SMPTE STANDARD

Interoperable Master Format — Core Constraints

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Foreword

SMPTE (the Society of Motion Picture and Television Engineers) is an internationally-recognized standards developing organization. Headquartered and incorporated in the United States of America, SMPTE has members in over 80 countries on six continents. SMPTE's Engineering Documents, including Standards, Recommended Practices, and Engineering Guidelines, are prepared by SMPTE's Technology Committees. Participation in these Committees is open to all with a bona fide interest in their work. SMPTE cooperates closely with other standards-developing organizations, including ISO, IEC and ITU.

SMPTE Engineering Documents are drafted in accordance with the rules given in its Standards Operations Manual. This SMPTE Engineering Document was prepared by Technology Committee 35PM.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Engineering Document. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

Introduction

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

A single TV or movie title is transformed into multiple content versions (airline edits, special edition, languages…) These versions, which share common assets sourced from high-quality source masters, are ultimately made available to multiple distribution channels (Internet, optical media, broadcast...) across multiple territories and over the span of many months to over a year.

The IMF is a file-based framework that allows these high-quality versions, called Compositions, to be efficiently represented, managed, played back, processed and transformed on file-based systems. For example, it facilitates the generation of multiple outputs of the same Composition (through instructions contained in an Output Profile List defined in other documents) to accommodate the specific needs of distribution channels. Since management and processing of Compositions are performed across multiple devices and service providers, interoperability is desirable.

1   Scope

This document specifies provisions used by multiple IMF Applications. These provisions include essence and metadata constraints, but exclude image essence constraints, which are specified along with other parameters by each IMF Application.

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.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

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; then 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 engineering document. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this engineering document are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE ST 330:2011, Unique Material Identifier (UMID)

SMPTE ST 334-1:2015, Vertical Ancillary Data Mapping of Caption Data and Other Related Data

SMPTE ST 377-1:2011, Material Exchange Format (MXF) — File Format Specification

SMPTE ST 377-4:2012, MXF Multichannel Audio Labeling Framework

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

SMPTE ST 400:2012, SMPTE Labels Structure

SMPTE ST 429-5:2017, D-Cinema Packaging — Timed Text Track File

SMPTE ST 429-6:2006, D-Cinema Packaging — MXF Track File Essence Encryption

SMPTE ST 429-8:2007, D-Cinema Packaging — Packing List

SMPTE ST 429-9:2014, D-Cinema Packaging — Asset Mapping and File Segmentation

SMPTE ST 430-2:2017, D-Cinema Operations — Digital Certificate

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

SMPTE ST 2001-1:2015, XML Representation of SMPTE Registered Data — Mapping Rules

SMPTE ST 2029:2009, Uniform Resource Names for SMPTE Resources

SMPTE ST 2067-3:2020, Interoperable Master Format — Composition Playlist

SMPTE ST 2067-5:2020, Interoperable Master Format — Essence Component

SMPTE ST 2067-8:2013, Interoperable Master Format — Common Audio Labels

SMPTE ST 2067-9:2018, Interoperable Master Format — Sidecar Composition Map

SMPTE ST 2067-100:2014, Interoperable Master Format — Output Profile List

ISO/IEC 14496-22:2019, Open Font Format

IEC 61966-2-1:1999, Multimedia systems and equipment - Colour measurement and management - Part 2-1: Colour management - Default RGB colour space - sRGB

Internet Engineering Task Force (IETF) (December 1997). RFC 2253 — Lightweight Directory Access Protocol (v3): UTF-8 String Representation of Distinguished Names

Internet Engineering Task Force (IETF) (April 2005). RFC 4051 — Additional XML Security Uniform Resource Identifiers (URIs).

Internet Engineering Task Force (IETF) (July 2005). RFC 4122 — A Universally Unique Identifier (UUID) URN Namespace.

Internet Engineering Task Force (IETF) (May 2006). RFC 4539 — Media Type Registration for the Society of Motion Picture and Television Engineers (SMPTE) Material Exchange Format (MXF).

Internet Engineering Task Force (IETF) (September 2009). RFC 5646 — Tags for Identifying Languages.

World Wide Web Consortium (W3C) (26 November 2008). Extensible Markup Language (XML) 1.0 (Fifth Edition)

World Wide Web Consortium (W3C) (08 November 2018), TTML Profiles for Internet Media Subtitles and Captions 1.1 (IMSC1.1)

World Wide Web Consortium (W3C) (28 October 2004). XML Schema Part 1: Structures (Second Edition)

World Wide Web Consortium (W3C) (11 April 2013). XML Signature Syntax and Processing Version 1.1

4 Overall

4.1 XML Schema and Namespace

XML elements defined by this specification shall conform to the XML schema definitions (see W3C XML Schema Part 1: Structures) found in this specification. In the event of a conflict between schema definitions and the prose, the prose shall take precedence.

The XML schema root element shall be as defined in Table 1.

Table 1. XML Schema root element definition

```
<xs:schema targetNamespace="http://www.smpte-ra.org/ns/2067-2/2020"
    xmlns:cpl="http://www.smpte-ra.org/schemas/2067-3/2016"
    xmlns:cc="http://www.smpte-ra.org/ns/2067-2/2020"
    xmlns:dcml="http://www.smpte-ra.org/schemas/433/2008/dcmlTypes/"
    xmlns:xs="http://www.w3.org/2001/XMLSchema"
    elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:import namespace="http://www.smpte-ra.org/schemas/2067-3/2016"/>
  <xs:import namespace="http://www.smpte-ra.org/schemas/433/2008/dcmlTypes/"/>
  <!-- schema definitions found in this document -->
</xs:schema>
```

4.2 UUID Generation

UUID values used by this specification shall be generated as specified in IETF RFC 4122.

Unless specified otherwise, e.g. in Section 7.3.1, UUID values that identify assets or cryptographic information shall be generated using a truly-random or pseudo-random number source, and shall have a Version field value of '4' (or 0100b).

Note: The 'b' suffix on this value indicates a binary encoding, most significant bit (MSB) first.

4.3 XML Character Encoding

XML documents shall use UTF-8 encoding, as specified in W3C Extensible Markup Language (XML).

5   Track Files

5.1   Overall

5.1.1   Format

Track Files shall conform to SMPTE ST 2067-5.

5.1.2   Shim Parameters

Track Files shall be associated with the shim parameter values (see SMPTE ST 2067-5) specified in Table 2.

Table 2. Shim Parameter Values Definitions

Shim Parameter	Value	Notes
audio_family	ST 2067-2	Section 5.3.2
audio_file_arrangement	ST 382	Section 5.3.3
data_family	CDP (ST334-1), IMSC1.1	Sections 5.5 and 5.6
data_file_arrangement	ST 436-1, ST429-5	Section 5.4 and 5.5
sys_item_tc	true	Metadata in the System Item can be copied or moved to header metadata.
partition_spacing	60s	Section 5.1.3
index_strategy_frame	Follow	Section 5.1.4
Index_strategy_clip	Follow	Section 5.1.4
track_tag_policy	none	Section 5.3.6
ingest_TC	none	No dominant source of timecode during ingest is specified.
lead_TC	CPL	The Composition Playlist (CPL) specified in SMPTE ST 2067-3 defines a synthetic timecode Composition timeline.
dropframe_tc	none	No constraints are specified on timecode tracks in Track File header metadata.

Note: The Composition Playlist specified in SMPTE ST 2067-3 provides synchronization across the Composition timeline and timecode is not used.

The shim parameters listed in Table 3 shall be defined by individual Applications.

Table 3. Shim Parameter defined by Applications

Shim Parameter
shim_id
gc_type
picture_family

> picture_bitrate
>
> picture_format
>
> picture_custom_ANC
>
> picture_render_ANC

5.1.3 Body Partition

With the exception of the last body partition, the body partitions of a frame-wrapped Track File shall occur every 60±6s.

5.1.4 Index tables

At each partition point in a Track File, the index partition shall follow the essence partition that it indexes.

5.1.5 Identification

The Package UID of a given Track File shall be a basic UMID per SMPTE ST 330, having a UUID value in the material number part and a material number generation method of UUID/UL. The Package UID value shall be further constrained as follows:

- Byte 11 of the UL portion of the UMID shall be 0Fh (unidentified material type).
- Byte 12 of the UL portion of the UMID shall be 20h (UUID/UL material number generation method and undefined instance number generation method).
- The three bytes of the instance number shall be 0 (zero).

Package UID values generated in accordance with the normative provisions of this subsection will thus have the following contents in the first 16 bytes: 060a2b34h 01010105h 01010f20h 13000000h.

5.1.6 MIME Type

The media type of a Track File shall be application/mxf as specified in IETF RFC 4539.

5.1.7 Origin Property

The Origin Property of all Track items in the top-level File Package shall be zero.

Note: When the Origin Property of a Track items in the top-level File Package is zero, the Zero Point, as defined in SMPTE ST 377-1, refers to the first Content Element in the Essence Element.

5.1.8 Empty Essence Elements

The Structural Components item of the Top-Level File Package shall not reference any Filler component, i.e., the Essence Element of the Essence Container is not empty.

5.2 Image Track Files

5.2.1 General

An Image Track File shall conform to Sections 5.1 and 5.2.

An Image Track File primarily contains image essence. This specification does not specify the nature of the image essence.

5.2.2 Alternative Center Cut

The item defined in Annex F may be present in the Generic Picture Essence Descriptor (see SMPTE ST 377-1).

5.2.3 Active Area Rectangle

The items defined in Annex G may be present in the Generic Picture Essence Descriptor (see SMPTE ST 377-1).

5.2.4 Essence Container Integrity

The Composition Playlist (SMPTE ST 2067-3) and IMF Packing List (Section 7) allow the integrity of an entire Track File to be checked.

To enable the integrity of individual image frames to be checked, Image Track Files may conform to SMPTE ST 429-6 with the following constraints:

- the value of the Cipher Algorithm ID shall be 00000000.00000000.00000000.00000000 ("No cipher algorithm used").

- the value of the MIC Algorithm ID shall be 060e2b34.04010107.02090202.01000000 ("HMAC-SHA1 with 128-bit key").

- the MIC item shall be present

- Plaintext Offset shall be equal to Source Length

- Cryptographic Key ID shall be equal to 42b5ea14-233d-415c-b7d8-8b2dbd95ad39

- Cipher Key shall be equal to 0xcdea9b5a9bf00a0d564dd5ff0c19757d

5.3 Audio Track Files

5.3.1 General

An Audio Track File shall conform to Sections 5.1 and 5.3.

An Audio Track File primarily contains audio essence.

Each Audio Track File is intended to carry a single soundfield group. If the audio that is to be carried consists of more than one soundfield group, then each is carried in its own Audio Track File(s).

Example: 3 Audio Track Files carry a 6+2 Music and Effects content: one containing the "Music and Effects Main" 5.1 soundfield group and two others containing each a monaural soundfield group with a single center channel, one for "Music and Effects Optional" and one for "Dialog Guide". The GroupOfSoundfieldGroupsLabelSubDescriptor (5.3.6.4) is used to associate the soundfield groups with each other.

5.3.2   Essence

5.3.2.1   General

The audio essence shall consist of an audio waveform digitally sampled at regular interval into a sequence of audio samples.

5.3.2.2   Audio Sampling Rate

The sampling rate of the audio samples shall be either 48000 Hz or 96000 Hz.

Note: The sampling rates specified above are absolute and specified independently of a video signal. The Composition Playlist (SMPTE ST 2067-3) provides the mechanism to synchronize audio and image essence.

5.3.2.3   Quantization

Each audio sample shall be uniformly quantized as a 24-bit signed integer in the range [$-(2^{23})$ .. $2^{23} - 1$].

Source audio uniformly quantized using signed integers with lower bit depth, e.g. 16- or 20-bit, shall be padded in the least significant bits to create 24-bit audio samples.

5.3.3   Wrapping

The audio essence within an Audio Track File shall be:

- clip-wrapped as a Wave Clip-Wrapped Element, as specified in SMPTE ST 382; and

- packed bit-by-bit as specified by AES31-2, as specified in Section 7.2.1 of SMPTE ST 382:2007.

5.3.4   Wave Audio Essence Descriptor

5.3.4.1   General

The Top-Level File Package shall reference a Wave Audio Essence Descriptor as specified in SMPTE ST 382.

The constraints specified in Table 4 shall apply. Items labeled "shall be present" shall be present in the Wave Audio Essence Descriptor. Items labeled "shall be ignored" shall be ignored if present.

Table 4. Wave Audio Essence Descriptor Constraints

Item	Constraints
Sample Rate	Same as "Audio sampling rate"
Audio sampling rate	See Section 5.3.2.2
Channel Count	See Section 5.3.6.6
Quantization bits	See Section 5.3.2.3
Sound Essence Coding	See Section 7.2.1 of SMPTE ST 382:2007
Locked/Unlocked	Shall be ignored
Audio Ref Level	Shall be ignored
Electro-Spatial Formulation	Shall be ignored
Dial Norm	Shall be ignored
Channel Assignment	See Section 5.3.4.2

5.3.4.2 Channel Assignment

The Channel Assignment item shall be present and shall be equal to the UL specified in Table 5.

Table 5. Specification of the Channel Assignment Label

Byte No.	Description	Value (hex)	Meaning
1-7	Registry Designator	See SMPTE ST 400	
8	Registry Version Number	0Dh	Version of SMPTE register (see SMPTE ST 400) in which this label first appears
9	Parametric	04h	Node used to define parametric data
10	Sound Essence	02h	Identifies sound essence coding
11	Sound Coding Characteristics	02h	Identifies sound coding characteristics
12	Sound Channel Labeling	10h	Identifies sound channel labeling
13	Sound Channel Labeling SMPTE ST2067-2	04h	Identifies sound channel labeling as defined in SMPTE ST2067-2
14	Application of the MXF Multichannel Audio Framework	01h	Indicates that the MXF Multichannel Audio Framework is used
15	Reserved	00h	Reserved
16	Reserved	00h	Reserved

5.3.5   Additional Generic Sound Essence Descriptor Items

The items specified in Annex E shall be subject to the constraints specified in Table 6.

Table 6. Additional Generic Sound Essence Descriptor Items Constraints

Item	Constraints
Reference Audio Alignment Level	Should be present.
Reference Image Edit Rate	Should be present. See Section 6.4.
	Note: This is the edit rate of the picture essence to which the sound essence was conformed initially. Audio Track Files can be used in Compositions that have different Composition Edit Rates than the value of the Reference Image Edit Rate item.

5.3.6   Multichannel Audio Labeling

5.3.6.1   General

An Audio Track File shall conform to SMPTE ST 377-4.

5.3.6.2   AudioChannelLabelSubDescriptor Instances

Each audio channel in an Audio Track File shall be associated with exactly one AudioChannelLabelSubDescriptor instance, and each AudioChannelLabelSubDescriptor instance shall be associated with exactly one audio channel.

Note: The MCA Channel ID item is used to make this association.

5.3.6.3   SoundfieldGroupLabelSubDescriptor Instances

An Audio Track File shall contain exactly one SoundfieldGroupLabelSubDescriptor instance, which all AudioChannelLabelSubDescriptor instances shall reference.

5.3.6.4   GroupOfSoundfieldGroupsLabelSubDescriptor Instances

An Audio Track File shall contain zero or one GroupOfSoundfieldGroupsLabelSubDescriptor.

5.3.6.5   Item Constraints

Within a given Audio Track File, the constraints of Table 7 shall apply in addition to those specified in SMPTE ST 377-4.

Table 7. MCA SubDescriptor Constraints

Item	AudioChannelLabel SubDescriptor Constraints	SoundfieldGroup Label SubDescriptor Constraints	GroupOfSoundfieldGroups Label SubDescriptor Constraints
SoundfieldGroupLinkID	Shall be present. See Section 5.3.6.3.		
MCA Channel ID	Shall be present unless the channel ID of the associated audio channel is equal to 1, in which case the item may be omitted. See Section 5.3.6.2.	Shall be ignored.	
MCA Tag Name	Shall be present.		
RFC 5646 Spoken Language	Shall be ignored.	Shall be equal to the primary spoken language associated with the soundfield group. It shall be absent if and only if the soundfield group is not associated with a primary spoken language.	Shall be ignored.
MCA Audio Content Kind	Shall be ignored.	Shall be present.	
MCA Audio Element Kind			
MCA Title			
MCA Title Version			

Other items defined in SMPTE ST 377-4 but not required by this specification may be present and may be safely ignored by implementations.

Note 1: MCA Tag Name contains a human-readable text intended for display to the user. The MCA Label Dictionary ID is used to unambiguously determine the nature of the underlying audio channel, soundfield group or group of soundfield groups.

Note 2: MCA Audio Content Kind, MCA Element Kind, MCA Title and MCA Title Version contain human-readable descriptive text intended for display to the user. Grouping of audio channels and soundfield groups is achieved through SoundfieldGroupLabelSubDescriptor and GroupOfSoundfieldGroupsLabelSubDescriptor, respectively.

5.3.6.6   Common Audio Channels, Soundfield Group and Group of Soundfield Groups

The following applies for audio channels, soundfield group and group of soundfield groups identified using SMPTE ST 2067-8, which Audio Track Files should use whenever possible.

The MCA Label Dictionary ID, MCA Tag Symbol and MCA Tag Name item values shall be set according to Table 8.

Table 8. Mapping of SMPTE ST 2067-8 parameters to SMPTE ST 377-4 item values

SMPTE ST377-4 item	SMPTE ST 2067-8 parameters
MCA Label Dictionary ID	UL parameter value
MCA Tag Symbol	Symbol prepended with the string • 'ch' for audio channels. • 'sg' for sound field groups. • 'gg' for groups of soundfield groups.
MCA Tag Name	Name

Not all audio channels belonging to the soundfield group carried by a given Audio Track File need be present in the Audio Track File, but only AudioChannelLabelSubDescriptor instances associated with audio channels belonging to the given soundfield group shall reference the SoundfieldGroupLabelSubDescriptor associated with that soundfield group.

The use of groups of soundfield groups is optional. A GroupOfSoundfieldGroupsLabelSubDescriptor instance need not be present even though some or all SoundfieldGroupLabelSubDescriptor instances associated with soundfield groups belonging to a given group of soundfield groups are present. However, only SoundfieldGroupLabelSubDescriptor instances associated with soundfield groups belonging to a given group of soundfield groups may reference the GroupOfSoundfieldGroupsLabelSubDescriptor associated with that group of soundfield groups.

5.4 Timed Text Track Files

5.4.1 General

A Timed Text Track File shall conform to Sections 5.1 and 5.4.

A Timed Text Track File primarily contains Timed Text essence, e.g. subtitle and caption.

The DataEssenceCoding items shall not be present in a Timed Text Track File.

5.4.2 Wrapping

Timed Text Track Files shall conform to SMPTE ST 429-5.

The Timed Text Resource shall contain a single Document Instance that conforms to either the Text or Image Profile specified in W3C TTML Text and Image Profiles for Internet Media Subtitles and Captions 1.1.

The NamespaceURI item of the Timed Text Descriptor shall be equal to a profile designator of a profile to which the Document Instance conforms.

Note: As specified in Section 5.4.1 of W3C TTML Text and Image Profiles for Internet Media Subtitles and Captions 1.1, the NamespaceURI item can contain profile designators other than those defined in W3C TTML Text and Image Profiles for Internet Media Subtitles and Captions 1.1, which are superset of other profiles.

Example: The NamespaceURI item of the Timed Text Descriptor can be equal to
`http://www.w3.org/ns/ttml/profile/imsc1/image`

5.4.3   Essence

Any of the generic font families defined in W3C Timed Text Markup Language may be referenced.

For compatibility with earlier versions of this specification, the metadata element of the head element (see W3C Timed Text Markup Language) may contain a single instance of the TimedTextResourceID element specified in Table 9. The UUID value of this element shall equal the UUID value of the Resource ID item of the TimedTextDescriptor.

Table 9. TimedTextResourceID element schema definition

```
<xs:element name="TimedTextResourceID" type="dcml:UUIDType"/>
```

Note: Timed Text Track Files can contain data essence mapped from CEA-608 and CEA-708 using SMPTE RP 2052-10 and SMPTE RP 2052-11, respectively. The data tunnel specified in the latter is not used by this specification.

If the data essence is associated with a single primary language, the xml:lang attribute of the root <tt> element shall identify the primary language.

If the data essence is associated with multiple languages, the xml:lang attribute of the root <tt> element shall be the empty string and the xml:lang attribute of each topmost element associated with a single language shall identify the language contained therein.

5.4.4   RFC 5646 Language Tag List

The Timed Text Descriptor may contain the RFC 5646 Language Tag List property specified in Annex H. The value of the property shall indicate the languages associated with the data essence within the Timed Text Track File. Absence of the property shall indicate that no language is associated with the Timed Text Track File.

5.4.5   Image Resources

For each distinct image resource referenced in a Data Essence Track File, an image resource shall be carried as an Ancillary Resource in the same Data Essence Track File.

Note: W3C IMSC 1.1 specifies that each image resource is a PNG image as specified in W3C Portable Network Graphics (PNG) Specification (Second Edition).

The color space of each image resource shall be sRGB, as defined in IEC 61966-2-1.

The MIMEMediaType of each Ancillary Resource containing an image resource shall be "image/png".

The AncillaryResourceID of each Ancillary Resource containing an image resource shall be a Type 5 UUID as specified in IETF RFC 4122, using (i) the image resource URI as the name, (ii) SHA-1 as the algorithm, and (iii) the NameSpace_URL constant as the Name Space ID.

Example: the relative URI animage.png would result in an AncillaryResourceID with the value of 1c939cc8-f4b5-503b-9c47-f7445a85ba11.

5.4.6 Font Resources

For each distinct font family that is (a) referenced in a Timed Text Track File and (b) not a generic font family as defined in W3C Timed Text Markup Language, a font resource shall be carried as an Ancillary Resource in the same Timed Text Track File.

Each font resource shall be a OpenType font file as specified in ISO/IEC 14496-22.

The MIMEMediaType of each Ancillary Resource containing a font resource shall be either "font/otf", as specified in RFC 8081, or "application/x-font-opentype".

The media type "application/x-font-opentype" should not be used, unless compatibility with earlier versions of this specification is desired.

The AncillaryResourceID of each Ancillary Resource containing a font resource shall be a Type 5 UUID as specified in IETF RFC 4122, using (i) the font family name exactly as it appears in the data essence as the name, (ii) SHA-1 as the algorithm, and (iii) b6cc57a0-87e7-4e75-b1c3-3359f3ae8817 as the Name Space ID.

For instance, the URI "Arial" would result in an AncillaryResourceID with the value of fe16f8e4-57a9-56b5-a93c-6c27d6f61619.

Note: The mapping of generic font families to font resources is implementation-dependent, and is never overridden by font resource embedded in the Track File. An author wishing to both specify a generic font family (e.g. proportionalSansSerif) and include the font resources used at authoring (Arial) specifies tts:fontFamily="Arial,default" and embeds the Arial font resource in the Track File.

5.4.7 Mapping of the Root Container Region

The Root Container Region of the Document Instance shall be mapped to the Display Rectangle (defined by SMPTE ST 377-1) of the Main Image Virtual Track.

Note: This allows the timed text essence to be re-purposed in applications that do define an Active Area, and the timed text essence to be positioned in mattes, if present.

5.5 Ancillary Data Track Files

An Ancillary Data Track File shall conform to Section 5.1.

An Ancillary Data Track File shall conform to SMPTE ST 436-1.

An Ancillary Data Track File can be used to carry VBI and/or ANC data contained in source material. This specification neither constrains nor specifies this data.

5.6 Caption Description Packet (CDP) Track File

A CDP Track File is an Ancillary Data Track File (see Section 5.5) that shall contain only the payload defined in SMPTE ST 334-1:2015, Table 1, "Closed captioning (CEA-708) (CDP)" with Section 5.3.1, "Format of the closed captioning (CEA-708) (CDP)" — i.e. only DID=61h (161h) with SDID=1 (101h).

Note: CDPs can contain both CEA-708 captions and CEA-608 data – SMPTE ST 334-2 (as referenced in SMPTE ST 334-1) for a description of the CDP payload.

6   Composition

6.1   Application Identification

The ExtensionProperties element of the Composition Playlist instance shall include a single instance of the ApplicationIdentification element specified in Table 10.

Table 10. XML Schema definition for ApplicationIdentification element

```
<xs:element name="ApplicationIdentification">
  <xs:simpleType>
    <xs:restriction>
      <xs:simpleType>
        <xs:list itemType="xs:anyURI"/>
      </xs:simpleType>
      <xs:minLength value="1"/>
    </xs:restriction>
  </xs:simpleType>
</xs:element>
```

Each item of the ApplicationIdentification element is an Application ID value, which identifies an Application to which a Composition conforms.

Each Application shall define an Application ID value that uniquely and globally identifies the normative provisions of the Application.

Two Application ID values are identical if and only if they are identical as specified by the Comparing URI References procedure defined in W3C XML Namespaces.

Note: The comparison algorithm above is case-sensitive, regardless of the case-sensitiveness of the underlying URI value. Applications are therefore encouraged to list Application ID values in lowercase whenever possible to reduce the potential for confusion.

6.2   Homogeneous Essence

6.2.1   Audio

Within a given a composition, the audio essence characteristics listed in Table 11 shall remain constant.

Table 11. Homogeneous Audio Essence Characteristics

Characteristic	Definition
Quantization	See Section 5.3.2.3
Sampling Rate	See Section 5.3.2.2

6.3 Virtual Tracks

6.3.1 Main Image Virtual Track

A Composition shall contain exactly one Main Image Virtual Track.

The Main Image Virtual Track shall consist of one or more MainImageSequence elements, as specified in Table 12.

Table 12. MainImageSequence element schema definition

```
<xs:element name="MainImageSequence" type="cpl:SequenceType"/>
```

If the underlying image essence consists of a sequence of pairs of image frames for stereoscopic viewing, a left eye frame and a right eye frame coincident in time, each MainImageSequence element shall contain Resource elements of type StereoImageTrackFileResourceType, as defined in Annex C, that reference two Image Track Files conforming to Section 5.2.

If the underlying image essence is monoscopic, all MainImageSequence elements shall contain Resource elements of type TrackFileResourceType that reference a Track File that conforms to Section 5.2.

The Edit Rate of the Resource elements shall be equal to the value of the Sample Rate item in the Generic Picture Essence Descriptor, as defined by SMPTE ST 377-1, of the underlying essence.

6.3.2 Audio Virtual Tracks

A Composition shall contain zero or more Audio Virtual Tracks.

Each Audio Virtual Track shall consist of one or more MainAudioSequence elements, as specified in Table 13.

Table 13. MainAudioSequence element schema definition

```
<xs:element name="MainAudioSequence" type="cpl:SequenceType"/>
```

All Audio Essence Track Files referenced by a given Virtual Track shall have identical sets of GroupOfSoundfieldGroupsLabelSubDescriptors, SoundfieldGroupLabelSubDescriptors and AudioChannelLabelSubDescriptors instances.

Each MainAudioSequence element shall contain Resource elements of type TrackFileResourceType that reference Audio Track File conforming to Section 5.3.

The Edit Rate of the Resource elements shall be equal to the audio sampling rate of the underlying essence.

6.3.3   Timed Text Virtual Tracks

A Composition shall contain zero or more Timed Text Virtual Tracks.

Each Timed Text Virtual Track shall consist of one or more instances of one of the element specified in Table 14.

Table 14. Timed Text Sequence schema definition

```
<xs:element name="SubtitlesSequence" type="cpl:SequenceType"/>
<xs:element name="HearingImpairedCaptionsSequence" type="cpl:SequenceType"/>
<xs:element name="VisuallyImpairedTextSequence" type="cpl:SequenceType"/>
<xs:element name="CommentarySequence" type="cpl:SequenceType"/>
<xs:element name="KaraokeSequence" type="cpl:SequenceType"/>
<xs:element name="ForcedNarrativeSequence" type="cpl:SequenceType"/>
```

Each element of Table 14 contains Timed Text of the kind specified in Table 15.

Table 15. Timed Text Element Sequence Content Kind

Data Sequence Element	Kind of Timed Text Content as defined in Annex B
SubtitlesSequence	Subtitle
HearingImpairedCaptionsSequence	Captions for the Hearing Impaired
VisuallyImpairedTextSequence	Text for the Visually Impaired
CommentarySequence	Commentary
KaraokeSequence	Karaoke
ForcedNarrativeSequence	Forced Narrative

Each Resource elements within Timed Text Virtual Track:

- shall be of type TrackFileResourceType
- shall reference a Track File that conform to Section 5.4.
- shall have a native start point, as defined in SMPTE ST 2067-3, corresponding to time coordinate 0 in the timeline of the underlying Timed Text Track File.
- shall have a native duration, as defined in SMPTE ST 2067-3, equal to or larger than the time coordinate after which no element will be active in the timeline of the underlying Timed Text Track File.

Annex D provides guidance in the situation where there is no Timed Text associated with a particular Segment of the Composition.

The edit rate of the Resource elements may be set to any value since Timed Text Essence does not define an Edit Rate. It is usually set to the Composition Edit Rate.

Note: Each Timed Text Virtual Track is sufficient for a complete presentation of the Timed Text Essence contained therein. For example, a Timed Text Virtual Track containing Subtitle Timed Text Essence does not

depend on any other Timed Text Virtual Track, including any other Forced Narrative Timed Text Virtual Track present in the Composition.

6.3.4 Ancillary Data Virtual Track

A Composition shall contain zero or more Ancillary Data Virtual Tracks.

Each Ancillary Data Virtual Track shall consist of one or more instances of one of the element specified in Table 16.

Table 16. Ancillary Data Sequence schema definition

```
<xs:element name="AncillaryDataSequence" type="cpl:SequenceType"/>
```

All AncillaryDataSequence elements shall contain Resource elements of type TrackFileResourceType that reference Track File that conform to Section 5.5.

6.3.5 CDP Virtual Track

For each Timed Text Virtual Track that contains HearingImpairedCaptionsSequence elements as specified in Section 6.3.3, a Composition shall contain zero or one CDP Virtual Track.

Each CDP Virtual Track shall consist of one or more instances of one of the elements specified in Table 17.

Table 17. CDP Sequence schema definition

```
<xs:element name="CDPSequence">
  <xs:complexType>
   <xs:complexContent>
    <xs:extension base="cpl:SequenceType">
     <xs:sequence>
      <xs:element name="ParentTrackID" type="dcml:UUIDType"/>
     </xs:sequence>
    </xs:extension>
   </xs:complexContent>
  </xs:complexType>
 </xs:element>
```

All CDPSequence elements shall contain Resource elements of type TrackFileResourceType that reference a CDP Track File that conforms to Section 5.6.

The ParentTrackId shall contain the TrackId of the Timed Text Virtual Track associated with the CDP Virtual Track.

6.3.6 Main Marker Virtual Track

A Composition shall contain zero or one Main Marker Virtual Track.

The Main Marker Virtual Track shall consist of one or more MarkerSequence elements specified in SMPTE ST 2067-3.

6.4   Composition Edit Rate

The Composition Edit Rate shall be equal to the edit rate of the image essence referenced by the Main Image Virtual Track.

Note: The Composition Edit Rate does not constrain the rate at which implementations can reproduce a Composition. For instance, a Composition with an Edit Rate of 24/1 can be reproduced at 24,000/1,001 frames per second.

6.5   Track File Identification

The UUID value of the TrackFileId element of TrackFileResourceType instances shall be equal to the material number part of the Package UID of the Top-level File Package.

Per the constraints of Section 5.1.5, there is therefore a one-to-one mapping between the value of the TrackFileId element and the complete UMID value of the Package UID of the Top-level File Package of the Track File; and the UUID URN value of the TrackFieldId element shall be considered equivalent to the corresponding complete UMID URN, encoded as specified in Section 8.1 of SMPTE ST 2029:2009.

For instance, a TrackFileId value of

urn:uuid:75b7e2a0-e5cc-11e1-aff1-0800200c9a66

is equivalent to the following UMID

urn:smpte:umid:060a2b34.01010105.01010f20.13000000.75b7e2a0.e5cc11e1.aff10800.200c9a66

6.6   Segment Duration

The duration of a Segment shall be greater than or equal to the duration of one image essence frame referenced by the Main Image Virtual Track.

6.7   Content Version

The Id element within each ContentVersion element may contain any valid URI. A few schemes are listed in Table 18 for illustration.

Table 18. Examples of URI schemes for Content Version identification (Informative)

Basic UMID (SMPTE ST 2029)
ISAN (IETF RFC 4246)
UUID (IETF RFC 4122)
Info (IETF RFC 4452)

6.8   EssenceDescriptor

The entire File Descriptor structure (including Sub Descriptors) referenced by the top-level File Package of each Track File referenced by the Composition Playlist shall be mapped to the <xs:any> element of a single

EssenceDescriptor element (see Section 6.1.10.1 in SMPTE ST 2067-3:2020) as a single RegXML fragment as specified in SMPTE ST 2001-1.

In particular, instances of the following Descriptors and Sub Descriptors shall be mapped:

- Wave Audio Essence Descriptor (SMPTE ST 382) including the additional items defined in Annex E,

- MCA Label Descriptors (SMPTE ST 377-4),

- ANC Data Descriptor (SMPTE ST 436-1),

- Timed Text Descriptor (SMPTE ST 429-5), and

- Timed Text Resource Descriptor (SMPTE ST 429-5).

6.9 Digital Signature

The Signature element of the Composition Playlist shall satisfy the following constraints:

- The KeyInfo element shall be present and shall contain the entire certificate chain for the signer.

- The Object element shall not be present and the URI attribute of the Reference element shall be the empty string, i.e. the signature is enveloped.

- The Reference element shall contain a single DigestMethod element, with its Algorithm attribute set to the URI value http://www.w3.org/2001/04/xmlenc#sha256.

- The Reference element shall contain a single Transform element, with its Algorithm attribute set to the URI value http://www.w3.org/2000/09/xmldsig#enveloped-signature.

- The CanonicalizationMethod shall be set to the URI value http://www.w3.org/TR/2001/REC-xml-c14n-20010315.

- The SignatureMethod shall be set to the URI value http://www.w3.org/2001/04/xmldsig-more#rsa-sha256 as defined in IETF RFC 4051.

If X.509 certificates are used as specified in W3C XML Signature Syntax and Processing, then the entire certificate chain shall be carried in the KeyInfo element as a sequence of X509Data elements. Each of the X509Data elements shall correspond to one certificate in the chain, and contain one X509IssuerSerial element and one X509Certificate element. The Distinguished Name value in all X509IssuerName elements shall be compliant with RFC 2253 as specified in W3C XML Signature Syntax and Processing.

6.10 Digital Certificates

If the Signature element is present in a Composition Playlist or a Sidecar Composition Map instance as specified in SMPTE ST 2067-9, the digital certificate used shall conform to SMPTE ST 430-2.

6.11 Definition

A Composition consists of one Composition Playlist, as specified in SMPTE ST 2067-3, and all Assets, e.g Track Files, it references.

7 Packaging

7.1 Overview (Informative)

An Interoperable Master Package (IMP) combines assets into a logical unit intended for delivery and ingest.

Each IMP is defined by a single IMF Packing List, which is an XML document that lists all assets contained in the IMP. To allow the same IMP to be used across multiple delivery media, e.g. HTTP and USB stick, the IMF Packing List uses a unique identifier of each Asset, i.e. its UUID, instead of its actual location, e.g. filename. As a corollary, an IMP cannot be delivered without a mapping of asset identifiers to actual locations, for instance, files on a file system or HTTP resources. The mapping between asset identifiers and asset locations, and thus the delivery of IMPs, is specified in Section 8.

An IMP can contain any combination of assets, and not necessarily complete compositions. Similarly, a given asset can be present in multiple IMPs. As illustrated in Annex I, this flexibility can be used, for instance, for replacing defective Assets or supplementing already delivered Assets, e.g. delivering language versions.

7.2   Interoperable Master Package (IMP)

An Interoperable Master Package (IMP) consists of one IMF Packing List, as specified in Annex J, and all the assets it references.

7.3   IMF Packing List Constraints

7.3.1   Asset Identification

No two Asset elements in a given IMF Packing List instance shall have identical Id elements.

The value of the Id element shall be extracted from the asset as specified in Table 19 for the asset defined therein.

Table 19. Asset Identification

Asset	Identifier
Composition Playlist	Id element of the CompositionPlaylist instance as specified in SMPTE ST 2067-3.
Track File	Material number of the Package UID value of the Top-level File Package.
Output Profile List	Id element of the OutputProfileList instance as specified in SMPTE ST 2067-100.
Sidecar Composition Map	Id element of the SidecarCompositionMap instance as specified in SMPTE ST 2067-9.

The Packing List may reference assets not listed in Table 19. For such assets, the Id element shall be a Type 5 UUID as specified in IETF RFC 4122, using (i) the SHA-1 hash of the entire asset as the Type 5 UUID Name, (ii) SHA-1 as the Type 5 UUID Hash Algorithm, and (iii) af86b7ec-4cdf-4f9f-820f-6fd8d3003023 as the Type 5 UUID Name Space ID.

Example: The Packing List can refer to a QC report with media type "application/pdf".

7.3.2   Digital Signature and Certs

When the Signature element of the IMF Packing List is present, digital certificates in the signer's certificate chain shall conform to the provisions of SMPTE ST 430-2.

7.3.3 Group ID

The GroupId element of the IMF Packing List should not be present, and shall be ignored.

8 Delivery

8.1 Introduction

As illustrated in Figure 1, the mapping of Asset identifiers contained in an IMF Packing List to locations on a delivery medium is accomplished using the Asset Map mechanism specified in SMPTE ST 429-9. Some media, e.g. hard drive, can contain multiple Deliveries.
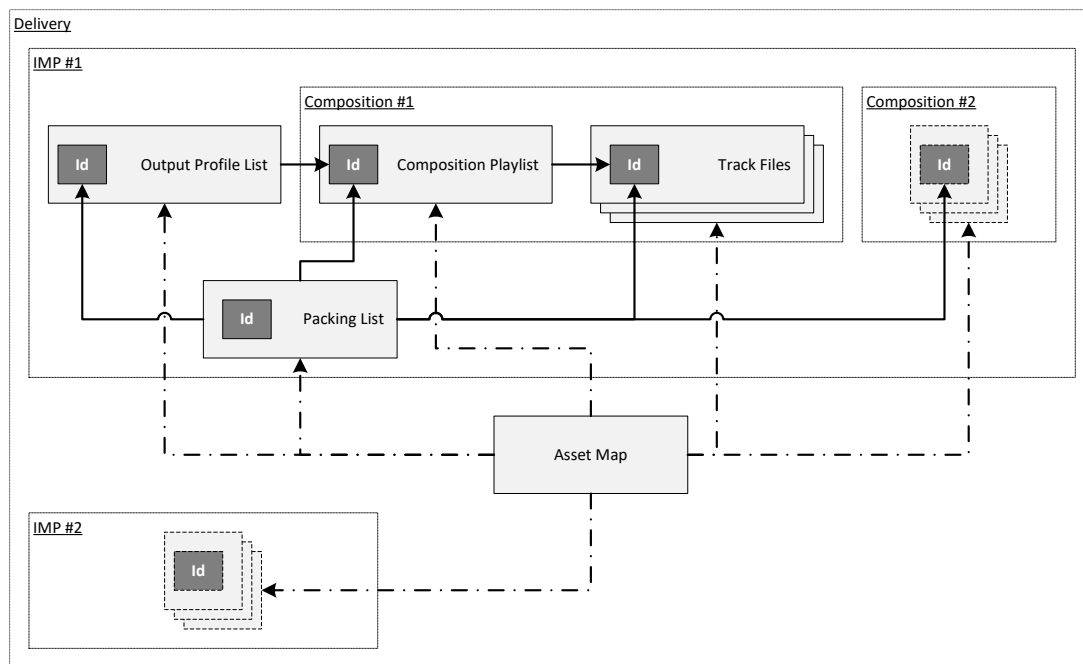

Figure 1. Relationship between Composition, Assets, Packages and Delivery

8.2 Definition

A Delivery is a collection of one or more IMPs contained in a single Mapped File Set, as specified in SMPTE ST 429-9.

8.3 Ingest

A Delivery should be ingested according to the algorithm of Table 20.

Table 20. **Delivery Ingest Algorithm**

```
locate and read the Asset Map of the Mapped File Set

for each Packing List in the Asset Map
  locate and open the Packing List

  if the Packing List is selected for ingest
    for each Asset in the Packing List
      find the Path of the Asset using the Asset Map
      locate and ingest the Asset
      validate the message digest of the Asset
```

Specifically:

- since the algorithm specifies that a Packing List is ingested in its entirety, a Packing List should only contain related assets that are intended to be ingested as a group;

- assets not referenced by both an Asset Map and a Packing List should be ignored entirely, e.g. not parsed or queried; and

- assets intended to be ingested should be referenced by both the Packing List and the Asset Map.

Note 1: IMF Packing List and Asset Map structures are not used for the processing of Compositions and can be discarded after ingest. Packing List and Asset Map metadata (e.g. Id, AnnotationText, Creator, etc…) can however be retained for tracking, logging and debugging purposes.

Note 2: No specific structure to Path values, including filename extensions, are specified.

Note 3: Only those Assets that are referenced by a Packing List are ingested. As a result the delivery medium can contain other files that are not ingested, and the Asset Map can reference Assets that are not ingested. This last scenario is useful for future extensions.

Note 4: Multiple factors can determine whether the Packing List is selected for ingest, and are not detailed here. For instance, a user can explicitly request the ingest of a specific Packing List based on the presence of Composition Playlists of interest. Similarly, an implementation can select a Packing List for ingest if the Packing List contains Assets referenced by an already ingested Composition Playlist. As another example, ingest can be based on the validation of a trusted digital signature on the Packing List.

Note 5: The Path values are not necessarily unique across Mapped File Sets. It is therefore the responsibility of the implementation to organize its internal storage mechanisms to prevent collisions across Deliveries.

Note 6: An Asset referenced by the Packing List but not by an Asset Map is not ingested since its location is not specified.

8.4   Delivery Media

SMPTE ST 429-9 specifies the mapping of Mapped File Sets onto a hierarchical, random-access filesystem which supports long path names and files larger than 4GB.

Annex K specifies the mapping of Mapped File Sets onto HTTP and HTTPS.

Annex A   Consolidated Schema (Informative)

This specification is accompanied by the following elements, which are XML schema documents as specified in XML Schema Part 1: Structures.

st2067-2a-2020.xsd
st2067-2b-2020.xsd

These elements collects the XML schema definitions defined in this specification. They are informative and, in case of conflict, this specification takes precedence.

Annex B   Timed Text Definitions (Normative)

B.1 Subtitles

Subtitles are a textual representation of the audio track, usually just the dialog and usually in a language other than the audio track dialog, intended for foreign language audience.

B.2 Captions for the Hearing Impaired

Captions for the Hearing Impaired are a textual representation of the audio track, usually including all sounds, and usually in the same language as the audio track dialog, intended for hearing impaired audiences.

B.3 Text for the Visually Impaired

Text for the Visually Impaired is a textual description of visual elements of the content and usually in the same language as the audio track dialog, intended for visually impaired audiences.

B.4 Commentary

Commentary provides extra information about the associated content (e.g. Producer Commentary) usually in the same language as the audio track dialog.

B.5 Karaoke

Karaoke is a textual representation of songs' lyrics, usually in the same language as the associated song.

B.6 Forced Narrative

Timed text related to foreign or alien language or translation of text that appears in media, such as in a sign, that is intended to be displayed if no other timed text, such as subtitles or captions, is enabled.

Annex C   StereoImageTrackFileResourceType (Normative)

The StereoImageTrackFileResourceType shall represent stereoscopic content consisting of two Track Files, each consisting of monoscopic essence. The Track Files referenced by the Left Eye and Right Eye elements shall contain views associated with the left and right eyes of the viewer.

Table C.1. Stereo Image Track File Resource Type schema

```
<xs:complexType name="StereoImageTrackFileResourceType">
  <xs:complexContent>
   <xs:extension base="cpl:BaseResourceType">
    <xs:sequence>
     <xs:element name="LeftEye" type="cpl:TrackFileResourceType" />
     <xs:element name="RightEye" type="cpl:TrackFileResourceType" />
    </xs:sequence>
   </xs:extension>
  </xs:complexContent>
 </xs:complexType>
```

Each of the following elements shall have the same value across an instance of StereoImageTrackFileResourceType and its LeftEye and RightEye elements:

- SourceDuration; and
- EditRate.

The RepeatCount of each of the LeftEye and RightEye elements shall be equal to 1.

Annex D   Sparse Encoding of Timed Text Essence (Normative)

In some situations, the Timed Text essence underlying a virtual track may be altogether absent from a given Segment, e.g. a Sequence within a Composition may not have any captions associated with it. In these situations, the Sequence associated with the virtual track within such a Segment should contain a single Resource and this Resource should be associated with an otherwise valid asset conveying the absence of essence for a duration equal to that of the Segment.

Figure D.1 depicts an example where no captions are associated with two Segments of a Composition. Each of these two Segments contains a single Sequence that itself contains a single Resource. These two Resources reference the same Track File ID=AF..12, which is a valid Timed Text Track File (an MXF File that wraps an XML representation of the caption timeline) that contains no actual caption (the timeline is empty).
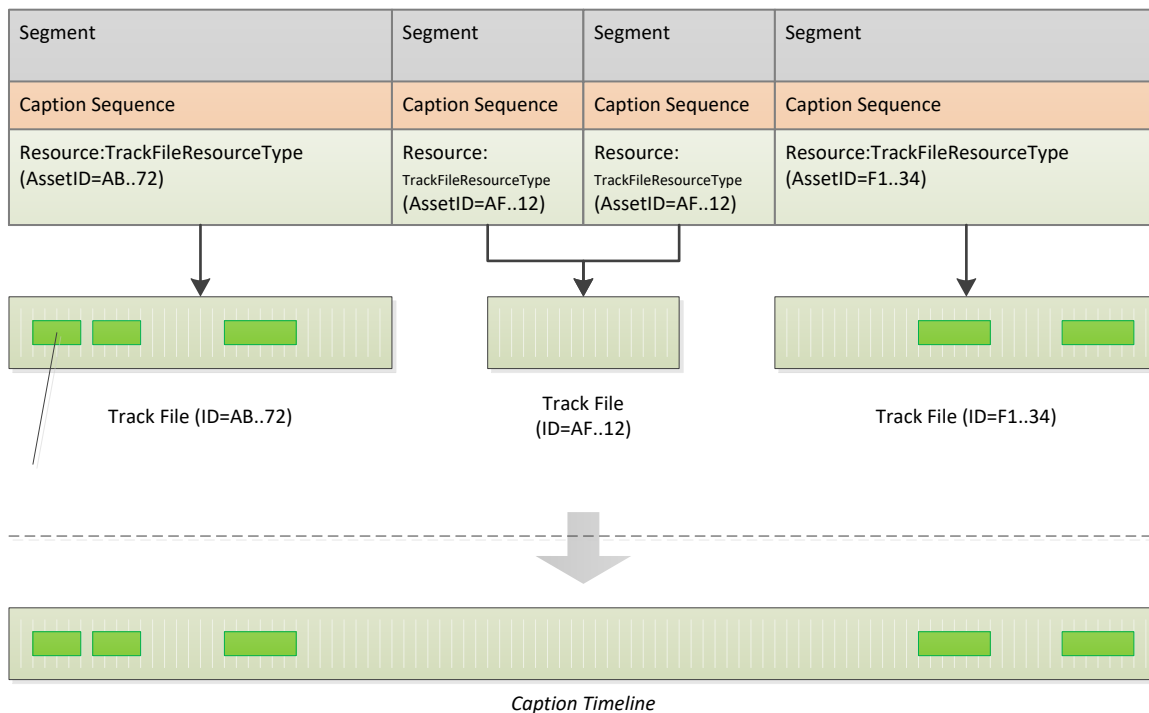

Figure D.1. Sparse Encoding of Timed Text

Annex E   Additional Generic Sound Essence Descriptor Items (Normative)

E.1 General

Annex E shall specify items for the Generic Sound Essence Descriptor (see SMPTE ST 377-1).

E.2 Reference Image Edit Rate

Table E.1. Specification of the Reference Image Edit Rate Item

Item Name	Item Symbol	Type	Len	Local Tag	Item UL	Req ?	Meaning	Default
Reference Image Edit Rate	ReferenceImageEditRate	Rational	8	dyn	06.0E.2B. 34.01.01. 01.0E.04. 02.01.01. 06.00.00. 00	Opt	Edit rate of the image essence with which the audio is intended to sync. For example, 24/1.001 fps, 24 fps, 25 fps	

The Reference Image Edit Rate shall indicate the edit rate of the image to which the audio is designed to sync. Absence of the item shall indicate that the Reference Image Edit Rate is unknown.

E.3 Reference Audio Alignment Level

Table E.2. Specification of the Reference Audio Alignment Level Item

Item Name	Item Symbol	Type	Len	Local Tag	Item UL	Req ?	Meaning	Default
Reference Audio Alignment Level	ReferenceAudioAlignmentLevel	Int8	1	dyn	06.0E.2B. 34.01.01. 01.0E.04. 02.01.01. 07.00.00. 00	Opt	Reference alignment level of the audio expressed in dBFS. For example, -20dBFS.	

The Reference Audio Alignment Level shall be the reference alignment level of the audio expressed in dBFS. This is the number of dB below full scale on a PPM meter that represents the analog "0 VU" nominal alignment level, for example -20 dBFS. Absence of the item shall indicate that the Audio Reference Alignment Level is unknown.

Annex F   Alternative Center Cuts (Normative)

The following specifies an additional optional item for the Generic Picture Essence Descriptor (see SMPTE ST 377-1).

Table F.1 shall specify the Alternative Center Cuts item.

The Alternative Center Cuts item specified in Table F.1 contains zero or more Alternative Center Cut values.

Table F.1. Specification of the Alternative Center Cuts Item

Item Name	Item Symbol	Type	Len	Local Tag	Item UL	Req ?	Meaning	Default
Alternative Center Cuts	AlternativeCenterCuts	Batch of UL	Var	dyn	06.0E.2B. 34.01.01. 01.0E.04. 01.03.02. 0B.00.00. 00	Opt	Specifies the alternate aspect ratio subset(s) of the Active Area Rectangle, containing all of the critical action and centered on the Active Area Rectangle.	

As illustrated in Figure F.1, each Alternative Center Cut value shall be a UL defining an aspect ratio for a rectangular area containing all of the critical action that is (a) centered on the Active Area Rectangle, (b) entirely contained within the Active Area Rectangle and (c) has a height or width equal to that of the Active Area Rectangle. Table F.2 defines Alternative Center Cut values, which may be used as values in the Alternative Center Cuts batch. The Active Area Rectangle is defined in Annex G.
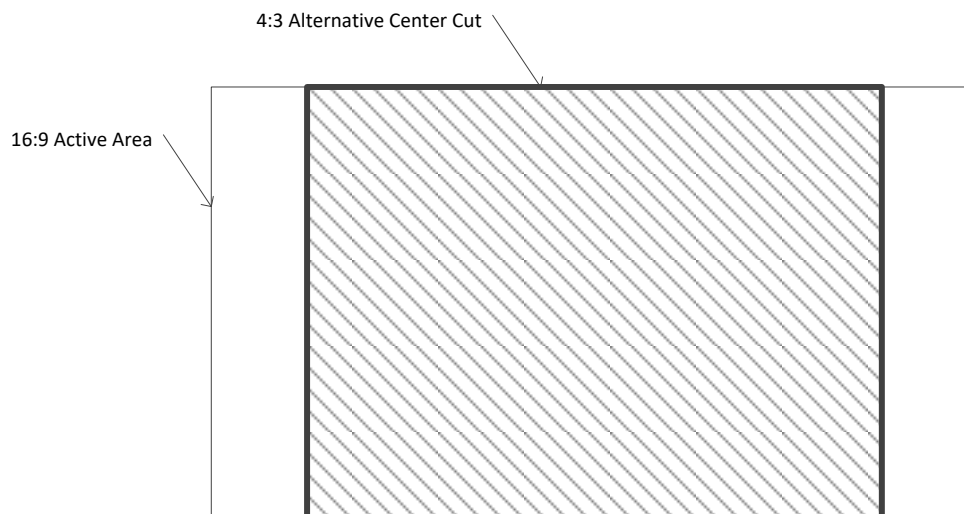

Figure F.1. Alternative Center Cut Example

The presence of an Alternative Center Cut value shall not indicate that a cut is necessary, but merely that a cut is possible.

The presence of more than one Alternative Center Cut values shall indicate that more than one Alternative Center Cut are possible.

When generating an output deliverable from an IMP, an Alternative Center Cut value can be used to generate an AFD word (see SMPTE ST 2016-1) or crop the image to match the aspect ratio of the output. For example, given 16:9 image content associated with a 4:3 Alternative Center Cut value, a processing device can, depending on the downstream delivery requirements, output a 16:9 deliverable that contains an AFD word signaling a 4:3 Center Cut or create a 4:3 center cut deliverable by cropping the 16:9 image.

Table F.2. Alternative Center Cut UL values

Byte No.	Name	Symbol	Value (hex)	Meaning
1-7	See Picture Source Characteristics as specified in SMPTE register (SMPTE ST 400)			
8	Version Number		0Dh	Registry Version at the point of registration of this label
9-12	See Picture Source Characteristics as specified in SMPTE register (SMPTE ST 400)			
13	Alternative Center Cut	AlternativeCenterCut	04h	Rectangular area of specified aspect ratio containing all of the critical action that is (a) centered on the Active Area Rectangle, (b) entirely contained within the Active Area Rectangle and (c) has a height or width equal to that of the Active Area Rectangle.
14	4:3 Alternative Center Cut	CenterCut43	01h	Indicates that the image essence can accommodate an alternative center cut with a 4:3 aspect ratio.
	14:9 Alternative Center Cut	CenterCut149	02h	Indicates that the image essence can accommodate an alternative center cut with a 14:9 aspect ratio.

Annex G   Active Area Rectangle (Normative)

This section specifies additional optional items for the Generic Picture Essence Descriptor (see SMPTE ST 377-1)

The items specified in Table G.1 shall define the Active Area Rectangle.

The Active Area Rectangle shall be the rectangular region which is intended to be visible to the viewer, at the sole discretion of the author. As such the Active Area Rectangle may contain letterboxing or side mattes.

As illustrated in Figure G.1, the coordinates of the Active Area Rectangle are defined relative to the Display Rectangle (see SMPTE ST 377-1).
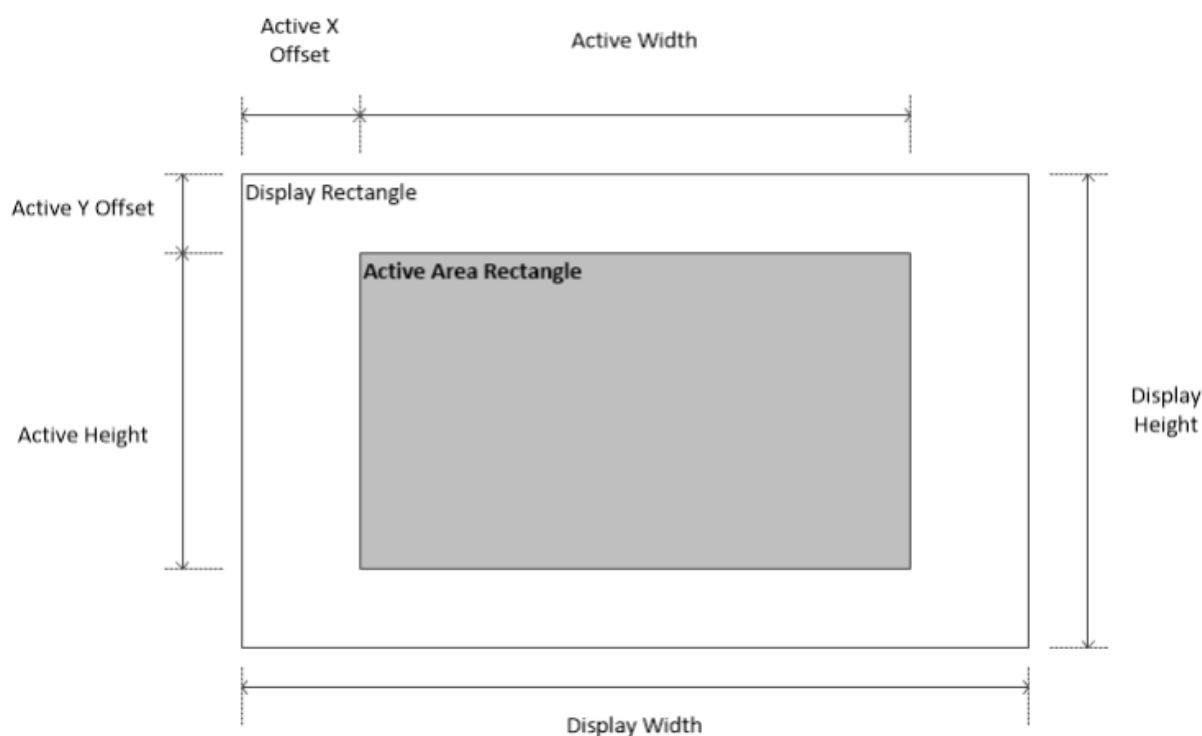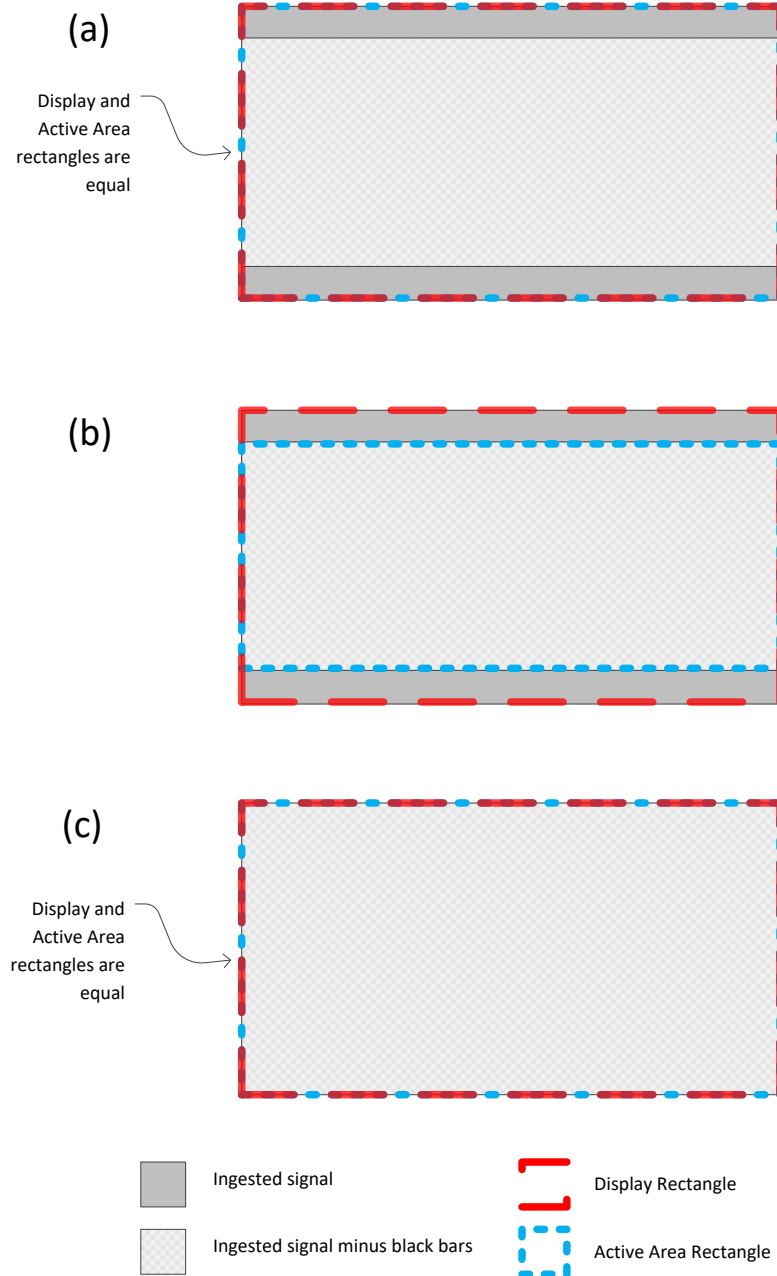

Figure G.1. Active Area Rectangle

The Active Area Rectangle shall be defined by its Width and Height Properties in pixels. These Properties shall default to the same value as the Display Width and Display Height. The Active Rectangle Width and Height values shall be no greater than the Display Width and Display Height values taking into account any Active X Offset and Active Y Offset Property values.

The mapping from the Display Rectangle to the Active Area Rectangle shall be defined by the Active X Offset and Active Y Offset Properties, which give the zero-based coordinates of the Active Area Rectangle relative to the upper left corner of the Display Rectangle. Their values shall not be negative.

Table G.1. Specification of the Active Area Rectangle

Item Name	Item Symbol	Type	Len	Local Tag	Item UL	Req ?	Meaning	Default
Active Height	ActiveHeight	UInt32	4	dyn	06.0E.2B.34 .01.01.01.0 E.04.01.05. 01.13.00.00. 00	Opt	Specifies the height of the Active Area Rectangle.	Display Height
Active Width	ActiveWidth	UInt32	4	dyn	06.0E.2B.34 .01.01.01.0 E.04.01.05. 01.14.00.00. 00	Opt	Specifies the width of the Active Area Rectangle.	Display Width
Active X Offset	ActiveXOffset	UInt32	4	dyn	06.0E.2B.34 .01.01.01.0 E.04.01.05. 01.15.00.00. 00	Opt	Specifies the horizontal offset of the Active Area Rectangle from the left side of the Display Rectangle.	0
Active Y Offset	ActiveYOffset	UInt32	4	dyn	06.0E.2B.34 .01.01.01.0 E.04.01.05. 01.16.00.00. 00	Opt	Specifies the vertical offset of the Active Area Rectangle from the upper side of the Display Rectangle.	0

Figure G.2 illustrates examples of the use of the Active Area Rectangle. For instance, as shown in (a) and (b), two different users may elect to identify different portions of the same image as the Active Area Rectangle.

(a)

Display and
Active Area
rectangles are
equal

(b)

(c)

Display and
Active Area
rectangles are
equal

	Ingested signal		Display Rectangle
	Ingested signal minus black bars		Active Area Rectangle

	a	b	c
Display Rectangle	1920x1080	1920x1080	1920x1080
Active Area Rectangle	1920x1080	1920x800	1920x1080
DisplayHeight	1080	1080	1080
DisplayWidth	1920	1920	1920
ActiveHeight	1080	800	1080
ActiveWidth	1920	1920	1920
ActiveXOffset	0	0	0
ActiveYOffset	0	140	0

Figure G.2. Display Rectangle and Active Area Rectangle Scenarios (Informative)

Annex H   RFC 5646 Language Tag List (Normative)

The following specifies an additional optional item for the Timed Text Descriptor (see SMPTE ST 429-5).

Table H.1 shall define the RFC 5646 Language Tag List item.

The RFC 5646 Language Tag List item specified in Table H.1 shall contain a list of one or more Language Tags (as specified in IETF RFC 5646) using the following syntax.

```
RFC5646LanguageTagList = Language-Tag *( "," Language-Tag )
```

Table H.1. Specification of the RFC 5646 Language Tag List Item

Item Name	Item Symbol	Type	Len	Local Tag	Item UL	Req ?	Meaning
RFC 5646 Language Tag List	RFC5646LanguageTagList	UTF16	Var	dyn	06.0E.2B. 34.01.01. 01.0E.03. 01.01.02. 02.16.00. 00	Opt	Identifies one or more languages as a comma-separated list of RFC 5646 language tags.

Annex I   Packaging and Delivery Examples (Informative)

I.1 Replacement Asset

In this example, an initial Delivery A contains a Complete IMP with a single Composition Playlist B and all referenced Assets. An Asset C in Delivery A is found to be defective, e.g. illegal JPEG 2000 codestream. A Delivery D consisting of the following Assets is created to address this issue:

- Composition Playlist E
- Asset F

Asset F corrects the problems of Asset C but is otherwise identical. Similarly, Composition Playlist E is identical to Composition Playlist B with the following exceptions:

- Asset F is referenced instead of Asset C.
- Id
- IssueDate

Composition Playlist B and Asset C can be removed from the system if desired.

I.2 Original Version (OV) and Version File (VF)

I.2.1   General

Composition Playlist A is targeted at English-speaking audiences, while Composition Playlist B is targeted at Spanish-speaking audiences. Composition Playlist B reuses the image and audio Assets of Composition Playlist A, but introduces additional Spanish audio assets.

A Complete IMP C (the "Original Version") is created with Composition Playlist A and all Assets referenced by Composition Playlist A.

An Incomplete IMP D (the "Version File") is created with Composition Playlist B and all Assets referenced by Composition Playlist B not already included in IMP C.
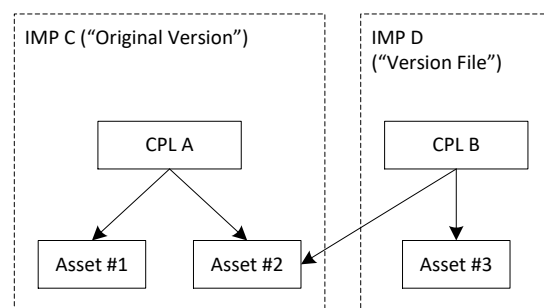

Figure I.1. Original Version and Version File IMP

I.2.2   Scenario #1

A Delivery E containing IMP C is sent to recipients interested in Composition Playlist A.

A Delivery F containing both IMP C and D is sent to recipients interested in Composition Playlist B.
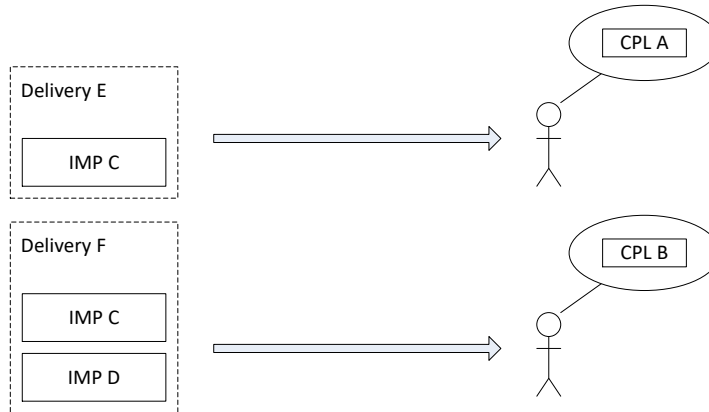

Figure I.2. Version File Single Delivery

I.2.3   Scenario #2

A Delivery E containing IMP C is sent both to recipients interested in Composition Playlist A and to recipients interested in in Composition Playlist B.

A Delivery G containing IMP D only is also sent to recipients interested in Composition Playlist B.
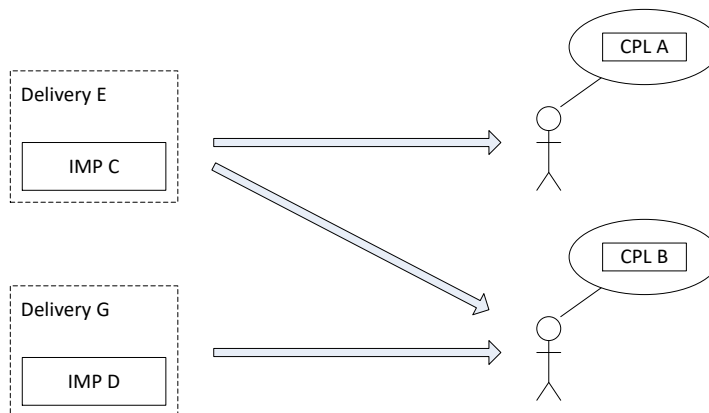

Figure I.3. Version File Dual Delivery

Annex J   IMF Packing List (Normative)

The IMF Packing List document shall be a Packing List document as specified in SMPTE ST 429-8, with the following modifications.

The namespace name http://www.smpte-ra.org/schemas/429-8/2007/PKL shall be replaced with http://www.smpte-ra.org/schemas/2067-2/2016/PKL

The XML schema definition of the Asset element shall conform to Table J.1.

Table J.1. Asset Element XML schema definition

```
<xs:element name="Asset" type="pkl:AssetType"/>
<xs:complexType name="AssetType">
  <xs:sequence>
    <xs:element name="Id" type="pkl:UUID"/>
    <xs:element name="AnnotationText" type="pkl:UserText" minOccurs="0"/>
    <xs:element name="Hash" type="xs:base64Binary"/>
    <xs:element name="Size" type="xs:positiveInteger"/>
    <xs:element name="Type" type="xs:string"/>
    <xs:element name="OriginalFileName" type="pkl:UserText" minOccurs="0"/>
    <xs:element name="HashAlgorithm" type="ds:DigestMethodType"/>
  </xs:sequence>
</xs:complexType>
```

As detailed in W3C XML Signature Syntax and Processing, the algorithm used to compute the value of the Hash element shall be specified by the HashAlgorithm element.

Implementations shall support the algorithms listed in Table J.2.

Table J.2. Hash Algorithms

Algorithm attribute of the HashAlgorithm element	Defining specification
http://www.w3.org/2000/09/xmldsig#sha1	W3C XML Signature Syntax and Processing

Annex K   IMF HTTP Map Profile (Normative)

K.1   General (Informative)

The IMF HTTP Map Profile allows a single Mapped File Set to be retrieved using HTTP or HTTPS.

K.2   Asset Map Location and Encoding

The Asset Map document shall be identified by an absolute-URI that conforms to the following:

- the scheme shall be "`http`" or "`https`"; and

- the last path segment shall be equal to "`ASSETMAP.xml`".

The Asset Map document shall be encoded using the UTF-8 encoding as specified in W3C Extensible Markup Language 1.0

Note 1: The means by which the Asset Map URI is communicated to the recipient of the Mapped File Set is outside the scope of this specification.

Note 2: Fragments and query components in the Asset Map URI are not constrained by this specification.

K.3   Asset Location and Path Constraints

Each Path element of the Asset Map shall be a relative-path reference as specified in RFC 3986. No query or fragment component shall be present.

Each Asset referenced by the Asset Map shall be identified by an absolute-URI constructed by resolving, as specified in RFC 3986, its Path element relative to the Asset Map URI.

Every location traversed by this resolved relative-path reference shall be at the same or deeper hierarchical level than the Asset Map URI.

EXAMPLE: For an Asset Map located at `/foo/ASSETMAP.xml`, the Path element value `bar/../../foo/bar/Image.mxf` is forbidden since the location `bar/../..` is outside the tree rooted at `/foo`.

Each path segment, as specified in IETF RFC 3986, shall consist of characters from the set `a-z`, `A-Z`, `0-9`, "-" (dash), "_" (underscore) and "." (period). No segment shall have more than 128 characters, and the value of the Path element shall not exceed 1024 characters in length.

A Path element value shall have no more than 10 segments.

No two paths in an Asset Map shall have identical values, regardless of case.

Note 1: A relative-path reference cannot begin with a "`/`" character.

Note 2: "`.`" and "`..`" path segments are allowed.

K.4   Retrieving Resources

The resources identified by a URI using the `"http"` or `"https"` schemes shall be retrieved as the response to a `GET` request to the URI.

Note: Authentication can be required to access these resources. Alternatively, Assets can be encrypted and no authentication required. Such mechanisms are outside the scope of this specification.

Bibliography (Informative)

SMPTE ST 334-2:2015, Caption Distribution Packet (CDP) Definition

SMPTE ST 2016-1:2009, Format for Active Format Description and Bar Data

[1] SMPTE RP 2052-10:2012, Conversion from CEA-608 Data to SMPTE-TT

SMPTE RP 2052-11:2013, Conversion from CEA-708 Caption Data to SMPTE-TT

CEA-608-E (ANSI) (2008), Line 21 Data Services

CEA-708-D, Digital Television (DTV) Closed Captioning

Internet Engineering Task Force (IETF) (February 2006). RFC 4246 — International Standard Audiovisual Number (ISAN) URN Definition

Internet Engineering Task Force (IETF) (April 2006). RFC 4452 — The "info" URI Scheme for Information Assets with Identifiers in Public Namespaces

[1] Note: The reference to superseded version of this standards is intentional.