SMPTE Public Committee Draft

Mapping VC-6 into the MXF Generic Container

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Foreword

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Introduction

This section is entirely informative and does not form an integral part of this Engineering Document.

For review purposes only, September 2, 2022

SMPTE ST 2117-1 (VC-6) is a versatile intra-frame compression scheme. This document maps the VC-6 bitstream into the MXF Generic Container. The usage of this mapping to synchronise with other components such as audio and video is outside the scope of this document.

The MXF Generic Container is a streamable Essence Container that can be placed on any suitable transport and stored. SMPTE ST 379-1 defines the MXF Generic Container as the native Essence Container in MXF files. SMPTE ST 379-2 defines the MXF Constrained Generic Container.

Other MXF mapping documents such as SMPTE ST 382 define how Audio can be mapped and synchronised with the video stream in the MXF Generic Container.

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1 Scope

This Standard constrains the MXF mapping of SMPTE ST-2117-1 into the MXF Generic Container or MXF Constrained Generic Container.

2 Normative References

The following contains provisions that, through reference in this text, constitute provisions of this standard. [Dated references require that the specific edition cited shall be used as the reference]. Undated citations refer to the edition of the referenced document (including any amendments) current at the date of publication of this document. All s are subject to revision, and users of this engineering document are encouraged to investigate the possibility of applying the most recent edition of any undated reference.

SMPTE ST 326:2000, Television — SDTI Content Package Format (SDTI-CP)

SMPTE ST 331:2011, Element and Metadata Definitions for the SDTI-CP

SMPTE ST 377-1:2019, Material Exchange Format (MXF) — File Format Specification

SMPTE ST 378:2004, Television — Material Exchange Format (MXF) — Operational pattern 1A (Single Item, Single Package)

SMPTE ST 379-1:2009, Material Exchange Format (MXF) — MXF Generic Container

SMPTE ST 379-2:2010, Television — Material Exchange Format (MXF) — MXF Constrained Generic Container

SMPTE ST 381-2:2011, Material Exchange Format (MXF) — Mapping MPEG Streams into the MXF Constrained Generic Container

SMPTE ST 382:2007, Material Exchange Format — Mapping AES3 and Broadcast Wave Audio into the MXF Generic Container

SMPTE ST 385:2012, Material Exchange Format (MXF) — Mapping SDTI-CP Essence and Metadata into the MXF Generic Container

SMPTE ST 400:2012, SMPTE Labels Structure

SMPTE ST 436-1:2013, MXF Mappings for VI Lines and Ancillary Data Packet

3 Terms and Definitions

For the purposes of this document, the terms and definitions given in SMPTE ST 377-1 and SMPTE ST 379-2 apply.

4 MXF File Structure and Mapping

4.1 General

SMPTE ST-2117-10 MXF files specified by this document shall have one of the two structures illustrated in Figure 1 and Figure 2 respectively. **HPP** is an shorthand for Header Partition Pack, **BPP** is an shorthand for Body Partition Pack and **FPP** is a shorthand for Footer Partition Pack.
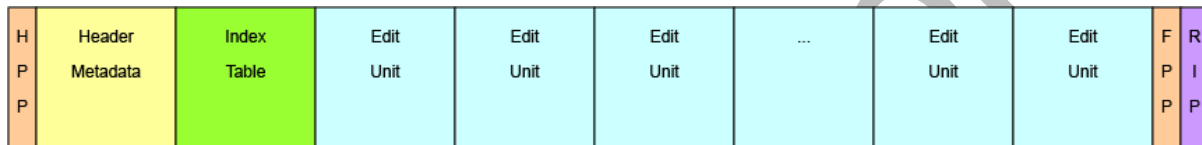

Figure 1 - Single Essence Location Style
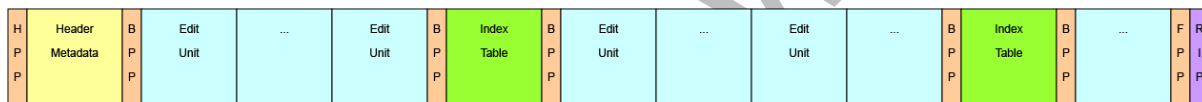
Figure 2 - Multiple Essence Location Style

4.2 Single Essence Location Style

As shown in Figure 1, this style consists of a Header Partition, a Footer Partition, and a Random Index Pack.

The Index Table is placed prior to the Essence Container.

Some of the aspects of this style are shown below.

- It is easy to handle because of a simple structure
- It is easy to edit while file transferring
- It is easy to select an extract, or a "Partial file"

The following Index Layout Properties shall be set according to SMPTE ST 377-1.

- Index Table Segment::Single Index Location TRUE (Single Location)
- Index Table Segment::Single Location TRUE (Single Location)
- Index Table Segment::Forward Index Direction TRUE (Forward)
- Preface:: is RIP present TRUE

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4.3 Multiple Essence Location Style

As shown in Figure 2, this style consists of a Header Partition, segmented Body Partition(s), a Footer Partition, and a Random Index Pack. Each Body Partition carrying VC-6 data shall be followed by one Index Table Segment that carries the Index Entries for the Edit Units of that Body Partition.

Some of the aspects of this style are shown below.

- It is only necessary to include one Index Table Segment for each Body Partition period on the sender side
- It is easy to perform the function "Play while receiving file" on the receiver side
- It is easy to select an extract, or a "Partial file"

The following Index Layout Properties shall be set according to SMPTE ST 377-1.

- Index Table Segment::Single Index Location FALSE (Distributed Location)
- Index Table Segment::Single Essence Location FALSE (Distributed Location)
- Index Table Segment::Forward Index Direction FALSE (Backward)
- Preface:: is RIP present TRUE
- Essence Container Data:: Following Index Table TRUE (A Complete Index Table follows all Essence)

5 Mapping VC-6 Bitstream into the MXF Generic Container

VC-6 streams shall be mapped using the MXF Generic Container using frame wrapping as defined in SMPTE ST 379-1 and SMPTE ST 379-2

Figure 4 shows the SMPTE ST-2117 picture element, the bitstream shall comply with SMPTE ST-2117.
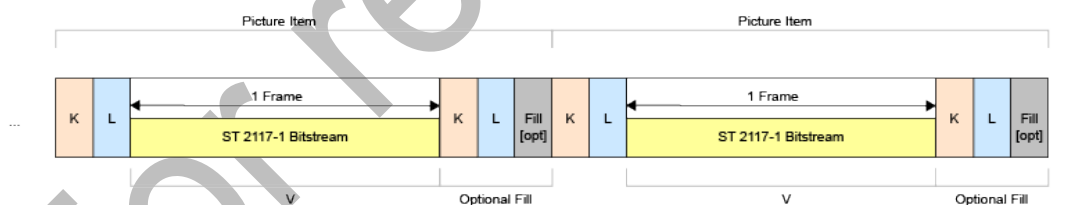

Figure 4 - Mapping of ST-2117 Picture Item Element

6 Key Length Value Encoding

6.1 Picture Element Key

6.1.1 SMPTE ST-2117 Picture Element Key

Table 1 - Picture Element Keys

Symbol	Kind	Item UL
FrameWrappedVC6PictureElement	LEAF	urn:smpte:ul:060E2B34.01020101.0D010301.157f1f7f

NOTE: The table shows the `Item UL` in the SMPTE Metadata registers where the value `7f` in bytes 14 and 16 are placeholders for the Essence element count and Essence element number of the Element within the Picture Item as defined in SMPTE ST 379.

`FrameWrappedVC6PictureElement` key bytes 1-13 are defined in SMPTE ST 379-2.

`FrameWrappedVC6PictureElement` key bytes 14 and 16 shall be set to 1 in this version of the standard. Future versions may allow this constraint to be loosened.

6.1.2 SMPTE ST-2117 Picture Element Length

The length field of the KLV coded Element shall comply with SMPTE ST 379-2.

6.1.3 SMPTE ST-2117 Picture Element Value

Each Picture Element value shall be a bitstream for a single image compliant with SMPTE ST-2117-1.

7 MXF Labels

7.1 Essence Container Label

The Essence Container Label is carried in the Essence Containers Properties of the Partition Packs, Preface Set and File Descriptor as defined in SMPTE ST 377-1.

The values of the Essence Container Label for VC-6 bitstreams in MXF shall be one of the values in Table 2.

Table 2 – Essence Container Label Values for VC-6

Symbol	Kind	Item UL
MXFGCVC6BitstreamContainerLabels	NODE	urn:smpte:ul:060e2b34.0401010d.0d010301.02240000
MXFGCVC6FrameWrappedGenericBitstream	LEAF	urn:smpte:ul:060e2b34.0401010d.0d010301.02240100
MXFGCVC6FrameWrappedProgressivePictures	LEAF	urn:smpte:ul:060e2b34.0401010d.0d010301.02240200
MXFGCVC6FrameWrappedInterlacedPictures	LEAF	urn:smpte:ul:060e2b34.0401010d.0d010301.02240300

The `VC6FrameWrappedGenericbitstream` shall only be used in cases where neither `VC6FrameWrappedProgressivePictures` nor `VC6FrameWrappedInterlacedPictures` describe the Pictures that are VC-6 encoded.

7.2 Picture Essence Coding Label

Labels intended for use as values for the Picture Essence Coding item of the Generic Picture Essence Descriptor, specified in SMPTE ST 377-1, are given in Table 3.

Table 3 – Picture Essence Coding Label Values for VC-6

Symbol	Kind	Item UL
VC6BitstreamCoding	NODE	urn:smpte:ul:060e2b34.0401010d.04010202.01470000
VC6UnrestrictedBitstream	LEAF	urn:smpte:ul:060e2b34.0401010d.04010202.01470100

NOTE The Picture Essence Coding item of the Generic Picture Essence Descriptor is intended to allow a decoder to fast-fail when processing the MXF file.

NOTE The Public CD for this document will start with no constrained bitstream flags. If requirements for constrained bitstreams arise during the Public CD phase, then we will add them to the table above.

8 `VC6SubDescriptor`

A `VC6SubDescriptor` should be present for VC-6 content in MXF, even if all the optional properties are omitted. The `VC6SubDescriptor` is strongly referenced from a CDCI Descriptor or RGBA Descriptor and has the properties shown in Table 4.

Table 4 - `VC6SubDescriptor` ULs

Symbol	Register.Kind	Item UL
VC6Parameters	Elements.NODE	urn:smpte:ul:060e2b34.0101010e.0401060d.00000000
VC6SubDescriptor	Groups.LEAF	urn:smpte:ul:060e2b34.027f0101.0d010101.01018104
VC6GCUpsamplersBatch	Elements.LEAF	urn:smpte:ul:060e2b34.0101010e.0401060d.01000000
VC6ShortcutBitvectorBatch	Elements.LEAF	urn:smpte:ul:060e2b34.0101010e.0401060d.02000000
VC6Lossless	Elements.LEAF	urn:smpte:ul:060e2b34.0101010e.0401060d.03000000
VC6CBR	Elements.LEAF	urn:smpte:ul:060e2b34.0101010e.0401060d.04000000
VC6Bitrate	Elements.LEAF	urn:smpte:ul:060e2b34.0101010e.0401060d.05000000
VC6CompressedFrameMax	Elements.LEAF	urn:smpte:ul:060e2b34.0101010e.0401060d.06000000
VC6CompressedFrameAvg	Elements.LEAF	urn:smpte:ul:060e2b34.0101010e.0401060d.07000000
VC6MaxNoOfEchelons	Elements.LEAF	urn:smpte:ul:060e2b34.0101010e.0401060d.08000000
VC6EchelonsArray	Elements.LEAF	urn:smpte:ul:060e2b34.0101010e.0401060d.09000000

NOTE: `VC6SubDescriptor` is a child of `SubDescriptor` as specified in SMPTE ST 377-1 annex B.3 and includes properties of the parent.

Table 5 - Elements in the `VC6SubDescriptor` Set

Symbol	type	Len	Req?	Meaning
VC6SubDescriptor	Set UL	16	Req	VC-6 Sub-Descriptor
Length	BER Length	4	Req	Set Length
VC6GCUpsamplersBatch	UInt8Array	8 + 16n	Opt	Unordered Batch of UInt8 Upsampler Indices used in the Generic Container
VC6ShortcutBitvectorBatch	UInt16Array	8 + 16n	Opt	Unordered Batch of unique UInt16 ShortcutBitvector values used in the Generic Container
VC6Lossless	UInt8	1	Opt	Non-zero if the encoder created a lossless bitstream

Symbol	type	Len	Req?	Meaning
VC6CBR	UInt8	1	Opt	Non-zero if the encoder intended a constant bitrate stream
VC6Bitrate	UInt64	8	Opt	Target CBR bitrate or Maximum VBR bitrate in bits per second
VC6CompressedFrameMax	UInt64	8	Opt	Maximum Size in bits of a Compressed Frame in the Generic Container
VC6CompressedFrameAvg	UInt64	8	Opt	Average Size in bits of a Compressed Frame in the Generic Container
VC6MaxNoOfEchelons	UInt8	1	Opt	Maximum Number of Echelons in any Frame in the Generic Container
VC6EchelonsArray	VC6EchelonPropertiesStrongReferenceArray	8 + 16n	Opt	An ordered set (lowest to highest resolution) of Strong references to VC6EchelonProperties sets

A zero value of VC6CBR shall indicate that VC6Bitrate represents the target CBR bitrate. A non-zero value shall indicate that VC6Bitrate represents the maximum bitrate value in bits per second for one frame period.

NOTE: VC6ShortcutVectorsBatch contains only unique values. In theory there are 65536 different permutations of ShortcutVector. In practice only a few are actually created by an encoder. This property can be used by a decoder to help determine the resources required for decoding the generic container.

Table 6 - VC6EchelonProperties ULs

Symbol	Register.Kind	Item UL
VC6EchelonProperties	Groups.LEAF	urn:smpte:ul:060e2b34.027f0101.0d010101.01018105
VC6EchelonIndex	Elements.LEAF	urn:smpte:ul:060e2b34.0101010e.0401060d.0a000000
VC6SampledHeight	Elements.LEAF	urn:smpte:ul:060e2b34.0101010e.0401060d.0b000000
VC6SampledWidth	Elements.LEAF	urn:smpte:ul:060e2b34.0101010e.0401060d.0c000000

NOTE: VC6EchelonProperties is a child of InterchangeObject as specified in SMPTE ST 377-1 and includes properties of the parent.

Table 7 - Elements in the VC6EchelonProperties Set

Symbol	type	Len	Req?	Meaning
VC6EchelonProperties	Set UL	16	Req	Properties that describe an Echelon in a VC-6 bitstream
Length	BER Length	4	Req	Set Length
VC6EchelonIndex	UInt32	4	Req	Signed Index of this Echelon as identified in ST 2117-1:2020 §4.8.9
VC6SampledHeight	UInt32	4	Req	Sampled Height of the reconstructed pixel grid for the echelon
VC6SampledWidth	UInt32	4	Req	Sampled Width of the reconstructed pixel grid for the echelon

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9 Application Issues

9.1 Application of the KAG

MXF encoders and decoders shall comply with the KAG rules defined in SMPTE ST 377-1. The default value of the KAG is 1. Other KAG values may be used within the range defined by SMPTE ST 377-1.

9.2 Index Tables and the Fill Item

VC-6 coding is frame-based and the KLV fill item can be used to maintain a constant edit unit size for all frames.

Where the application defines a constant edit unit size, an index table shall be used. This includes the cases where the VC-6 essence element is the sole essence component and where it is interleaved with other essence components.

Where the application has a variable edit unit size an index table should be used wherever possible. SMPTE EG 377-3 illustrates the use of index tables for both mono and multi-essence mappings and for both constant and variable length edit unit sizes.

9.3 Operational Pattern Usage

This essence mapping may be used with any generalized operational pattern.

   NOTE This does not preclude the use of specialized operational patterns.

9.4 Mapping Track Numbers to Generic Container Elements

Each track number value for an essence element defined in this standard shall be derived as described in the MXF Constrained Generic Container specification (SMPTE ST 379-2).

9.5 Essence Container Partitions

Frame wrapping maintains each content package of the generic container as a separate editable unit with the contents of the system, picture, sound and data items in synchronism. If a frame-wrapped essence container is partitioned, then individual content packages should not be fragmented by the partitioning process.

   NOTE SMPTE ST 377-1:2019, Section 6.2.2 (Partition Rules Summary) summarizes the use of partitions in MXF files.

9.6 MXF Header Metadata Property Values

The following restrictions apply to Picture Stream wrapped with this standard

Property	Progressive Pictures	Interlaced Pictures
Bitstreams per KLV Element	1	2
Frame Layout (ST 377-1 §G.2.1)	0 (full_frame)	1 (separate_fields) or 4 (segmented_frame)
Sample Rate (ST 377-1 §G.2.2)	Frame	Frame

Property	Progressive Pictures	Interlaced Pictures
Edit Rate (ST 377-1 §B.12)	Frame	Frame
Index Edit Rate (ST 377-1 §11.2.3)	Frame	Frame
Aspect Ratio (ST 377-1 §G.2.4)	Frame	Frame

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