Reaffirmed 2013

SMPTE 394M-2006

SMPTE STANDARD

for Television — Material Exchange Format (MXF) — System Scheme 1 for the MXF Generic Container

1 Scope

This standard specifies the data format for the System Item of the MXF Generic Container (GC) that is called System Scheme 1. This data format is a superset of the System Item defined in SMPTE 385M (Mapping SDTI-CP Essence and Metadata into the MXF Generic Container) and provides a more generic and flexible data structure that can provide system elements for flexible GC wrappings including clip-based wrapping. This document defines the rules that System Elements in the System Item shall follow in order to be classified as a System Scheme 1 System Element.

The MXF Generic Container is the native Essence Container of the Material Exchange Format (MXF) File Body. The MXF Generic Container is defined for the interchange of streamable audio-visual material.

This document defines the data structure at the signal interfaces of networks or storage media. This document does not define internal storage formats for MXF compliant devices.

2 Normative References

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

SMPTE 336M-2001, Television — Data Coding Protocol using Key-Length-Value

SMPTE 377M-2004, Television — Material Exchange Format (MXF) — File Format Specification

SMPTE 379M-2004, Television — Material Exchange Format (MXF) — MXF Generic Container

SMPTE RP 210, Metadata Dictionary Registry of Metadata Element Descriptions

3 Glossary of Acronyms, Terms and Data Types

The general glossary of acronyms, terms and data types used in the MXF specification is given in SMPTE 377M and is supplemented in SMPTE 379M. These are not repeated here to avoid any divergence of meaning.

4 Introduction

The MXF Generic Container is defined in SMPTE 379M. This standard specifies a generic System Item structure that can be used to carry metadata that describes the essence elements in the Content Package. It also describes methods of wrapping the essence and metadata elements as either “Frame Wrapping” or “Clip

Copyright © 2006 by THE SOCIETY OF
MOTION PICTURE AND TELEVISION ENGINEERS
3 Barker Avenue, White Plains, NY 10601
(914) 761-1100

Approved
July 7, 2006

Wrapping". The System Item comprises a number of System Elements. Each of these System Elements contains metadata that is intimately related to essence within the same Content Package. The System Elements are not intended to carry metadata that is to be described in the MXF Header Metadata by a Track, SourceClip or Segment. Neither is it intended to carry metadata that should be carried in a non-Essence Data Partition.

This standard defines a generic scheme for the GC System Item that allows System Elements to be added as required by an application. SMPTE 405M defines metadata elements and individual data items that are compatible with this GC System Scheme 1. SMPTE 389M defines a System Reverse Play Element which is compatible with this GC System Scheme 1.

SMPTE 385M defines how the System Item that is defined in SMPTE 326M (SDTI Content Package Format) can be mapped in a MXF GC System Item. SMPTE 326M is constrained to frame-based wrapping and thus the System Item mapping defined by SMPTE 385M is also limited for frame-based wrapping.

This standard defines a compatible superset of the System Item defined in SMPTE 385M in that it provides a System Item that can be used with all known Generic Container wrappings including clip-wrapping. Figure 1 illustrates the use of the System Item in a Content Package.

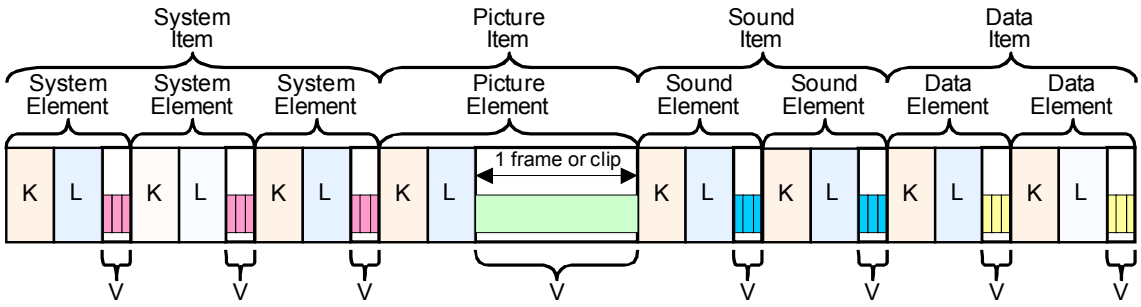

Figure 1 – Illustration of a GC System Item in a Content Package

In clip wrapping, one or more contiguous essence frames may be wrapped within a single GC Essence Element in a GC Essence Item. Any GC System Element must be capable of carrying any stream metadata that is associated with an Essence Element in a Content Package. Some stream metadata is present on a "per frame basis" and this needs to be mapped into a GC System Element as a vector of values corresponding to the vector of frames within a GC Essence Element.

Because the System Scheme defined in this standard provides compatibility with SMPTE 385M, any elements that can be used in SMPTE 385M can also be used in the System Item defined in this standard. However, this System Scheme cannot generally be used where compatibility with SMPTE 326M is required.

The System Item defined in SMPTE 379M comprises a contiguous sequence of up to 127 KLV coded System Elements as illustrated in Figure 2. As in SMPTE 379M, for each Content Package, every System Element comprises metadata or control data that is intimately related to the Essence Elements within the same Content Package.

As in SMPTE 379M, each System Element may be coded as a Fixed-length Pack, a Variable-length Pack or a Local Set according to SMPTE 336M.

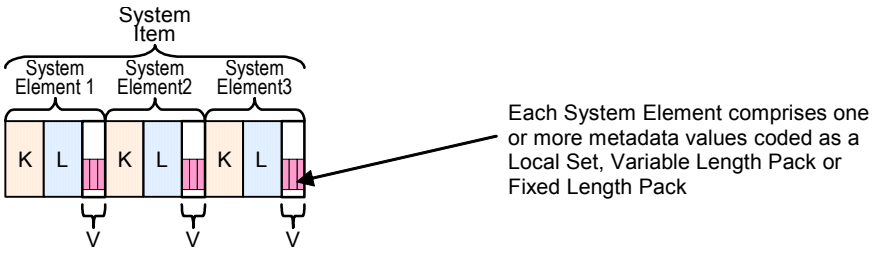

Figure 2 – Example of a GC System Item as a Sequence of Metadata Elements

5 GC System Scheme-1 Definitions

GC System Scheme 1 shall comprise the following System Element types as defined in Table 1.

Table 1 – Specification of the Elements in the GC System Scheme 1

Element Identifier	Element Name	Element Description
01h	First Element	A System Element coded as a local set that contains metadata pertaining to the Content Package as a whole and is the first element in the System Item
02h	Subsequent Element	A System Element coded as a local set that contains metadata pertaining to the Content Package as a whole and is not the first element in the System Item
03h	Picture Item Descriptor	A System Element coded as a local set that contains metadata pertaining to any Picture Element in the Picture Item of the Content Package
04h	Sound Item Descriptor	A System Element coded as a local set that contains metadata pertaining to any Sound Element in the Sound Item of the Content Package
05h	Data Item Descriptor	A System Element coded as a local set that contains metadata pertaining to any Data Element in the Data Item of the Content Package
06h	Control Data Set	A System Element coded as a local set that contains control data pertaining to the Content Package
07h	Compound Item Descriptor	A set that contains metadata pertaining to any essence element in the Compound Item of the Content Package
08h – 0Fh	Reserved	Reserved
10h – 7Fh	Pack coded System Elements	A System Element coded as a SMPTE 336M compliant pack

The Element Identifier value shall be used as the value of byte 15 of the Set Key as defined in Table 2.

Within any GC System Scheme 1 compliant System Item:

- The System Item shall start with a System Element of type “First Element”.
- There shall be exactly one instance of a System Element of type “First Element”.
- There may be zero or more instances of the other system elements as required.
- The total number of instances of System Elements shall not exceed the maximum defined in SMPTE 379M.

Other System Elements not explicitly defined in Table 1 may be individually added by the creation of a separate document that normatively references this standard.

5.1 Set Keys

The Key of a System Element shall be as defined in Table 2.

Table 2 – Specifications of the Set Key for the System Elements

Byte No.	Description	Value (hex)	Meaning
1~12	As defined in SMPTE 379M, Table 1		See SMPTE 379M, Table 1
13	Item Type Identifier	14h	GC-Compatible System Item
14	System Scheme Identifier	02h	GC System Scheme 1
15	Metadata or Control Element Identifier	Table 1	As defined by Table 1 or by a separate document
16	Element Number	xxh	Unique Element Instance Number (Always 00h for the First Content Package Descriptor element)

The KLV coded System Element of type “First Element” shall have a KLV set key as defined in Table 2; it may have a KLV Length field with the value 0, and hence the KLV Value field may be absent.

Each and every System Element of type “First Element” shall be of fixed length for a given Essence Container (of a given BodySID value).

INFORMATIVE NOTE – Since the System Item, where present, is the first Item in a Content Package, this allows decoders to identify an unambiguous starting point of the Content Package.

Byte 16 shall be used to define the value of the Element Number in the range 00h~7Fh. The System Element of type “First Element” shall use the reserved value of “00h”. For all other instances of an element, the value shall be set by the encoder to be unique amongst all the elements in a System Item. This value shall be constant for a given System Element within an Essence Container. The use of this byte is only to identify System Elements between Content Packages within an Essence Container (of a given BodySID value).

INFORMATIVE NOTE – The unique element number allows multiple audio tracks to have several instances of a System Element containing metadata for each audio track, one for each sound track. Each instance of the Sound Item Descriptor will have a different Key for ease of identification and will include an Essence Track Number to link to the individual sound track that it describes.

All System Elements which employ local set encoding shall be coded using 2-byte local tags and either 2-byte or 4-byte lengths. Byte 6 of the set Key shall have the respective values of ‘53h’ and ‘73h’ as defined by SMPTE 336M. The tag values used shall be defined by the appropriate System Element specification document.

The tag values have only the scope of the Content Package and shall be neither entered nor looked up in the Header Metadata Primer Pack. The tag values shall be universally unique and either defined in SMPTE 405M or informatively copied into SMPTE 405M from the defining document.

INFORMATIVE NOTE – 2-byte lengths are typically used with frame-wrapping and 4-byte length with clip-wrapping. However, decoders must be prepared to decode whichever length is indicated in byte 6 of the Key.

5.2 Element Values

A System Element of type “First Element” or “Subsequent Element” shall relate to the Content Package as a whole. Pack coded System Elements shall specify their scope.

All other GC System Scheme 1 Elements may optionally be linked to a specific Essence Element within the Content Package. The Essence Track Number within the System Element shall match the 32-bit value comprising bytes 13,14,15 and 16 of the linked Essence Element Key. This linking value, or batch of linking values, shall be included in the appropriate System Element Value field to establish the link. If no linking values are present in the System Element then, by default, the System Element describes all essence elements of the associated type (e.g. Picture, Sound, Data, etc).

NOTE – This link value is identical to the essence track number as defined in SMPTE 379M, but has only the scope of the essence in the Content Package within which it resides. It has no relationship to the Header Metadata ‘Track Number’ property in SMPTE 377M.

Most (but not all) of the individual items within the System Element sets or pack may be characterized as follows:

- Those that define a single value which describes some aspect of the Essence Element in frame-wrapping mode or,
- Those that define a single value which describes some aspect of the content in clip-wrapping mode or,
- Those that define a multiple value which describe some aspect of each frame of the content in clip-wrapping mode. These multiple values will typically be arrays so that the sequence of values in the array will relate to the sequence of frames in the clip.

Those individual items that define multiple values for use in clip-wrapping mode shall constrain the first value in the System Element to describe the first frame of the KLV wrapped Essence Element. Each subsequent value in the System Element shall relate to the next frame in the Essence Element. The number of values in the System Element will typically be equal to the number of frames in the Essence Element. The number of values in the System Element shall not exceed the number of frames in the Essence Element. However, the number of values in the System Element may be less than the number of frames in the Essence Element

INFORMATIVE NOTE – Individual data items that may be used in this standard are defined or listed in SMPTE 405M.

Annex A (Informative)
Use of System Item Metadata

Within an MXF file, there are four potential locations for metadata (in order of preference):

- As part of the Header Metadata.
- As a separate data stream component in an MXF file.
- Intimately associated with the essence via the System Item of a Content Package, as defined in this standard.
- Embedded within the essence stream itself. Common examples are VITC (Vertical Interval Time Code) and AES-3 channel status data.

The order of priority of metadata use is subject to many constraints, but the following text provides some guidance.

As a rule, metadata is best placed in the Header Metadata wherever possible since that provides the greatest accessibility for all MXF readers. However, there are some limitations such as metadata size (limited to 64 kB) and mapping constraints in live file creation.

Bulky metadata, such as a stream of time-code, can be extracted from the Essence Container and placed in an MXF file as a data stream. This offers ease of access that is slightly less than that provided by the Header Metadata, but is more accessible than parsing the contents of the Essence Container.

Metadata that is created at the time of content creation may be presented as a live stream of audio-visual content. In this situation, metadata may be created at the same time as the audio-visual content, and, in this case, it is necessary to embed the metadata with the essence. This can be done by the traditional method of embedding in the essence stream itself, as with VITC, AES-3 Channel Status metadata and other, similar, examples, or by using the System Item. Both these methods of metadata carriage provide less access to the metadata than in a file environment. On the other hand, they are perfectly suited to live content creation that precedes the instantiation of a file.

Thus, System Item metadata and control data is intended only for that which is intimately associated with the content. Typical examples of the use of the System Item for the carriage of metadata are:

- Time Code, as created by the content creation device. This could be a copy of the VITC or a single representation of the equivalent of VITC.

- Extended UMID (as defined by SMPTE 330M) that can be added by a device such as a camera enabled with a Global Positioning System (GPS) receiver that associates each picture with a source pack comprising the date and time of content creation, the GPS coordinates and the owner of the camera. The use of the metadata link mechanism in this GC System-1 scheme allows multiple UMIDs to be created, such as may be used in sports, where the microphone and camera locations may be different and may provide different UMID values according to the devices used to create the content yet may be combined into one audio-visual stream for a contribution feed over a telco or satellite link.

- The frame rate of the essence stream for those data streams that do not have another form of synchronization such as an SDI/SDTI interface. This is useful for network transfers of the essence stream where the basic picture rate is not known.

The summary of this brief introduction is that metadata in the System Item should only incorporate that metadata which is intimately linked to the content, most likely during the creation of live content. Metadata in the System Item is better than metadata embedded within the essence stream, but is not intended as a replacement for the more easily accessed locations of the MXF Header Metadata area and the data stream. In general, originating data may be copied to higher, more accessible layers. Systems that use this metadata should use the highest layer for ease of access and only use the lower layers whenever specific access is required; for example, to copy a change of metadata from a higher layer through to lower layers to maintain data integrity.

An example of the use of this System Item is where the essence source has an extended UMID embedded in its System Item, as may occur in camcorders that provide GPS capability. The sequence of extended UMID values is typically too large to copy into the Header Metadata where the 64 kB limit would restrict the useable essence length to only a few minutes. In this case, the extended UMID may be extracted to a data stream for ease of access by decoders.

Annex B (Informative)
Bibliography

ANSI/SMPTE 298M-1997, Television — Universal Labels for Unique Identification of Digital Data

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

SMPTE 385M-2004, Television — Material Exchange Format (MXF) — Mapping SDTI-CP Essence and Metadata into the MXF Generic Container

SMPTE 389M-2005, Television — Material Exchange Format (MXF) — MXF Generic Container Reverse Play System Element

SMPTE 405M-2006, Television — Material Exchange Format (MXF) — Elements and Individual Data Items for the MXF Generic Container System Scheme 1

SMPTE EG 41-2004, Television — Material Exchange Format (MXF) — Engineering Guideline

SMPTE Journal, Vol. 109, No 3, March 2000, pp. 205-210, "A Tutorial on SDTI-CP"