containing V3C bitstream in case of single-track container

3.6

V3C atlas track

volumetric visual track containing V3C atlas bitstream in case of multi-track container

3.7

V3C atlas tile track

volumetric visual track containing portion of V3C atlas bitstream corresponding to one or more tiles in case of multi-track container

3.8

V3C video component track

video track which carries 2D video encoded data for any of the occupancy, geometry, or attribute component video bitstreams of the V3C bitstream

4 Abbreviated terms

2D	two-dimensional
3D	three-dimensional
CVS	coded V3C sequence
DASH	dynamic adaptive streaming over HTTP
HTTP	Hyper-text transfer protocol
IRAP	intra random access point
ISOBMFF	ISO base media file format
LoD	level of detail
PCC	point cloud compression
SEI	supplemental enhancement information
V3C	visual volumetric video-based coding
VPS	V3C parameter set
V-PCC	video-based Point Cloud Coding

5 Overview

5.1 General

Visual volumetric video-based coding (V3C) provides mechanism for coding visual volumetric frames. Visual volumetric frames are coded by converting the 3D volumetric information into a collection of 2D images and associated data. The converted 2D images are coded using widely available video and image coding specifications and the associated data, i.e., atlas data, is coded according to ISO/IEC 23090-5. The coded images and the coded atlas data are multiplexed and form a V3C bitstream.

A V3C bitstream consists of one or more CVSs. A CVS starts with a VPS, included in at least one V3C unit or provided through external means, and contains one or more V3C units carrying V3C sub-bitstreams, with each V3C sub-bitstream associated with a V3C component, e.g., atlas, occupancy, geometry, or attribute.

5.2 Overall architecture for carriage of V3C data

Figure 1 shows a typical content flow process for V3C media.

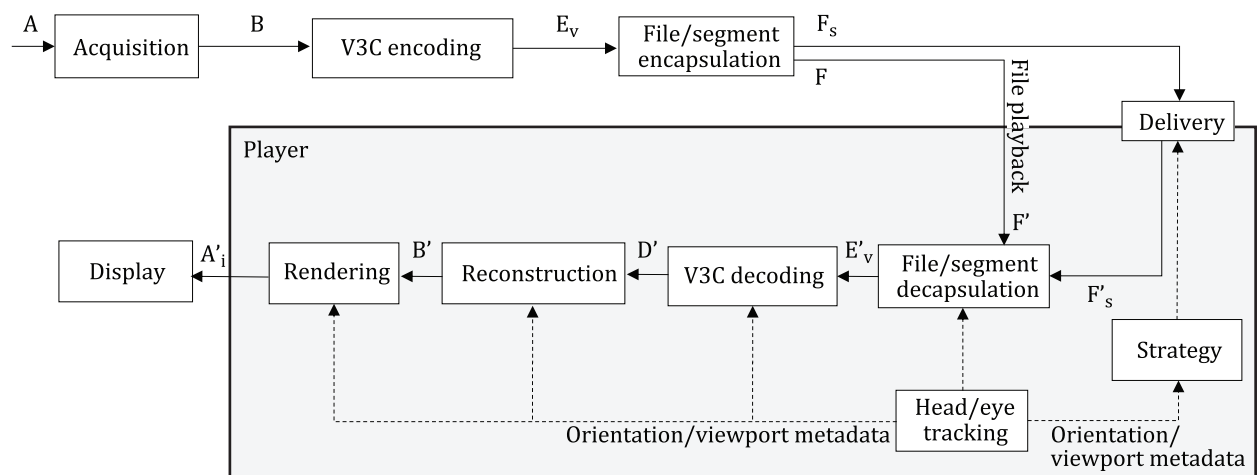


Figure 1 — Content flow process for V3C media

A real-world or synthetic visual scene (A) is captured by a set of cameras, a camera device with multiple lenses and sensors, or by virtual cameras. The acquisition results in source volumetric data (B). One or multiple volumetric frames are encoded as a coded V3C bitstream including an atlas bitstream, at most one occupancy bitstream, a geometry bitstream, and zero or more attribute bitstreams (E_v). One or more coded bitstreams are then packaged into a media file for local playback (F) or a sequence of an initialization segment and media segments for streaming (F_s), according to a particular media container file format. In this document, the media container file format is the ISO Base Media File Format specified in ISO/IEC 14496-12. The file encapsulator may also include metadata into the file or the segments. The segments F_s are delivered using a delivery mechanism to a player.

The file that the file encapsulator outputs (F) is identical to the file that the file decapsulator takes as input (F'). A file decapsulator processes the file (F') or the received segments (F'_s) and extracts the coded bitstreams (E'_v) and parses the metadata. The V3C bitstream is then decoded into a decoded signal (D'). The decoded volumetric data (D') are reconstructed, rendered, and displayed onto the screen of a head-mounted display or any other display device based on the current viewing orientation or viewport. The current viewing orientation is determined by the head tracking and possibly also eye tracking functionality. In viewport-dependent delivery, the current viewing orientation is also passed to the strategy module, which determines the tracks to be received based on the viewing orientation.

The process described above is applicable to both live and on-demand use cases.

The following interfaces are normatively specified in this document:

- F/F': media file including the specification of the track formats, which may contain constraints on the elementary streams contained within the samples of the tracks; see [Clause 7](#) for timed V3C content and [Clause 8](#) for non-timed V3C data.
- [Clause 11](#) specifies the delivery related interfaces for DASH delivery.
- [Clause 12](#) specifies the delivery related interfaces for MMT delivery.

5.3 Summary of referenceable code points

5.3.1 Brands

ISO/IEC 14496-12 defines the concept of brands, which may be indicated in the FileTypeBox. Brands are used in this document to indicate conformance to an encapsulation mode and a specific set of tools, as well as requirements on other specifications (e.g., ISO/IEC 14496-12).

The brands specified in this document are listed in [Table 1](#) and defined in [Annex A](#).

Table 1 — Brands specified in this document

Brand	Clause	Informative description
v3st	A.2	Single track encapsulation mode
v3mt	A.3	Multi-track encapsulation mode
v3mp	A.3	Multi-track encapsulation mode with partial access support
v3nt	A.4	Non-timed V3C data

5.3.2 Uniform resource names

The URNs specified in this document are listed in [Table 2](#).

Table 2 — URNs specified in this document

URN	Clause	Informative description
urn:mpeg:mpegI:v3c:2020	11.3.1	Namespace for the XML elements and attributes specified in this document
urn:mpeg:mpegI:v3c:2020:component	11.3.2	Scheme identifier for the V3C component DASH MPD descriptor
urn:mpeg:mpegI:v3c:2020:v3c	11.3.3	Scheme identifier for the V3C content DASH MPD descriptor
urn:mpeg:mpegI:v3c:2020:v3sr	11.6.1	Scheme identifier for the V3C static spatial region DASH MPD descriptor

5.3.3 Restricted scheme types

The restricted scheme types specified in this document are listed in [Table 3](#).

Table 3 — Restricted scheme types specified in this document

Restricted scheme type	Clause	Informative description
vvvc	7.4.5.1	V3C component video

5.3.4 Sample entry types

The sample entry types specified in this document are listed in [Table 4](#).

Table 4 — Sample entry types specified in this document

Sample entry type	Clause	Informative description
v3e1	7.3.2.2	For use with the single-track mode with all atlas parameter sets and SEI messages carried in decoder configuration record
v3eg	7.3.2.2	For use with the single-track mode with atlas parameter sets and SEI messages carried in decoder configuration record and in track samples
v3c1	7.4.2	For use with the multi-track mode with a single atlas and all atlas parameter sets and SEI messages carried in decoder configuration record
v3cg	7.4.2	For use with the multi-track mode with a single atlas and atlas parameter sets and SEI messages carried in decoder configuration record and in track samples
v3cb	7.4.2	For use with a base track in the multi-track mode with multiple atlases
v3a1	7.4.2	For use with an atlas track in the multi-track mode with multiple atlases and all atlas parameter sets and SEI messages carried in decoder configuration record
v3ag	7.4.2	For use with an atlas track in multi-track mode with multiple atlases and atlas parameter sets and SEI messages carried in decoder configuration record and in track samples
v3t1	7.4.3	For use with an atlas tile track in the multi-track mode
dyvm	9.7.1	For use with a timed metadata track indicating the dynamic spatial regions that are dynamically changing over time
6vpt	10.3.2	For use with a timed metadata track indicating viewport information that are dynamically changing over time

5.3.5 Box types

The box types specified in this document are listed in bold in [Table 5](#). Mandatory boxes are marked with an asterisk. Box types without a four-character code are marked with '-' in the structure.

Table 5 — Box types specified in this document

Box types, structure, and cross-reference (Informative)											
moov									*	ISOBMFF	<i>container for all the metadata</i>
	trak								*	ISOBMFF	<i>container for an individual track or stream</i>
		trgr								ISOBMFF	<i>track grouping indication</i>
			potg							7.4.8.2	<i>playout track group box</i>
			vtcg							9.4	<i>atlas tile components track group box</i>
		mdia							*	ISOBMFF	<i>container for the media information in a track</i>
			minf						*	ISOBMFF	<i>media information container</i>
				stbl					*	ISOBMFF	<i>sample table box, container for the time/space map</i>
					stds				*	ISOBMFF	<i>sample descriptions (codec types, initialization etc.)</i>
						-				ISOBMFF	<i>sample entry or restricted sample entry</i>
							rinf			ISOBMFF	<i>restricted scheme info box</i>
								frma		ISOBMFF	<i>original format box</i>
								schi		ISOBMFF	<i>scheme type box</i>
										ISOBMFF	<i>scheme information box</i>
								vunt	7.2.3		<i>V3C unit header box</i>
								mmvi	7.4.5.2		<i>Multimap video box</i>
						dyvm			9.7.2		<i>dynamic volumetric metadata sample entry</i>
						6vpt			10.3.2		<i>viewport information sample entry</i>
							6vpC		10.3.2		<i>viewport information configuration box</i>
						-			ISOBMFF		<i>visual sample entry</i>

Table 5 (continued)

Box types, structure, and cross-reference (Informative)											
						-				6.4	<i>volumetric visual sample entry</i>
							v3cC			7.2.2	<i>V3C decoder configuration box</i>
							vunt			7.2.3	<i>V3C unit header box</i>
							v3tC			7.4.3	<i>V3C atlas tile configuration box</i>
							vpbb			9.5	
							v3sc			9.6	<i>Static spatial region collection box</i>
meta										ISOBMFF	<i>Metadata</i>
	grpl									ISOBMFF	<i>group list box</i>
		eply								8.5.5.2	<i>playout entity group box</i>
		swpc								7.2.5	<i>object switch alternatives box</i>
	iprp									ISOBMFF	<i>item properties box</i>
		ipco								ISOBMFF	<i>item property container box</i>
			v3cp							8.5.2	<i>V3C configuration item property</i>
			vutp							8.5.3	<i>V3C unit header item property</i>
			v3tp							8.5.4	<i>V3C atlas tile configuration item property</i>

5.3.6 Track reference types

The track reference types specified in this document are listed in [Table 6](#).

Table 6 — Track reference types specified in this document

Track reference type	Clause	Informative description
v3cs	7.4.6.1	Referenced track is a V3C atlas track
v3ct	7.4.6.2	Referenced track is a V3C atlas tile track
v3vo	7.4.6.3	Referenced track is a V3C video component track carrying occupancy data
v3vg	7.4.6.3	Referenced track is a V3C video component track carrying geometry data
v3va	7.4.6.3	Referenced track is a V3C video component track carrying attribute data

5.3.7 Track grouping types

The track grouping types specified in this document are listed in [Table 7](#).

Table 7 — Track grouping types specified in this document

Track grouping type	Clause	Informative description
potg	7.4.8.2	Playout track grouping
vtcg	9.4	V3C tile components track grouping

5.3.8 Entity grouping types

The entity grouping types specified in this document are listed in [Table 8](#).

Table 8 — Entity grouping type specified in this document

Entity grouping type	Clause	Informative description
eply	8.5.5.2	Playout entity grouping
swpc	7.2.5	Object switch alternatives box

5.3.9 Sample grouping types

The sample grouping types specified in this document are listed in [Table 9](#).

Table 9 — Sample grouping types specified in this document

Sample grouping type	Clause	Informative description
vaps	7.2.4	V3C atlas parameter set sample grouping

6 Volumetric media

6.1 General

This clause contains descriptions and definitions, which are intended to be defined in ISO/IEC 14496-12.

6.2 Volumetric visual media

A volumetric visual track shall be identified by the volumetric visual media handler type 'volv' in the `HandlerBox` of the `MediaBox`, as defined in ISO/IEC 14496-12, and by a volumetric visual media header as defined in this document.

Multiple volumetric visual tracks may be present in the file.

6.3 Volumetric visual media header

6.3.1 Definition

Box Type: 'vvhd'
 Container: `MediaInformationBox`
 Mandatory: Yes
 Quantity: Exactly one

Volumetric visual tracks shall use a `VolumetricVisualMediaHeaderBox` in the `MediaInformationBox` as defined in ISO/IEC 14496-12.

6.3.2 Syntax

```
aligned(8) class VolumetricVisualMediaHeaderBox
    extends FullBox('vvhd', version = 0, 0) {
}
```

6.3.3 Semantics

`version` is an integer that specifies the version of this box

6.4 Volumetric visual sample entry

6.4.1 Definition

Volumetric visual tracks shall use a `VolumetricVisualSampleEntry`

6.4.2 Syntax

```
class VolumetricVisualSampleEntry(unsigned int(32) codingname)
    extends SampleEntry (codingname) {
```

```

    unsigned int(8)[32] compressorname;
    // other boxes from derived specifications
}

```

6.4.3 Semantics

`compressorname` is a name, for informative purposes. It is formatted in a fixed 32-byte field, with the first byte set to the number of bytes to be displayed, followed by that number of bytes of displayable data encoded using UTF-8, and then padding to complete 32 bytes total (including the size byte). The field may be set to 0.

6.5 Volumetric visual sample group entry

```

abstract class VolumetricVisualSampleGroupEntry (unsigned int(32) grouping_type) extends
SampleGroupDescriptionEntry (grouping_type){}

```

6.6 Volumetric visual samples

The format of a volumetric visual sample is defined by the coding system.

7 Carriage of visual volumetric video-based coding data

7.1 General

This clause defines the storage for a V3C bitstream utilizing the existing capabilities of the ISO base media file format and defining extensions, when necessary.

Two methods of the storage for V3C data are specified; a single track encapsulation, where a V3C data is stored as one track, and multi-track encapsulation, where each V3C component is stored as a separate track.

7.2 Common boxes and data structures

7.2.1 V3C decoder configuration record

7.2.1.1 Definition

The V3C decoder configuration record provides V3C bitstream's decoding specific information (i.e. parameter sets and SEI messages) for further configuration and initialization of the V3C decoder. This document sets the following restrictions for V3C content encapsulation:

- `num_of_v3c_parameter_sets` in `V3CDecoderConfigurationRecord` shall be equal to 1. Under the 'v3a1' and 'v3ag' sample entry, `num_of_v3c_parameter_sets` shall be equal to 0.
- For a given atlas the tile IDs shall remain unique for the duration of the sequence. Tile IDs shall not be re-used between atlas frame parameter sets.
- V3C data is naturally represented as variable bit rate in the file format and should be filled for transmission if needed. Filler Data NAL units and Filler Data SEI messages shall not be present in the file format stored stream when the sample entry does not also permit in-stream parameter sets.

If the version number is not supported or recognized by the reader, then it shall not attempt to decode this configuration record or the bitstreams to which it applies.

7.2.1.2 Syntax

```

aligned(8) class V3CDecoderConfigurationRecord {
    // version 0
    unsigned int(3) unit_size_precision_bytes_minus1;
    unsigned int(5) num_of_v3c_parameter_sets;
    for (int i=0; i < num_of_v3c_parameter_sets; i++) {

```

```

    unsigned int(16) v3c_parameter_set_length;
    // v3c_unit() as defined in ISO/IEC 23090-5
    v3c_unit v3c_parameter_set(v3c_parameter_set_length);
}
unsigned int(8) num_of_setup_unit_arrays;
for (int j=0; j < num_of_setup_unit_arrays; j++) {
    unsigned int(1) array_completeness;
    bit(1) reserved = 0;
    unsigned int(6) nal_unit_type;
    unsigned int(8) num_nal_units;
    for (int i=0; i < num_nal_units; i++) {
        unsigned int(16) setup_unit_length;
        // nal_unit(size) as defined in ISO/IEC 23090-5
        nal_unit setup_unit(setup_unit_length);
    }
}
// additional fields
}

```

7.2.1.3 Semantics

`unit_size_precision_bytes_minus1` plus 1 specifies the precision, in bytes, of the sample stream NAL unit or sample stream V3C unit to which this configuration record applies. The value of this field shall be conditional on the 4CC-code of the sample entry. For V3C atlas tracks `unit_size_precision_bytes_minus1` shall be equal to `ssnh_unit_size_precision_bytes_minus1` in `sample_stream_nal_header()`. For V3C bitstream tracks `unit_size_precision_bytes_minus1` shall be equal to `ssvh_unit_size_precision_bytes_minus1` in `sample_stream_v3c_header()`.

`num_of_v3c_parameter_sets` specifies the number of V3C parameter set units signalled in the decoder configuration record.

`v3c_parameter_set_length` indicates the size, in bytes, of the `v3c_parameter_set` field.

`v3c_parameter_set` is a V3C unit payload for V3C unit of type `V3C_VPS`, as defined in ISO/IEC 23090-5.

`num_of_setup_unit_arrays` indicates the number of arrays of atlas NAL units of the indicated type(s).

`array_completeness` when equal to 1 indicates that all atlas NAL units of the given type are in the following array and none are in the stream; when equal to 0 indicates that additional atlas NAL units of the indicated type may be in the stream; the default and permitted values are constrained by the sample entry name.

`nal_unit_type` indicates the type of the atlas NAL units in the following array (which shall be all of that type); it takes a value as defined in ISO/IEC 23090-5; it is restricted to take one of the values indicating a `NAL_ASPS`, `NAL_AAPS`, `NAL_AFPS`, `NAL_PREFIX_ESEI`, `NAL_PREFIX_NSEI`, `NAL_SUFFIX_ESEI`, or `NAL_SUFFIX_NSEI` atlas NAL unit.

`num_nal_units` indicates the number of atlas NAL units of type `nal_unit_type` included in the configuration record for the stream to which this configuration record applies.

`setup_unit_length` indicates the size, in bytes, of the `setup_unit` field. The length field includes the size of both the NAL unit header and the NAL unit payload but does not include the length field itself.

`setup_unit` contains a NAL unit according to related `nal_unit_type`. When present in `setup_unit`, `NAL_PREFIX_ESEI`, `NAL_PREFIX_NSEI`, `NAL_SUFFIX_ESEI`, or `NAL_SUFFIX_NSEI` contain SEI messages of a 'declarative' nature, that is, those that provide information about the stream as a whole. An example of such an SEI could be a user-data SEI.

The `setup_unit` arrays shall include atlas sub-bitstream parameter sets that are constant for the CVS referred to by the sample entry in which the decoder configuration record is present as well as atlas sub-bitstream SEI messages.

7.2.2 V3C decoder configuration box

7.2.2.1 Definition

A V3C decoder configuration box includes a `V3CDecoderConfigurationRecord` as defined in [subclause 7.2.1](#).

In this this document `version` shall be equal to 0.

7.2.2.2 Syntax

```
class V3CConfigurationBox extends FullBox('v3cC', version = 0, 0) {  
    V3CDecoderConfigurationRecord();  
}
```

7.2.2.3 Semantics

`V3CDecoderConfigurationRecord` is defined in [subclause 7.2.1](#)

7.2.3 V3C unit header box

7.2.3.1 Definition

Box Types: `'vunt'`
Container: Sample Entry (`'v3c1'`, `'v3cg'`, `'v3cb'`, `'v3a1'`, or `'v3ag'`) and `SchemeInformationBox`
Mandatory: Yes
Quantity: one

A single `V3CUnitHeaderBox` is present in the sample entry of a V3C atlas track and in `scheme_specific_data` Box array of the `SchemeInformationBox` of all V3C video component tracks. `V3CUnitHeaderBox` contains the V3C unit header describing the data carried by the respective track.

7.2.3.2 Syntax

```
aligned(8) class V3CUnitHeaderBox extends FullBox('vunt', version = 0, 0){  
    v3c_unit_header header(); // 4-bytes as defined in ISO/IEC 23090-5  
}
```

7.2.3.3 Semantics

`header` contains a single instance of the 32-bit V3C unit header as defined in ISO/IEC 23090-5.

7.2.4 V3C atlas parameter set sample group

7.2.4.1 Definition

Box Types: `'vaps'`
Container: Sample Group Description Box (`'sgpd'`)
Mandatory: No
Quantity: Zero or one

The use of `'vaps'` for the `grouping_type` in sample grouping represents the assignment of samples in V3C atlas track or V3C bitstream track to the atlas parameter sets carried in this sample group. When a `SampleToGroupBox` with `grouping_type` equal to `'vaps'` is present, an accompanying

SampleGroupDescriptionBox with the same grouping type shall be present and contains the ID of the group that the samples belong to.

Sample grouping type 'vaps' shall not be used with a track with a sample entry 'v3c1', 'v3e1' or 'v3a1'.

NOTE V3C atlas parameter set sample group can be used to improve random access of atlas tracks, by removing the need to replicate parameter sets and SEI messages for sync samples.

7.2.4.2 Syntax

```
aligned(8) class V3CAtlasParamSampleGroupDescriptionEntry() extends VolumetricVisualSample
GroupEntry('vaps') {
    unsigned int(8) num_of_setup_units;
    for (int i=0; i < num_of_setup_units; i++) {
        unsigned int(16) setup_unit_length;
        // nal_unit(size) as defined in ISO/IEC 23090-5
        nal_unit setup_unit(setup_unit_length);
    }
}
```

7.2.4.3 Semantics

num_of_setup_units specifies the number of setup units signalled in the sample group description.

setup_unit_length indicates the size, in bytes, of the setup_unit field. The length field includes the size of both the NAL unit header and the NAL unit payload but does not include the length field itself.

setup_unit is a NAL unit of type NAL_ASPS, NAL_AAPS, NAL_AFPS, NAL_PREFIX_ESEI, NAL_PREFIX_NSEI, NAL_SUFFIX_ESEI, or NAL_SUFFIX_NSEI carrying data associated with this group of samples.

7.2.5 Object switch alternatives box

7.2.5.1 Definition

Box Types: 'swpc'

Container: Groups List Box ('grpl')

Mandatory: No

Quantity: Zero or more

EntityToGroupBox with grouping_type equal to 'swpc' specifies tracks and items that are associated with each other based on a logical context and are user switchable alternatives of each other. If ObjectSwitchAlternativesBox is absent, there is no information on which items or tracks should be played out together. When ObjectSwitchAlternativesBox contains alternatives, only items or tracks from one point-cloud object within an alternate group should be played or streamed at any one time.

7.2.5.2 Syntax

```
aligned(8) class ObjectSwitchAlternativesBox extends EntityToGroupBox('swpc') {
}
```

7.3 Single track encapsulation of V3C data

7.3.1 General

A single-track encapsulation of V3C data requires the V3C bitstream to be represented by a single-track declaration, referred to as V3C bitstream track.

Single-track encapsulation of V3C data is utilized in the case of direct ISOBMFF encapsulation of a V3C bitstream. V3C bitstream is directly stored as a single track without further processing. V3C unit header data structures are kept in the bitstream as-is. A single-track encapsulated V3C data could be provided to media workflows for further processing (e.g., multi-track file generation, transcoding, DASH segmentation, etc.).

7.3.2 V3C bitstream sample entry

7.3.2.1 Http

7.3.2.2 Definition

Sample Entry Type: 'v3e1', 'v3eg'

Container: SampleDescriptionBox

Mandatory: A 'v3e1' or 'v3eg' sample entry is mandatory

Quantity: One or more

V3C bitstream tracks shall use `VolumetricVisualSampleEntry` with a sample entry type of 'v3e1' or 'v3eg'.

A V3C bitstream track sample entry shall contain a `V3CConfigurationBox`, as defined in [subclause 7.2.2](#).

Under the 'v3e1' sample entry, all atlas parameter sets and SEI messages, as defined in ISO/IEC 23090-5, shall be in the `setup_unit` array. Under the 'v3eg' sample entry, the atlas parameter sets and SEI messages may be present in the `setup_unit` array, or in the samples of the V3C bitstream track.

An optional `BitRateBox` as defined in ISO/IEC 14496-12 may be present in the V3C bitstream sample entry to signal the bit rate information of the V3C bitstream track.

7.3.2.3 Syntax

```
aligned(8) class V3CBitstreamSampleEntry() extends VolumetricVisualSampleEntry (type) {
    // type is 'v3e1' or 'v3eg'
    V3CConfigurationBox config;
}
```

7.3.2.4 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.

7.3.3 V3C bitstream track sample format

7.3.3.1 Definition

A V3C bitstream sample shall contain one or more V3C units which belong to the same presentation time, i.e., one V3C composition unit. A sample may be self-contained (e.g., a sync sample) or decoding-wise dependent on other samples of V3C bitstream track.

7.3.3.2 Syntax

```
aligned(8) class V3CBitstreamSample {
    // sample_size size of sample from SampleSizeBox
    for (int i=0; i < sample_size; ) {
        sample_stream_v3c_unit ss_v3c_unit; // as defined in ISO/IEC 23090-5
```

```

        i += ss_v3c_unit.ssvu_v3c_unit_size +
            V3CDecoderConfigurationRecord.unit_size_precision_bytes_minus1 + 1;
    }
}

```

7.3.3.3 Semantics

`ss_v3c_unit` contains a single V3C unit in V3C unit sample stream format as defined in ISO/IEC 23090-5:2021, Annex C.

`ssvu_v3c_unit_size` specifies the size, in bytes, of the sample stream V3C unit. The number of bits used to represent `ssvu_v3c_unit_size` is equal to $(V3CDecoderConfigurationRecord.unit_size_precision_bytes_minus1 + 1) * 8$.

7.3.3.4 V3C bitstream track sync sample

A V3C bitstream sync sample 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) are successfully decodable.

7.3.3.5 V3C bitstream track sub-sample

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

A V3C bitstream track shall contain one `SubSampleInformationBox` in its `SampleTableBox`, or in the `TrackFragmentBox` of each of its `MovieFragmentBoxes`, which lists the V3C bitstream 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`.

7.4 Multi-track encapsulation of V3C data

7.4.1 General

There may be three types of tracks in a multi-track encapsulated V3C data container: V3C atlas track, V3C atlas tile track, and V3C video component track. A multi-track encapsulated V3C data container shall include at least one V3C atlas track that references zero or more V3C atlas tile tracks or zero or more V3C video component tracks. A V3C atlas tile track, when present, references zero or more V3C video component tracks. The number of V3C video component tracks in a multi-track encapsulated V3C data container is dependent on the V3C toolset profile, defined in ISO/IEC 23090-5, that is used.

To indicate the association of V3C video component tracks to a V3C atlas track, or V3C atlas tile track, ISOBMFF track referencing is utilized, where the V3C atlas track, or V3C atlas tile track, contain track references to the V3C video component tracks.

Tracks belonging to the same CVS are time-aligned. Samples that contribute to the same volumetric frame across the different V3C video component tracks, V3C atlas track and V3C atlas tile tracks shall have the same composition time. Atlas parameter sets used for such samples shall have a decoding time equal or prior to the composition time of the volumetric frame. In addition, all tracks belonging to the same CVS shall have the same implied or explicit edit lists.

NOTE 1 Synchronization between the elementary streams in V3C atlas track, V3C atlas tile tracks and V3C video component tracks is handled by the ISOBMFF track timing structures (stts, ctts, and cslg), or equivalent mechanisms in movie fragments.

NOTE 2 The sync samples in the V3C atlas track, V3C atlas tile track and V3C video component tracks can be time-aligned. In the absence of time-alignment, random access can involve pre-rolling the various tracks from different sync start-times, to enable starting at the desired time. In the case of time-alignment (e.g., required by a V3C profile such as the V-PCC Basic toolset profile as defined in ISO/IEC 23090-5), the sync samples of the V3C atlas track can be considered as the random-access points for the V3C content, and random access can be done by only referencing the sync sample information of the V3C atlas track.

An example layout of a multi-track encapsulated V3C data container is shown in Figure 2. The boxes in the figure map to corresponding ISOBMFF boxes, as defined in ISO/IEC 14496-12. Payloads of V3C units of a V3C bitstream are mapped to individual tracks within the multi-track container file based on their types.

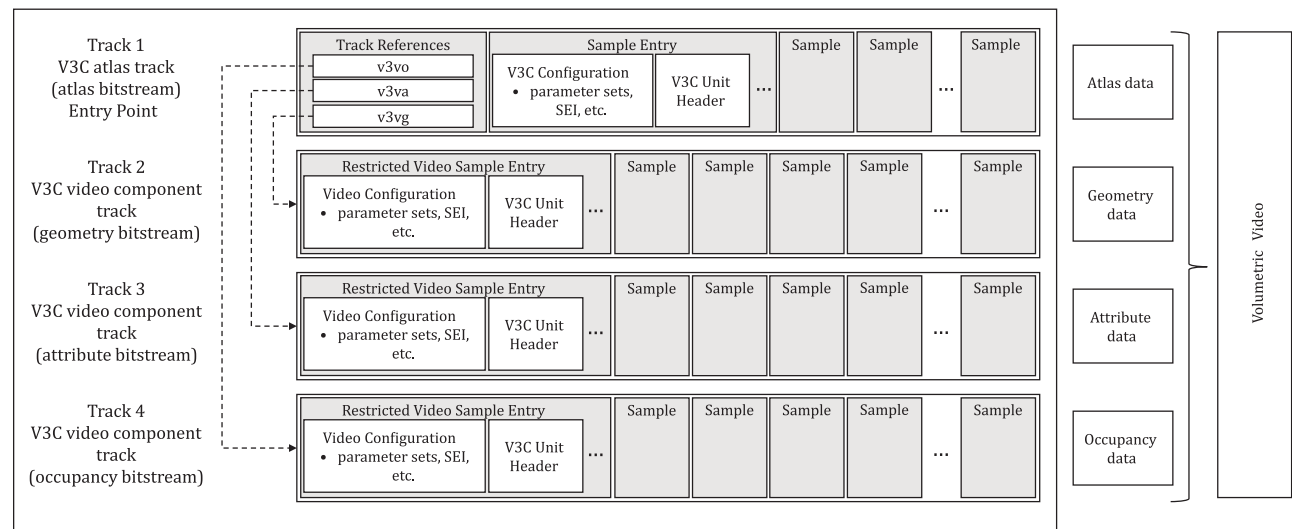


Figure 2 — Visualization of a multi-track encapsulation of V3C data container file

A multi-track encapsulated V3C data container shall include the following:

- A V3C atlas track which contains a V3C parameter set and may contain atlas parameter sets in the sample entry and atlas component bitstream NAL units in the samples. A V3C atlas track may also include track references to other tracks carrying the payloads of video compressed V3C units (i.e., V3C unit types equal to V3C_OVD, V3C_GVD, and V3C_AVD) or to V3C atlas tile tracks.
- Zero or more V3C video component tracks where the samples contain access units of a video-coded elementary stream for occupancy data (i.e., payloads of V3C units of type equal to V3C_OVD).
- Zero or more V3C video component tracks where the samples contain access units of video-coded elementary streams for geometry data (i.e., payloads of V3C units of type equal to V3C_GVD).
- Zero or more V3C video component tracks where the samples contain access units of video-coded elementary streams for attribute data (i.e., payloads of V3C units of type equal to V3C_AVD).
- Zero or more V3C atlas tile tracks where the samples contain only ACL NAL units for a sub-set of atlas tiles. V3C atlas tile track may also contain track references to other tracks carrying the payloads of video compressed V3C units (i.e., V3C unit types equal to V3C_OVD, V3C_GVD, and V3C_AVD) for the indicated sub-set of atlas tiles.

7.4.2 V3C atlas sample entry

7.4.2.1 Definition

Sample Entry Type: 'v3c1', 'v3cg', 'v3cb', 'v3a1', or 'v3ag'

Container: SampleDescriptionBox

Mandatory: A 'v3c1', 'v3cg', 'v3cb', 'v3a1', or 'v3ag' sample entry is mandatory

Quantity: One or more

V3C atlas tracks use `V3CAtlasSampleEntry` which extends `VolumetricVisualSampleEntry` with a sample entry type of 'v3c1', 'v3cg', 'v3cb', 'v3a1', or 'v3ag'. Following restrictions are set for V3C atlas tracks:

- A V3C atlas track shall not carry ACL NAL units belonging to more than one atlas.
- In track header the `track_in_movie` flag is set to 1.
- A V3C atlas track sample entry contains a `V3CConfigurationBox`, as defined in [subclause 7.2.2](#), and a `V3CUnitHeaderBox`, as defined in [subclause 7.2.3](#).

NOTE V3C atlas tracks with sample entry type 'v3cb', 'v3a1' and 'v3ag' are relevant for carrying multiple atlases.

Depending on V3C content or sample entry type of the atlas track, following further restrictions may be placed on atlas tracks

- When the V3C bitstream contains a single atlas, a V3C atlas track with sample entry 'v3c1' or 'v3cg' shall be used.
- When the V3C bitstream contains multiple atlases, each atlas bitstream shall be stored as a separate V3C atlas track. One of those tracks shall use sample entry type 'v3cb', while the other tracks shall use sample entry type 'v3a1', or 'v3ag'.
- A V3C atlas track with sample entry type 'v3cb' shall not include any ACL NAL units.
- Under the 'v3a1' and 'v3ag' sample entry, no V3C parameter set shall be stored in the `v3c_parameter_set` array.
- Under the 'v3c1' sample entry, all atlas parameter sets shall be stored in the `setup_unit` array. SEI messages that apply to the stream as a whole may be stored in the `setup_unit` array as well. Under the 'v3cg' and 'v3cb' sample entry, the parameter sets and SEI messages may be present in the `setup_unit` array, or in the samples of V3C atlas track.
- Under the 'v3a1' sample entry, all atlas parameter sets shall be stored in the `setup_unit` array. SEI messages that apply to the stream as a whole and are associated with the same `vuh_atlas_id` indicated in the V3C unit header box may be stored in the `setup_unit` array as well. Under the 'v3ag' sample entry, atlas parameter sets and SEI messages, associated with the same `vuh_atlas_id` indicated in the V3C unit header box, may be present in the `setup_unit` array, or in the samples of V3C atlas track.
- Under the 'v3c1' or 'v3a1', the default and mandatory value of `array_completeness` in `V3CDecoderConfigurationRecord` is 1 for arrays of all types of atlas parameter sets and for SEI messages that apply for the stream as a whole and are carried in the `V3CDecoderConfigurationRecord`. For all other arrays `array_completeness` is set to 0. When the sample entry 4CC is 'v3cg' or 'v3ag' or 'v3cb', the default value of `array_completeness` is 0 for all arrays.

An optional `BitRateBox` may be present in the V3C atlas sample entry to signal the bit rate information of the V3C atlas track.

7.4.2.2 Syntax

```
aligned(8) class V3CAtlasSampleEntry() extends VolumetricVisualSampleEntry (type) {
    // type is 'v3c1', 'v3cg', 'v3cb', 'v3a1', or 'v3ag'
    V3CConfigurationBox config;
```

```
V3CUnitHeaderBox unit_header;
}
```

7.4.2.3 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.

7.4.3 V3C atlas tile sample entry

7.4.3.1 Definition

Sample Entry Type: `'v3t1'`

Container: `SampleDescriptionBox`

Mandatory: Yes

Quantity: One or more

V3C atlas tile tracks use `V3CAtlasTileSampleEntry` which extends `VolumetricVisualSampleEntry` with a sample entry type of `'v3t1'`.

A V3C atlas tile track samples shall contain only ACL NAL units, which belong to the same atlas. V3C atlas tile tracks shall contain ACL NAL units of at least one tile, indicated by `tile_id` in `V3CAtlasTileConfigurationBox`.

The `V3CAtlasTileSampleEntry` shall not contain `V3CConfigurationBox` or `V3CUnitHeaderBox`. Information provided by these boxes is found in the V3C atlas track sample entry that references the V3C atlas tile track. Other optional boxes may be included.

7.4.3.2 Syntax

```
class V3CAtlasTileConfigurationBox extends FullBox('v3tC', version = 0, 0) {
    unsigned int(3) unit_size_precision_bytes_minus1;
    unsigned int(1) spatial_scalability_enabled_flag;
    bit(4) reserved = 0;
    if (spatial_scalability_enabled_flag) {
        unsigned int(8) lod_index;
    }
    unsigned int(16) num_tiles;
    for(int i=0; i < num_tiles; i++){
        unsigned int(16) tile_id;
    }
}
aligned(8) class V3CAtlasTileSampleEntry() extends VolumetricVisualSampleEntry ('v3t1') {
    V3CAtlasTileConfigurationBox tile_info;
}
```

7.4.3.3 Semantics

`unit_size_precision_bytes_minus1` plus 1 specifies the precision, in bytes, of the sample stream NAL unit to which the sample entry containing this configuration box applies. The value of this field shall be equal to `ssnh_unit_size_precision_bytes_minus1` in `sample_stream_nal_header()` for the atlas component bitstream.

`spatial_scalability_enabled_flag` is a flag indicating whether the LoD-based scalability is supported by the carried V3C content.

`lod_index` indicates the LoD index value associated with the tiles carried by the atlas tile track. An atlas tile track with a certain LoD index (if present) should be selected with all atlas tile tracks

with lower `lod_index` values carrying corresponding tiles. An LoD tile set associated with a lower `lod_index` value should be processed first.

`num_tiles` number of tiles contained in this track

`tile_id` specifies the tile ID of the tile present in the track. The value of `tile_id` is equal to value of `afti_tile_id` syntax element in atlas frame tile information, defined in ISO/IEC 23090-5.

`compressorname` in the base class `VolumetricVisualSampleEntry` indicates the name of the compressor used with the value "`\017V3C Atlas Tiles`" being recommended; the first byte is a count of the remaining bytes, here represented by `\017`, which (being octal 17) is 15 (decimal), the number of bytes in the rest of the string.

7.4.4 V3C atlas sample format

7.4.4.1 Definition

Each sample in a V3C atlas track or V3C atlas tile track corresponds to a single coded atlas access unit.

When '`v3cb`' sample entry is used, each sample in the V3C atlas track corresponds to one or more non-ACL NAL units.

When '`v3cl`', '`v3cg`', '`v3al`' or '`v3ag`' sample entry is used and one or more V3C atlas tile tracks are present, each sample in the V3C atlas track corresponds to one or more non-ACL NAL units associated with same `vuh_atlas_id` indicated in V3C unit header box in sample entry.

NOTE When V3C atlas sample contains no reconstruction SEI message as defined in ISO/IEC 23090-5, it can be marked as non-output sample as defined in ISO/IEC 14496-12.

7.4.4.2 Syntax

```
aligned(8) class V3CAtlasSample {
    // sample_size value is the size of the sample from the SampleSizeBox
    for (int i=0; i < sample_size; ) {
        sample_stream_nal_unit ss_nal_unit; // as defined in ISO/IEC 23090-5
        i += ss_nal_unit.ssn_u_nal_unit_size +
            V3CDecoderConfigurationRecord.unit_size_precision_bytes_minus1 + 1;
    }
}
```

7.4.4.3 Semantics

`ss_nal_unit` contains a single NAL unit in NAL unit sample stream format as defined in ISO/IEC 23090-5:2021, Annex D.

`ssnu_nal_unit_size` specifies the size, in bytes, of the sample stream NAL unit. The number of bits used to represent `ssnu_nal_unit_size` is equal to $(V3CDecoderConfigurationRecord.unit_size_precision_bytes_minus1 + 1) * 8$.

7.4.4.4 V3C atlas track and V3C atlas tile track sync sample

A sync sample in a V3C atlas track or V3C atlas tile track is a sample that contains an intra random access point (IRAP) coded atlas access unit as defined in ISO/IEC 23090-5.

NOTE Atlas parameter sets and SEI messages can be repeated, if needed, at a sync sample to allow for random access.

7.4.5 V3C video component track

7.4.5.1 General

A V3C video component track carries 2D video encoded data of V3C video component. The storage of V3C video component tracks utilizes the existing capabilities of the ISO base media file format and derived specifications, for example, ISO/IEC 14496-15 defines mechanisms for carriage of ISO/IEC 14496-10 and ISO/IEC 23008-2 coded V3C video components.

V3C video component tracks shall be represented in the file as restricted video and shall use a generic restricted sample entry 'resv' with additional requirements:

- `SchemeTypeBox` is present in `RestrictedSchemeInfoBox` and `scheme_type` is set to 'vvvc'
- `SchemeInformationBox` is present in `RestrictedSchemeInfoBox` and contain a `V3CUnitHeaderBox`.
- In track header the `track_in_movie` flag is set to 0, to indicate that this track should not be presented alone.

NOTE There is no restriction on the video codec used for encoding V3C video components. Each V3C video component can be encoded using different video codecs.

7.4.5.2 Multimap video box

7.4.5.2.1 Definition

Box Type:	'mmvi'
Container:	<code>SchemeInformationBox</code>
Mandatory:	No
Quantity:	Zero or One

The `MultiMapVideoBox` is used to indicate that decoded video frames contain two or more temporarily interleaved video frames that represent maps. This box shall not be present in the case of single-track encapsulation of V3C content.

When `MultiMapVideoBox` is present, it indicates that a temporal interleaving map packing arrangement is used. File parsers should implicitly set the composition time for `map_count_minus1 + 1` consecutive samples to be equal to that of the first sample in the group of samples in the interleaved map packing arrangement.

When temporal interleaving map packing arrangement is used, each sync sample and each SAP sample with `SAP_type` in the range of 1 to 3, inclusive, indicated by the stream access point sample group, represent an iterative arrangement of samples representing map 0 to `map_count_minus1`, in composition time order, up to but excluding the next sync sample or SAP sample with `SAP_type` in the range of 1 to 3, inclusive, indicated by the stream access point sample group.

7.4.5.2.2 Syntax

```
aligned(8) class MultiMapVideoBox extends FullBox('mmvi', version = 0, 0){
    bit(4) reserved = 0;
    unsigned int(4) map_count_minus1;
}
```

7.4.5.2.3 Semantics

`map_count_minus1` plus 1 indicates the number of maps present in the track as consecutive samples.

7.4.6 Track references

7.4.6.1 Referencing V3C atlas tracks

To link a V3C atlas track with sample entry 'v3cb' to V3C atlas tracks with sample entries 'v3a1' or 'v3ag', the track reference tool defined in ISO/IEC 14496-12 shall be used. The 4CCs of these track reference types shall be 'v3cs'.

7.4.6.2 Referencing V3C atlas tile tracks

To link a V3C atlas track with sample entries 'v3c1', 'v3cg', 'v3a1' or 'v3ag' to V3C atlas tile tracks with sample entry 'v3t1', the track reference tool of ISO/IEC 14496-12 shall be used. The 4CCs of these track reference types shall be 'v3ct'.

7.4.6.3 Referencing V3C video component tracks

To link a V3C atlas track with sample entries 'v3c1', 'v3cg', 'v3a1', or 'v3ag', or a V3C atlas tile track with sample entry 'v3t1' to video component tracks, the track reference tool of ISO/IEC 14496-12 shall be used. One or more `TrackReferenceTypeBoxes` shall be added to a `TrackReferenceBox` within the `TrackBox` of the V3C atlas track or V3C atlas tile track, one for each component. The `TrackReferenceTypeBox` shall contain an array of track_IDs designating the video tracks which the V3C atlas track or V3C atlas tile track references. The `reference_type` of a `TrackReferenceTypeBox` identifies the type of the video component (i.e., occupancy, geometry, or attribute). The 4CCs of these track reference types shall be:

- 'v3vo': the referenced track(s) contain the video-coded occupancy V3C component
- 'v3vg': the referenced track(s) contain the video-coded geometry V3C component
- 'v3va': the referenced track(s) contain the video-coded attribute V3C component

The type of the V3C component carried by the referenced restricted video track, and signalled in the `RestrictedSchemeInfoBox` of the track, shall match the reference type of the track reference from the V3C atlas track or V3C atlas tile track.

When 'v3ct' track reference is present in V3C atlas track, 'v3va', 'v3vo', 'v3vg' references shall not be used.

7.4.7 Track alternatives and track grouping

7.4.7.1 V3C content alternatives

V3C content may be encoded as different versions in the file format. Different alternatives are indicated by the alternate tracks mechanism defined in ISO/IEC 14496-12 (i.e., `alternate_group` field of the `TrackHeaderBox`). V3C atlas tracks which have the same `alternate_group` value shall be different versions of the same V3C content.

[Annex H](#) describes examples of using alternate V3C content.

7.4.7.2 V3C video component alternatives

V3C video component tracks may have alternatives. In such a case, only one of the V3C video component tracks that belong to an alternative group shall be referenced by the V3C atlas track or V3C atlas tile track. V3C video component tracks which are alternatives of each other should use the alternate grouping mechanism, as defined in ISO/IEC 14496-12.

[Annex H](#) describes examples of using alternate V3C video components.

7.4.8 Playout groups

7.4.8.1 General

When only some combination of tracks from the alternate versions of the V3C components should be played together, then playout group mechanism shall be used. Playout groups are signalled using `PlayoutTrackGroupBox`.

NOTE A track can be part of more than one playout group.

7.4.8.2 Playout track group

7.4.8.2.1 Definition

Box Types: 'potg'
 Container: `TrackGroupBox`
 Mandatory: No
 Quantity: Zero or more

Playout track groups are defined using the track group type `PlayoutTrackGroupBox`, which extends `TrackGroupTypeBox` defined in ISO/IEC 14496-12. A `PlayoutTrackGroupBox` indicates that a track belongs to a set of tracks constituting a playout group. Only tracks within the same playout group can be played out together. For each playout group that a track is a member of, a corresponding instance of `PlayoutTrackGroupBox` with the unique `track_group_id` for that playout group shall be present in the `TrackGroupBox` of that track.

7.4.8.2.2 Syntax

```
aligned(8) class PlayoutTrackGroupBox extends TrackGroupTypeBox('potg') {
    // track_group_id is inherited from TrackGroupTypeBox
}
```

7.4.9 Summary

[Table 10](#) provides a summary of the sample entry types for tracks carrying atlas data defined in this document.

Table 10 — Summary of sample entry types for V3C atlas tracks and atlas tile tracks

Sample entry type		'v3c1'	'v3cg'	'v3cb'	'v3a1'	'v3ag'	'v3t1'
V3C atlas sample entry	VPS	yes	yes	yes	no	no	N/A
	Atlas parameter sets	yes	yes	yes	yes ^a	yes ^a	N/A
	V3C unit header box	yes	yes	yes	yes	yes	N/A
Atlas parameter set sample group		may	may	no	may (partially ^b)	may (partially ^b)	N/A
^a It only includes atlas component sub-bitstream parameter sets associated with same <code>vuh_atlas_id</code> indicated in V3C unit header box. ^b Atlas component sub-bitstream parameter sets associated with same <code>vuh_atlas_id</code> indicated in V3C unit header box are included. ^c When 'v3t1' track is present, samples of 'v3c1', 'v3cg', 'v3a1' and 'v3ag' track only contains non-ACL NAL units. If 'v3t1' track is not present, samples shall also contain ACL NAL units.							

Table 10 (continued)

Sample entry type	'v3c1'	'v3cg'	'v3cb'	'v3a1'	'v3ag'	'v3t1'
Track references	'v3vo'	'v3vo'	'v3cs'	'v3vo'	'v3vo'	'v3vo'
	'v3vg'	'v3vg'		'v3vg'	'v3vg'	'v3vg'
	'v3va'	'v3va'		'v3va'	'v3va'	'v3va'
	'v3ct'	'v3ct'		'v3ct'	'v3ct'	'v3va'
Sample	ACL + non-ACL ^c	ACL + non-ACL ^c	non-ACL	ACL + non-ACL ^c	ACL + non-ACL ^c	ACL

^a It only includes atlas component sub-bitstream parameter sets associated with same vuh_atlas_id indicated in V3C unit header box.

^b Atlas component sub-bitstream parameter sets associated with same vuh_atlas_id indicated in V3C unit header box are included.

^c When 'v3t1' track is present, samples of 'v3c1', 'v3cg', 'v3a1' and 'v3ag' track only contains non-ACL NAL units. If 'v3t1' track is not present, samples shall also contain ACL NAL units.

8 Carriage of non-timed visual volumetric video-based coding data

8.1 General

Non-timed V3C content is stored in a file as ISO/IEC 14496-12 items. Three item types called V3C atlas item, V3C atlas tile item and V3C component item are defined for encapsulating non-timed V3C content.

A handler type 4CC code 'volv' stored in the `HandlerBox` of the `MetaBox` indicates the presence of V3C atlas items, V3C atlas tile items or V3C component items.

An overview of the structure for encapsulating non-timed V3C data in a single atlas with a single atlas tile is illustrated in Figure 3.

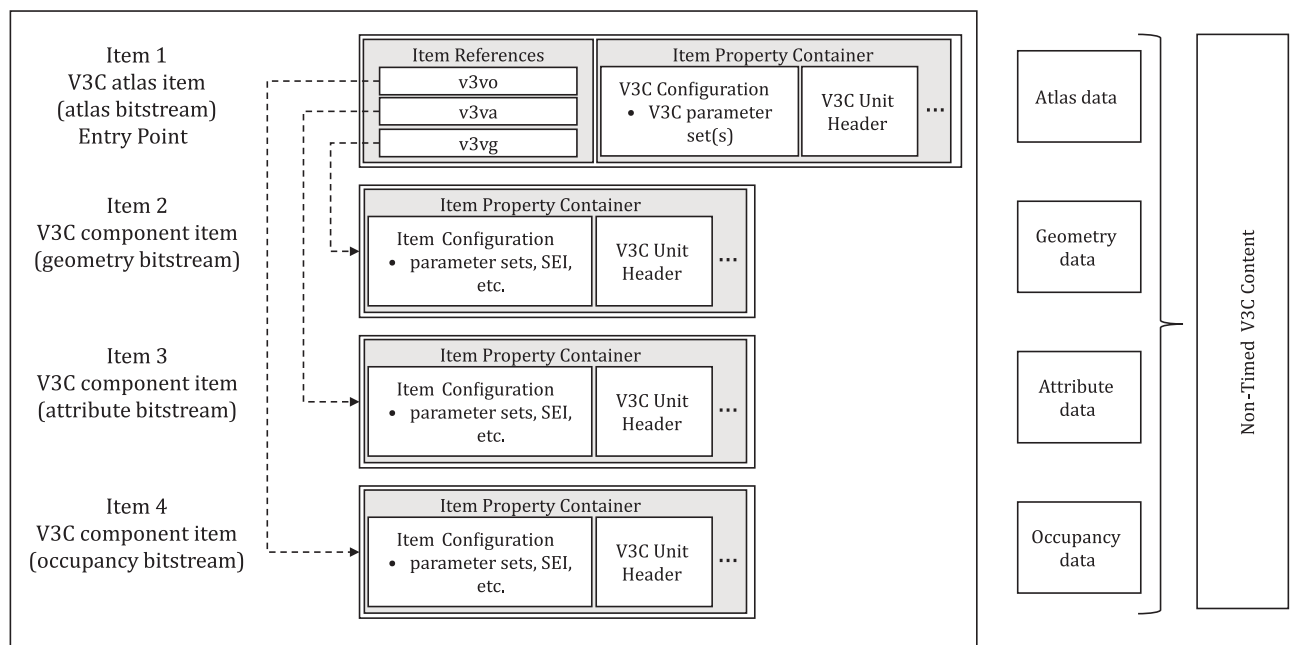


Figure 3 — Overview of structure for encapsulating non-timed V3C data in a single atlas with a single atlas tile