SMPTE RECOMMENDED PRACTICE

VC-4 Bitstream Storage in the ISO Base Media File Format

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Foreword

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SMPTE Engineering Documents are drafted in accordance with the rules given in Part XIII of its Administrative Practices.

SMPTE RP 2058-4 was prepared by Technology Committee 10E on Essence.

Intellectual Property

SMPTE draws attention to the fact that it is claimed that compliance with this Recommended Practice may involve the use of one or more patents or other intellectual property rights (collectively, "IPR"). The Society takes no position concerning the evidence, validity, or scope of this IPR.

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Attention is also drawn to the possibility that elements of this Recommended Practice may be subject to IPR other than those identified above. The Society shall not be responsible for identifying any or all such IPR.

Introduction

This section is entirely informative and does not form an integral part of this Recommended Practice.

The purpose of this specification is to define a minimum set of rules for the storage file format of a layered video stream derived from the ISO/IEC 14496-12 ISO based media file format. In particular, this specification is aimed to provide a storage file format encapsulating both base layer video stream from other video coding standards and enhancement layer video streams from the SMPTE Layered Video Extension (VC-4) coding where the video coding standard for the base layer is such as SMPTE ST 421 (SMPTE VC-1), ITU-T H.262 (MPEG-2), ISO/IEC 14496-2 (MPEG-4 Part2) or ITU-T H.264 (MPEG-4 AVC), etc.

1 Scope

The purpose of this specification is to define the storage file format for SMPTE Layered Video Extension (VC-4) video streams which extends a file format that is compliant with the ISO Base Media File Format. The VC-4 video streams can be dependent on any base layer video streams such as SMPTE ST 421 (SMPTE VC-1), ITU-T H.262 (MPEG-2), ISO/IEC 14496-2 (MPEG-4 Part 2) or ITU-T H.264 (MPEG-4 AVC), etc. The storage format for VC-4 shall be extended from a particular file format which encapsulates a base layer video stream on which the VC-4 shall be depedent. The following file formats derived from ISO Base Media File format shall be extensible from this specification but are not limited to these:

- MP4 file format (ISO/IEC 14496-14)
- AVC file format (ISO/IEC 14496-15)
- SMPTE VC-1 file format (SMPTE RP 2025)

The file format for storage of VC-4 content uses the existing capability of the ISO base media file format. In addition, the following new extensions to support new features of VC-4 codec are specified:

- **VC-4 Sample**: a newly defined sample including a subset of enhancement layers or all enhancement layers of a picture.
- **VC-4 Extractor**: a structure to enable efficient extraction of bitstream segment units from samples in other tracks instead of containing duplicate media data.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword “reserved” indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be defined in the future.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; followed by formal languages; then figures; and then any other language forms.

3 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this recommended practice. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this recommended practice are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE ST 2058-1:2011, VC-4 Layered Video Extension Bitstream Format and Decoding Process

ISO/IEC 14496-12:2008, Information Technology – Coding of Audio-Visual Objects – Part 12: ISO Base Media File Format

4 Notation

4.1 Abbreviations

This section provides a list of acronyms used in this document.

EBS	Encapsulated Bitstream Segment
HRD	Hypothetical Reference Decoder

4.2 Definition of Terminology

4.2.1 Base Layer

A picture that is decoded from the base layer stream, specified by other video coding standards, such as ITU-T H.262 (MPEG-2) or ITU-T H.264 (MPEG-4 AVC), etc, is used in reconstructing a new picture when integrating with the residual picture decoded from the enhancement layer stream. The synchronization of the base layer picture and other enhancement layer streams is expected to be signaled in the system layer.

4.2.2 Base Layer Stream

A sequence of bits that forms the representation of coded picture at the base layer consists of one or more video sequences which are specified by other video coding standards, such as ITU-T H.262 (MPEG-2) or ITU-T H.264 (MPEG-4 AVC), etc.

4.2.3 Enhancement Layer

A residual layer that has at least one lower layer. The lowest layer is the base layer. The number of enhancement layers should be greater than or equal to one and each enhancement layer is a residual layer.

4.2.4 Enhancement Layer Stream

A VC-4 residual enhancement layer stream consists of one or more VC-4 residual sequences. A VC-4 residual enhancement layer stream may also result from re-assembling enhancement residual sub-bitstreams.

4.2.5 Entry Point Sample

A sample which includes sequence header and is considered as the new starting point of the sequence. The subsequent coded samples do not use the previously coded samples as the reference sample before this entry point sample. It also means the current entry point sample does not use any reference samples for motion compensation.

5 File Identification

A file type box, as defined in the ISO base media file format (ISO/IEC 14496-12), shall be present in conforming files.

`major_brand`: This specification does not define the use of `'vc-4'` as a major brand.

`minor_version`: Major brand is not defined.

`compatible_brands`: Files that conform to this specification shall have `'vc-4'` in the compatible brands list. The brand used for base layer shall be in the compatible brands list, thus at least the base layer bitstream can be decoded by a player that supports the brand for the base layer but is non-conformant to this specification.

6 Track Definition

A base layer bitstream and an enhancement layer bitstream shall be separately represented by a base track and one or more VC-4 tracks, respectively. There shall be exactly one base track and at least one VC-4 track in a VC-4 file. In the terminology of the ISO base media file format (ISO/IEC 14496-12), a base track and a VC-4 track are video tracks. Therefore they use:

- A handler_type of `'vide'` in the Handler Reference Box.
- A Video Media Header Box in the Media Information Box.

Additionally, a VC-4 track shall use a box called **`VC4SampleEntry`** in the Sample Description Box (this box is derived from the `VisualSampleEntry` defined in ISO/IEC 14496-12).

A VC-4 track shall contain a subset of enhancement layers or all enhancement layers. When a VC-4 file has multiple enhancement layers, each enhancement layer may be contained separately in differenct VC-4 tracks, or each enhancement layer may be contained in multiple VC-4 tracks.

Each track shall be identified by the `track_ID` in the Track Header Box.

The base track and VC-4 tracks shall be linked to each other by means of track reference boxes, defined in Section 8.3.3 of ISO/IEC 14496-12. Each VC-4 track shall have one Track Reference Box. The following reference types are defined for VC-4 file format:

- `'vbas'` shall be used by VC-4 tracks to reference the base track. Every VC-4 track shall have this reference type in its track reference box.
- `'vext'` shall be used by VC-4 extractors to indicate the track from which the media data shall be copied (see Section 8.2.3).
- `'vdep'` shall be used by VC-4 tracks to reference the VC-4 tracks which are required to decode samples in the current track. These referenced VC-4 tracks shall have enhancement layers referenced by the layers in the current track. The referenced track IDs in `'vdep'` shall be arranged in the ascending order.

The visual samples in the base track and VC-4 tracks shall be temporally aligned in the decoding timeline and mapped at the same decoding time.

For every VC-4 track, its Track_in_preview flag in the flags of the Track Header Box shall be set to 0.

7 Layer Definition

7.1 Layer Table Box

7.1.1 Definition

Box Type: ‘ltbl’
Container: Movie Box (‘moov’)
Mandatory: Yes
Quantity: Exactly one

This box provides information about all the layers in the file, from base layer to the highest enhancement layer. This box shall contain layer_count Layer Information Boxes. Each Layer Information Box provides information of each layer. The Layer Table Box shall specify the information of the layers which exist in different tracks when all the layers including the base layer or a subset of the enhancement layers are separately stored in multiple tracks.

7.1.2 Syntax

```
class LayerTableBox extends Box(‘ltbl’) {
      unsigned int(8) layer_count;
      for ( i=1; i <= layer_count; i++) {
            LayerInfoBox();
      }
}
```

7.1.3 Semantics

layer_count shall be an integer that gives the number of layers. This field shall indicate the number of all the layers in the file, including the base layer and all enhancement layers.

LayerInfoBox is defined in Section 7.2. This box shall provide the information of each layer.

7.2 Layer Information Box

7.2.1 Definition

Box Type: ‘lyri’
Container: Layer Table Box (‘ltbl’)
Mandatory: Yes
Quantity: Two or more (one for the base layer and one or more for at least one enhancement layer)

This box shall provide the information about a single layer in the VC-4 file. This box shall consist of the layer ID, information of the tracks which contain the layer identified with the layer ID, the number of quality layers, scalable method, frame size, frame rate and bitrate.

7.2.2 Syntax

```
class LayerInfoBox extends FullBox(‘lyri’, version = 0, 0) {
      unsigned int(8) layer_ID;
      signed int(8) ref_layer_ID;
      unsigned int(8) track_count;
      unsigned int(32)[track_count] track_ID;
      unsigned int(3) reserved = 0;
```

```
        unsigned bit(1) quality_refinement_flag;
        if (quality_refinement_flag == 1) {
              unsigned int(4) max_quality_layer_ID;
        }
        else {
              unsigned int(4) reserved = 0;
        }
        unsigned int(8) [4] scalability;
        unsigned int(16) width;
        unsigned int(16) height;
        unsigned int(32) framerate;
        unsigned int(32) maxBitrate;
        unsigned int(32) avgBitrate;
}
```

7.2.3 Semantics

layer_ID specifies the identifier of the layer. For enhancement layers, this field shall provide the layer ID of the current enhancement layer. The value 0 is reserved for the base layer. A higher layer ID value indicates a higher layer. One enhancement layer may be present in multiple tracks. In this case, their layer IDs must be identical.

ref_layer_ID shall specify the layer ID of the lower layer referenced by the current layer. The value of this field shall be equal to the value of **REF_LAYER_ID** in the sequence header of the current layer (see Section 7.1.2 of SMPTE ST 2058-1). The value -1(0xFF) is reserved for the base layer.

track_count shall provide the number of tracks which contain the current layer. For the base layer, this field shall have the value 1 because only one base track exists in VC-4 file as specified in Section 6. For enhancement layers, the value of this field shall be equal to or greater than 1 because an enhancement layer may be contained in many VC-4 tracks.

track_ID is an array of track IDs which shall specify the tracks which contain the current layer.

quality_refinement_flag shall be equal to the value of **QUALITY_REFINEMENT_FLAG** (see Section 7.1.46 of SMPTE ST 2058-1). Value 1 shall indicate that quality refinement is used for the corresponding layer. Value 0 shall indicate that quality refinement is not used for the corresponding layer.

max_quality_layer_ID contains the value of the **MAX_QUALITY_LAYER_ID** in the picture header of the VC-4 elementary stream (see Section 8.1.5 of SMPTE ST 2058-1). `max_quality_layer_ID+1` specifies the number of quality layers in the layer.

scalability shall provide the information about the scalable method between the reference layer with the `ref_layer_ID` and the current layer. It is described by one of the four-character strings listed below:

Table 1 – Scalability field

Name	String	Details
Base layer	‘base’	Only used for the base layer
SNR scalability	‘snrs’	The layer is SNR scaled
Spatial scalability	‘spls’	The layer is spatially scaled

width and **height** shall specify the horizontal and vertical sizes of the layer, respectively.

framerate shall specify the frame rate (fps) of the layer. This field shall be set to 0xFFFFFFFF if the frame rate is not known, unspecified, or non-constant.

maxBitrate shall indicate the maximum rate in bits/second over a one-second window.

avgBitrate shall indicate the average rate in bits/second over the entire length of the current layer.

8 Video Stream Definition

8.1 Base Track

Samples of base track are defined in the ISO base file format specification of the codec with which they are encoded. Examples of available codecs for base layer bitstream include:

- SMPTE VC-1 (SMPTE RP 2025)
- ISO/IEC MPEG-4 (ISO/IEC 14496-14)
- ITU-T H.264 (ISO/IEC 14496-15)

Note: As more ISO base media file formats become available for other codecs, they may be used for the base track.

8.2 VC-4 Track

This section defines the structure of a sample in a video elementary bitstream of a VC-4 track.

8.2.1 VC-4 Sample Definition

A VC-4 sample consists of encapsulated bitstream segments (EBSs). Each EBS consists of a start code and a bitstream segment. The start code is used to identify the type of the EBS (see Annex B of SMPTE ST 2058-1). EBS types and order constraints of EBSs in a VC-4 sample are specified in Annex F of SMPTE ST 2058-1.

In a VC-4 track, a VC-4 sample shall contain data which belongs only to the enhancement layers contained in the current track.

An entry point sample shall start with *n* sequence header EBSs when the track contains *n* enhancement layers. The sequence header EBSs shall be located consecutively in lower-to-higher layer order and then frame or field picture data EBSs shall follow. A non-entry point sample starts with frame or field picture data EBSs, without sequence header EBSs.

Frame or field picture data EBSs are ordered in increasing order of their layer IDs. A frame picture data EBS consists of a start code, a frame header, and frame data. A field picture data EBS consists of a start code, a field header, and field data. Frame data and field data are again divided into one or more slice data EBSs.

When a VC-4 track has one enhancement layer, entry point samples in this track shall have one sequence header EBS, and then one frame or field picture data EBS shall follow. Non-entry point samples shall have one frame or field picture data EBS.

When a VC-4 track has *n* enhancement layers, entry point samples in this track shall have *n* sequence header EBSs, and then *n* frame or 2*n* field picture data EBSs shall follow. Non-entry point samples shall have *n* frame or 2*n* field picture data EBSs.

8.2.2 VC-4 Sub-sample Definition

A VC-4 sub-sample shall be defined as one or more contiguous EBSs within a VC-4 sample, which shall be categorized as follows:

- **Sequence header sub-sample** shall consist of one or more contiguous sequence header EBSs within an entry point sample. In a sample which consists of *n* enhancement layers, a sequence header sub-sample shall contain *n* sequence header EBSs. Only entry point samples shall contain sequence header sub-samples. If EBSs of the sequence-level user data exist between two sequence header EBSs, the EBSs of the sequence-level user data shall belong to sequence header sub-sample.

- **Picture sub-sample** shall consist of one or more contiguous slice data EBSs which have the same value of the following fields;

  LAYER_ID_SLICE when the quality refinement is not used (**QUALITY_REFINEMENT_FLAG** == 0).

  LAYER_ID_SLICE and **QUALITY_LAYER_ID** (see Section 8.2.2 of SMPTE ST 2058-1) when the quality refinement is used (**QUALITY_REFINEMENT_FLAG** == 1).

  When a picture sub-sample follows directly after a start code for a frame or field picture data EBS and a frame or field header, the picture sub-sample shall include the start code and the frame or field header.

  A VC-4 sample which consists of *n* enhancement layers shall have at least *n* picture sub-samples. A VC-4 sample shall have more than *n* picture sub-samples when the enhancement layers in the current track include multiple quality layers. When a VC-4 track has only one enhancement layer which does not use the quality refinement, the VC-4 samples in this track shall contain one picture sub-sample.

- **User data sub-sample** consists of one or more contiguous user data EBSs.

The Sub-sample Information Box (see Section 8.7.7 of ISO/IEC 14496-12) shall be used to provide information of VC-4 sub-samples. This box is optional and shall have the semantics defined here.

The `subsample_priority` field shall be set to a value as the definition of this field in ISO/IEC 14496-12.

The `discardable` field shall be set to 1 only if the sample containing current sub-sample can still be decoded when this sub-sample is discarded (e.g., sub-samples which only contain slice data of quality enhancement layer).

The `reserved` field of the Sub-sample Information Box is defined for VC-4 as follows;

```
unsigned bit(2) subsample_type;
if (subsample_type == 2) {
      unsigned int(4) reserved = 0;
      unsigned int(4) layer_ID;
      if (QUALITY_REFINEMENT_FLAG == 1) {
            unsigned int(4) reserved = 0;
            unsigned int(4) quality_layer_ID;
      }
      else {
            unsigned int(8) reserved = 0;
      }
}
else {
      unsigned int(16) reserved = 0;
}
unsigned int(14) reserved = 0;
```

subsample_type equal to 0 indicates that the current sub-sample is a sequence header sub-sample. Value 1 indicates that the current sub-sample is a user data sub-sample. Value 2 indicates that the current sub-sample is a picture sub-sample.

layer_ID contains the value of **LAYER_ID_SLICE** of the slice data EBSs in the sub-sample. This ID maps the sub-sample to a layer in the Layer Table Box (‘ltbl’).

quality_layer_ID is defined only when **QUALITY_REFINEMENT_FLAG** of the containing layer is set to 1 (i.e. quality refinement is used for the containing layer). This ID has the value of **QUALITY_LAYER_ID** of the slice data EBSs in the sub-sample.

8.2.3 VC-4 Extractor Definition

This subclause defines VC-4 Extractors, which extract, by reference, data of one enhancement layer from a sample in another VC-4 track.

A VC-4 Extractor resides in a VC-4 sample in the form of an EBS and contains an instruction to extract data from another track. It is preceded by a four-byte start code in the same way as other bitstream segments in VC-4 samples are. The start code suffix for the VC-4 Extractor shall be 0x20.

When a file is read, the file reader shall replace the VC-4 Extractor (including its start code) with the data it references. The referenced data shall consist of one or more contiguous picture sub-samples and must not contain sequence header sub-samples or user data sub-samples. Sequence header sub-samples or user data sub-samples must not be referenced by VC-4 Extractors.

The track from which the data is copied is referenced by its track ID in a track reference of type ‘vext’. The Track Reference Box of the current track shall contain one or more Track Reference Type Boxes with reference type ‘vext’.

A VC-4 Extractor must not reference another VC-4 Extractor.

8.2.3.1 Syntax

```
class VC4Extractor {
      unsigned int(8) track_ref_index;
      signed int(8) sample_offset;
      unsigned int(32) data_offset;
      unsigned int(32) data_length;
}
```

8.2.3.2 Semantics

track_ref_index shall specify the index of the track reference of type ‘vext’ used to find the track which contains the data to be extracted.

sample_offset shall specify the relative index of the sample to be extracted from the referenced track. The value 0 indexes the sample in the referenced track which is at the same decoding time as the VC-4 Extractor.

data_offset shall specify the location of the first byte of the data to be copied in the reference sample.

data_length shall specify the number of bytes to copy.

8.2.4 Random Access Points

The samples that contain sequence header EBSs shall be random access points.

The Sync Sample Box shall be used for marking random access points, as defined in Section 8.6.2 of ISO/IEC 14496-12.

8.2.5 Sample Descriptions

8.2.5.1 VC-4 Sample Entry

8.2.5.1.1 Definition

Box Type: ‘vc-4’
Container: Sample Description Box (‘stsd’)
Mandatory: Yes (in VC-4 tracks)
Quantity: Exactly one

VC-4 Sample Entry is an extension of Visual Sample Entry defined in ISO/IEC 14496-12. In addition to the fields of Visual Sample Entry, VC-4 Sample Entry contains a VC-4 Specific Box and an optional VC-4 Bitrate Box at the end.

This entry provides information about the bitrate of the containing track, and VC-4 decoder initialization of each layer in the sample.

The type of this entry specifies the unique registered identifier of the VC-4 decoder.

8.2.5.1.2 Syntax

```
class VC4SampleEntry extends VisualSampleEntry (‘vc-4’) {
      VC4SpecifixBox();
      VC4BitRateBox(); // optional
}
```

8.2.5.1.3 Semantics

width and **height** in the Visual Sample Entry shall give the width and height of the highest enhancement layer in the current track.

Compressorname in the Visual Sample Entry gives the name of the compressor used. The value “4VC-4” is recommended, where the first character ‘4’ is the length of its following string “VC-4”.

VC4SpecificBox and **VC4BitRateBox** are defined in Sections 8.2.5.2 and 8.2.5.4, respectively.

8.2.5.2 VC-4 Specific Box

8.2.5.2.1 Definition

Box Type: ‘vsbx’
Container: VC-4 Sample Entry (‘vc-4’)
Mandatory: Yes
Quantity: Exactly one

This box provides the number of enhancement layers in a sample and VC-4 decoder initialization parameters for each enhancement layer.

8.2.5.2.2 Syntax

```
class VC4SpecificBox extends Box (‘vsbx’) {
      unsigned int(8) layer_count;
      VC4DecSpecLayerStruc [layer_count] DecSpecificLayerInfo;
}
```

8.2.5.2.3 Semantics

layer_count shall specify the number of enhancement layers in samples of the containing track.

DecSpecificLayerInfo is an array of the VC-4 Decoder Specific Layer Structures which is used to store the VC-4 decoder initialization parameters for each enhancement layer. This array contains `layer_count` VC-4 Decoder Specific Layer Structures. VC-4 Decoder Specific Layer Structure is defined in Section 8.2.5.3.

8.2.5.3 VC-4 Decoder Specific Layer Structure

8.2.5.3.1 Definition

Container: VC-4 Specific Box (`‘vsbx’`)
Mandatory: Yes
Quantity: One or more

This structure contains the VC-4 decoder initialization parameters for each enhancement layer.

8.2.5.3.2 Syntax

```
class VC4DecSpecLayerStruc {
      unsigned int(8) layer_ID;
      unsigned int(3) profile;
      unsigned int(4) level;
      unsigned bit(1) cbr;
      unsigned int(16) sequence_header_length;
      bit(8*sequence_header_length) sequence_header;
}
```

8.2.5.3.3 Semantics

layer_ID shall specify for which enhancement layer these parameters are used.

profile shall specify the VC-4 profile used for encoding the enhancement layer bitstream. Its value ranges from 0 to 7. It shall be 1 for Main profile, 2 for High profile, and 3 for Stereo profile. The other values are SMPTE reserved as defined in Section 7.1.3 and Annex D of SMPTE ST 2058-1.

level shall specify the decoding level for the layer to which the sample belongs as defined in Section 7.1.4 and Annex D of SMPTE ST 2058-1.

cbr shall be set to 1 if the content was generated using a constant bit rate model. If it was generated using any other bit rate model, **cbr** shall be set to 0.

sequence_header_length specifies the byte length of the `sequence_header`.

sequence_header shall contain the sequence header EBS of the layer corresponding to the layer_ID. The layer_ID value shall be identical to the value of **LAYER_ID_SEQ** (see Section 7.1.1 of SMPTE ST 2058-1) in the contained sequence header EBS.

8.2.5.4 VC-4 Bitrate Box

8.2.5.4.1 Definition

Box Type: 'vbrt'
Container: VC-4 Sample Entry ('vc-4')
Mandatory: No
Quantity: Zero or one

VC-4 Bitrate Box provides information about the hypothetical reference decoders (HRDs) of all enhancement layers contained in the current track.

8.2.5.4.2 Syntax

```
class VC4BitRateBox extends Box ('vbrt') {
      unsigned int(8) layer_count;
      for ( i=1; i <= layer_count; i++) {
            unsigned int(8) layer_ID;
            unsigned int(24) hrd_buffer;
            unsigned int(32) hrd_rate;
      }
}
```

8.2.5.4.3 Semantics

layer_count shall indicate the number of enhancement layers contained in the current track.

layer_ID shall specify for which enhancement layer these HRD parameters are used.

hrd_buffer shall indicate the coded frame buffer size *B* of the HRD in milliseconds. The HRD is defined in Annex A of SMPTE ST 2058-1.

hrd_rate shall indicate the peak transmission rate *R* of the HRD in bits per second.

Annex A Bibliography (Informative)

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 421:2006) although, during a transitional phase, the document as published (printed or PDF) may bear an older designation (such as SMPTE 421M-2006). Documents with the same root number (e.g. 421) and publication year (e.g. 2006) are functionally identical.

SMPTE ST 421:2006, Television — VC-1 Compressed Video Bitstream Format and Decoding Process

Amendment 1:2007 to SMPTE ST 421:2006

Amendment 2:2011 to SMPTE ST 421:2006

SMPTE RP 2025-2007, VC-1 Bitstream Storage in the ISO Base Media File Format

ISO/IEC 14496-14:2003, Information Technology – Coding of Audio, Picture, Multimedia and Hypermedia Information – Part 14: MP4 File Format

ISO/IEC 14496-15:2010, Information Technology -- Coding of Audio-Visual Objects -- Part 15: Advanced Video Coding (AVC) File Format