

SMPTE ENGINEERING GUIDELINE

Material Exchange Format (MXF) — MXF Descriptive Metadata



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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.

SMPTE EG 42 was prepared by Technology Committee 31FS.

Introduction

This guideline is entirely informative and intended to provide guidance for implementing descriptive metadata within the header metadata of an MXF file SMPTE ST 377-1. This guideline supplements the MXF Engineering Guideline SMPTE EG 377-3.

This guideline is divided into a number of core sections, each section describing a particular aspect of descriptive metadata. The sections (together with their section number) are as follows:

This introduction including the usage of descriptive metadata and user requirements for descriptive metadata.

Section 4: The mechanisms by which descriptive metadata in the MXF header metadata can be linked to the essence in the MXF essence container.

Section 5: How to implement descriptive metadata as a sequence of KLV packets in the MXF header metadata and as XML for text-based interfacing.

Section 6: Guidance for implementing both MXF descriptive metadata and non-MXF descriptive metadata.

Section 7: Considerations for handling descriptive metadata in special operational circumstances.

Annex A: Provides a discussion of metadata characteristics.

Annex B: Provides an introduction to data modeling techniques.

Annex C: Provides an example of the options for XML coding.

Annex D: Bibliography

Dimensions of Descriptive Metadata Use

In general terms, the use of descriptive metadata has many dimensions as follows:

1. It is in widespread use within different content-based industries, including broadcast, film, music and web authoring.
2. It is in widespread use within different content-based applications, including capture/creation, production, post-production and archive/libraries.

3. It can be divided into several different broad categories including business transactions, publication information, content identification and labeling, compositional information and formatting, etc.
4. It can have different states such as being static for a defined duration, being dynamic (with several kinds of dynamic states including transitory, metronomic, incrementing and so on).
5. It can have different levels of stability with elements having durable values that remain stable or transient values that frequently change.

In the header metadata of an MXF file, the metadata is persisted and can be distributed over many copies. Thus descriptive metadata in an MXF file ought to include only that metadata which can be considered copy persistent. This does not mean that a value can never change between copies, but that, once written, individual copies will have to be edited where changes are required. For some types of metadata, this is not only acceptable, but encouraged, e.g. a property that defines the number of copies made.

One of the primary aims of this document is to identify that metadata which can be used to enhance the description of the content in a file. Metadata that is appropriate for use in databases is not considered in this guideline. Annex A describes metadata characteristics that can aid the reader to understand the attributes of different kinds of metadata items.

User Requirements for Descriptive Metadata

Many major content production facilities have custom methods for handling the descriptive metadata associated with the content. As audio-visual content exchange moves from tape-based to file-based operations, the opportunity arises to be able to both embed descriptive metadata in the file and to provide an intimate relationship between the metadata and the audio-visual content. This process allows metadata to be accrued within a file as it passes between operations in a way that has rarely before been achieved. Many users see the ability to embed metadata into an MXF file as a key requirement that extends the use of MXF beyond that primarily for the simple exchange of audio-visual content.

1 Scope

The MXF standard SMPTE ST 377-1 provides for descriptive metadata schemes as “plug-ins” to the MXF header metadata. This guideline is intended to provide guidance for the use of MXF descriptive metadata schemes. This guideline is a supplement to SMPTE EG 377-3.

This guideline explains the common structural metadata components by which all MXF descriptive metadata schemes can be related to the essence they describe. Additional constraints required for MXF descriptive metadata schemes are also described.

This guideline describes how MXF descriptive metadata is related to the essence using the structural metadata defined in SMPTE ST 377-1. It also describes how MXF descriptive metadata is coded as KLV data for use in MXF files and as XML for text-based metadata exchange. This guideline also provides guidance for implementing MXF descriptive metadata schemes.

Descriptive metadata is a complex topic and requires at least some basic understandings of the various attributes of descriptive metadata together with data modeling techniques. This guideline provides annexes that summarize these topics.

2 References

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 336:2007) although, during a transitional phase, the document as published (printed or PDF) may bear an older designation (such as SMPTE 336M-2007). Documents with the same root number (e.g. 336) and publication year (e.g. 2007) are functionally identical.

The following documents contain information used in this guideline. At the time of publication, the editions indicated were valid. All standards are subject to revision, and readers of this guideline are encouraged to investigate the possibility of applying the most recent edition of the documents indicated below.

SMPTE ST 298:2009, Universal Labels for Unique Identification of Digital Data

SMPTE ST 336:2007, Data Encoding Protocol Using Key-Length-Value

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

Amendment 1:2012 to SMPTE ST 377-1:2011

Amendment 2:2012 to SMPTE ST 377-1:2011

SMPTE ST 400:2012, SMPTE Labels Structure

SMPTE EG 377-3:2013, Material Exchange Format (MXF) — Engineering Guideline

3 Glossary of Acronyms, Terms and Data Types

The full glossary of acronyms, terms and data types used in the MXF specification is given in the MXF file format specification. It is not repeated here to avoid any divergence of meaning.

3.1 Acronyms

DM: Descriptive Metadata

DMS: Descriptive Metadata Scheme

HTML: Hyper-text Markup Language

MXF: Material exchange Format

O-O: Object Oriented

UML: Unified Modeling Language

XML: eXtensible Markup Language (text-based data coding)

3.2 Terms

Element: An atomic constituent of a data model.

Property: A named value denoting the characteristics of an element.

4 Relating Descriptive Metadata to Essence

The MXF structural header metadata describes the audio-visual content divided into individual essence tracks. Thus each track has associated with it a descriptor of the essence, where each property of that descriptor is static for that track duration. In MXF, each track can be divided into one or more segments, where each segment comprises a link to the appropriate segment of essence in the MXF essence container. This applies whether or not the essence is embedded in the file body. The same principles also apply to descriptive metadata tracks.

The MXF format specification SMPTE ST 377-1 defines the descriptive metadata plug-in mechanism together with the generic set keys for descriptive metadata sets (including any abstract sets) and a generic universal label for identification of a given DM scheme. It also includes a standardized mechanism to link descriptive metadata to any individual essence track, a defined group of essence tracks or all the essence tracks. This mechanism also defines the start and stop points along the essence track(s) where the descriptive metadata applies.

4.1 MXF Descriptive Metadata

SMPTE ST 377-1 defines DM tracks to describe the content of the essence in the essence container. Additional objects include a “DM segment” that defines a descriptive metadata track that can be used to describe the essence tracks and a “DM source clip” that can be used to link to either a real metadata track in the essence container or to a descriptive metadata track in the header metadata.

Note: Examples of a metadata track within the essence container are defined in the system item of the SDTI-CP specifications SMPTE ST 326 and SMPTE ST 331.

4.2 DM Tracks

Descriptive metadata tracks can be timeline, event or static. SMPTE ST 377-1 defines the use of these track types for descriptive metadata, which is summarized in the following sub-sections:

4.2.1 Timeline track

There can be multiple DM segments on a timeline track and the sum of the segments will equal the total track length. Thus adjacent segments of descriptive metadata will be butt-joined together and leave no gaps. It is perfectly valid to have a timeline track with a single DM segment, which occupies the whole track duration.

A timeline descriptive metadata track would be used to support metadata that is effectively timed along the track in a piecewise linear manner.

4.2.2 Event track

There can be multiple DM segments on an event track and the segments are unconstrained along the time axis. Thus adjacent segments can overlap or they can leave gaps where no descriptive metadata applies.

This kind of descriptive metadata track allows the greatest flexibility (and hence the greatest complexity) as illustrated in Figure 1.

4.2.3 Static track

If the DM track is a static type, then it has no timeline and all DM segments apply descriptive metadata to the entire duration of the linked essence track(s). There can be multiple DM segments that link to different essence tracks, but all DM segments in a static track describe the contents of the entire track duration. This is a special case of using descriptive metadata and applies to those kinds of descriptive metadata that have an inherently static value for the duration of the essence.

Descriptive metadata on a static track cannot be accessed directly if the essence has a timeline. In this case, the material package would access the static descriptive metadata in a source package using a DM source clip on a timeline or event track. This is analogous to sourcing a JPEG still image on a static track in a source package from a timeline track in the material package. Accessing metadata tracks through the DM source clip mechanism is explained in the next section.

If the descriptive metadata describes a static essence element such as a coded still picture (e.g. JPEG), then a static track would be used.

4.3 Using DM Segments

MXF provides for metadata tracks that logically run in parallel with the essence tracks. In effect, this adds tracks where metadata can be defined that links to one or more frames of one or more essence tracks. Note that MXF uses the same concept for the time-code track with the constraint that the time-code track always defines the time for all the other essence tracks.

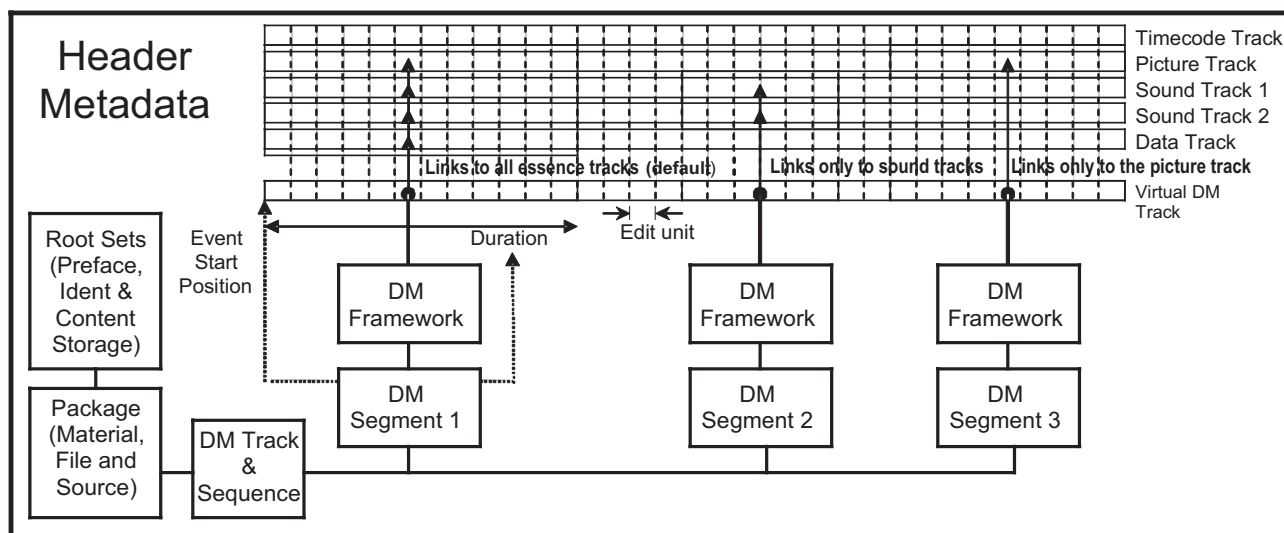


Figure 1 – Descriptive metadata track segments and their relationship to the content of an MXF essence container

Figure 1 illustrates that DM segment 1 is linking the metadata framework(s) of this segment to all the essence tracks of the first part of the A/V content (excluding the time-code track). DM segment 2 is linking the metadata framework(s) of this segment to only the middle part of the sound tracks. DM segment 3 is linking the metadata framework(s) to only the last part of the picture track (excluding the time-code track).

4.3.1 Summary of operation

The description above is of the plug-in mechanism defined in the MXF format. It can be summarized as follows:

1. The structural metadata provides a DM track that has a sequence. That sequence has one or more DM segments. Each DM segment defines the start and duration of the DM as well as identifying which essence tracks this DM segment describes.
2. The DM segment also provides a strong reference to a DM framework so that it can 'own' the DM framework.
3. This strong reference is the point at which the plug-in operates.

Note: The start and duration properties in the DM segment mentioned above will depend on the track kind as described above. For example, in a timeline track, the start point of each DM segment is not required because the segments are contiguous.

4.4 Using DM Source Clips

MXF also provides for sourcing from descriptive metadata tracks that symbolically run in parallel with the essence tracks. A common application of the use of DM source clips in the material package to access DM segments in the source package. In common with essence source clips, DM source clips use only a timeline track and are not supported for use in event tracks or static tracks.

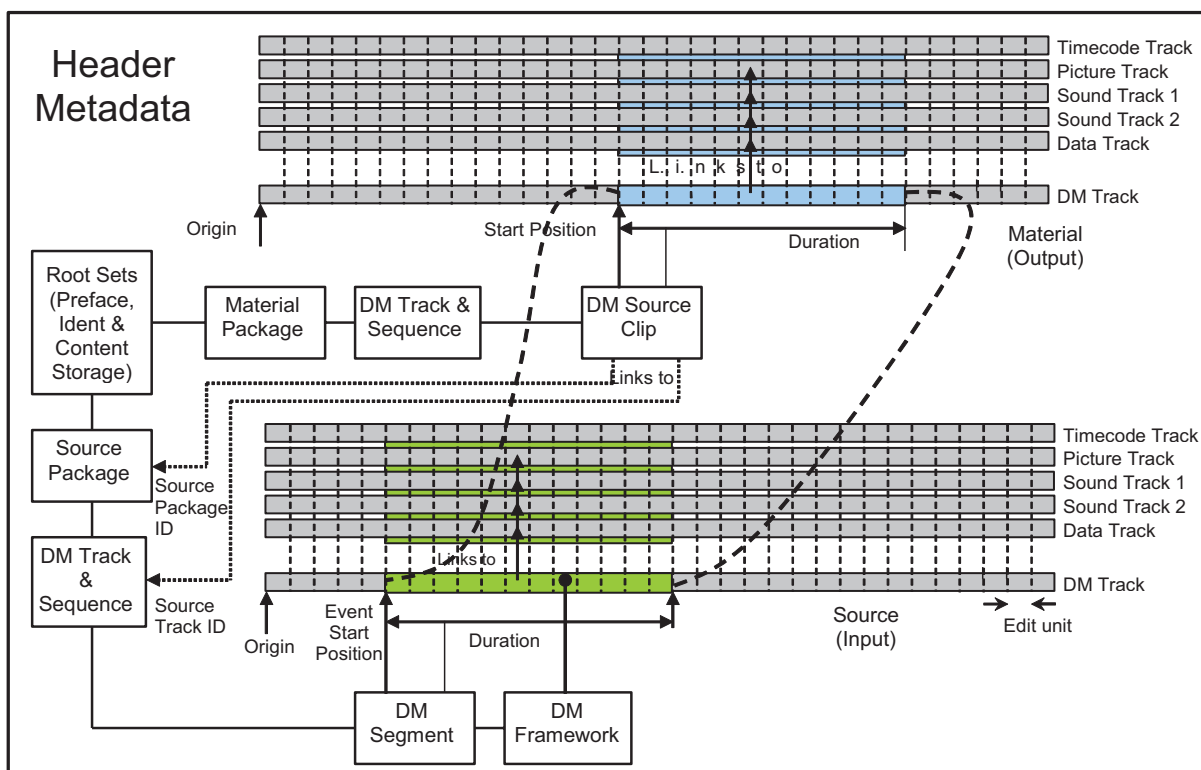


Figure 2 – Descriptive metadata track source clips and their relationship to the content of an MXF essence container

Figure 2 illustrates that the segment of a descriptive metadata track in a source package links the metadata framework to the segment of the essence tracks of the A/V content in the essence container (excluding the time-code track). The source clip of the descriptive metadata track in the material package then references the DM track in the source package and links it to the A/V content in the playout timeline. This referencing removes the need to duplicate the DM framework in the source package.

Furthermore, if the essence container includes a timeline metadata track (such as a system item in SDTI-CP) then the DM source clip could be used to reference the track ID of the timeline metadata track.

Note that if the clip is from the current package, the SourcePackageID has the value of the current PackageID.

4.5 Identification through the UL

The MXF format provides the template for a SMPTE label (as defined by SMPTE ST 400) to identify the DM scheme in use. This is recorded in the preface set of the structural metadata so that decoders have an early warning that descriptive metadata exists and to understand whether it is a recognized scheme. Individual label values are defined in the SMPTE Labels register, SMPTE RP 224 which is freely available on the SMPTE RA website at: <http://kws.smpite-ra.org/mdd/index.html>.

4.5.1 Identification of MXF descriptive metadata schemes

MXF DM schemes are those standardized schemes which use the plug-in mechanism provided by SMPTE ST 377-1 as described above. MXF DM schemes are designed within a known set of constraints, as described in section 8. The MXF format specification provides the template for the UL (or ULs) that identifies the scheme in use and the values for bytes 13~16 are publicly registered in order that the decoder can know the scheme. Every decoder will know that the scheme is public because bytes 1~12 are fixed for all MXF DM schemes. However, a decoder response to the descriptive metadata will depend on whether it understands the particular scheme identified.

Each set that implements any MXF DM scheme has bytes 1~12 of the set key defined by the MXF format specification. Byte 13 of every such key is defined to have the same value as that in byte 13 of the UL that identifies the scheme hence multiple MXF DM schemes can be accommodated in the MXF header metadata area.

4.5.2 Identification of non-MXF descriptive metadata schemes

Non-MXF descriptive metadata schemes are those schemes, which use ULs and keys other than those defined by the MXF format specification. The UL for such schemes differ in bytes 1~12 in order that they are recognizably non-MXF schemes. Furthermore, the keys used all differ from those defined for MXF DM schemes.

4.6 Using Multiple DM Schemes

A given DM scheme can provide for different DM frameworks each of which requires a different DM track kind. For example, DMS-1 defined in SMPTE ST 380 has three frameworks requiring the use of a static track, a timeline track and an event track due to the different characteristics of each DM framework.

There can also be occasions when a file includes more than one DM scheme; perhaps as a result of file editing or other operations that mix essence tracks in a file. Such files can end up with a mixture of different DM schemes. To avoid decoder confusion or worse, encoders need to ensure that each DM track is unique to each DM framework in a file, thereby ensuring that each DM track contains the contents from one DM framework only. Collating different DM schemes onto the same DM tracks in a file could cause decoder confusion, a failure to respond to one of the schemes or worse.

If an editing operation combines essence tracks from two or more sources, then the associated DM tracks might also need to be combined. In such a case, the combining process will depend on the nature of the DM