

# SMPTE ENGINEERING GUIDELINE

for Television —

## Material Exchange Format (MXF) — MXF Descriptive Metadata



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### 1 Scope

The MXF standard (SMPTE 377M) 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 41.

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 377M. 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 further provides guidelines 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 Normative references

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

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

SMPTE 336M-2001, Television — Data Encoding Protocol Using KLV.

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

SMPTE EG 41-2004, Television — 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

**AAF:** Advanced Authoring Format ([www.aafassociation.org](http://www.aafassociation.org))  
**DM:** Descriptive Metadata  
**DMS:** Descriptive Metadata Scheme  
**HTML:** Hyper-text Markup Language  
**ISO:** International Standards Organization  
**IP:** Intellectual Property (as used in rights management)  
**O-O:** Object Oriented  
**TFHS:** Task Force for the Harmonization of Standards (Bibliography)  
**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.  
**Attribute:** A named property of a classifier that describes a range of values that instances of a property may hold.  
**Entity:** An entity is an abstract term that can mean a single data element, a set of data elements or a higher construct.

### 3.3 Data types

None.

## 4 Introduction

This guideline is intended to provide guidance for implementing descriptive metadata within the header metadata of an MXF file (SMPTE 377M). This guideline supplements the MXF Engineering Guideline (SMPTE EG 41).

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:

1. Section 4: This introduction, including the usage of descriptive metadata and a catalogue of user requirements for descriptive metadata.
2. Section 5: The mechanisms by which descriptive metadata in the MXF header metadata may be linked to the essence in the MXF essence container.
3. Section 6: A description of the issues related to implementing a descriptive metadata model from the perspective of both MXF and AAF.
4. Section 7: How to implement descriptive metadata as a sequence of KLV packets in the MXF header metadata and as XML for text-based interfacing.
5. Section 8: Guidance for implementing both MXF descriptive metadata and non-MXF descriptive metadata.
6. Annex A: Provides a discussion of metadata characteristics.
7. Annex B: Provides an introduction to data modelling techniques.
8. Annex C: Provides an example of the options for XML coding.
9. Annex D: Bibliography of useful reading.

#### 4.1 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 in 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 labelling, compositional information and formatting, etc.
4. It may have different states such as being static for a defined duration, being dynamic (with several kinds of dynamic including transitory, metronomic, incrementing and so on).
5. It may have different levels of stability with elements having durable values that remain stable or transient values that may frequently change.

In the header metadata of an MXF file, the metadata is persisted and may be distributed over many copies. Thus descriptive metadata in an MXF file should 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 must 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 part of this guideline. Annex A describes metadata characteristics that may aid the reader to understand the attributes of different kinds of metadata items.

## 4.2 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. As a result of this desire, a list of user requirements for descriptive metadata has been developed as below.

SMPTE EG 41 (MXF Engineering Guideline) gives a table of user requirements for file formats as developed by the EBU. Although not all entries are valid for descriptive metadata, the following may apply:

NOTE – The following priorities were assigned:

A = Baseline ("Must"), B = Enhanced ("Can"), C = Extended ("May") U = Undecided or not determined, X = not allowed (should not be allowed).

**Table 1 – User requirements table for descriptive metadata**

| Priority      | User Requirement                                                                                              | Publication (Emission, Transmission, Store & Forward, etc.) | Content Repository                        | Finished Interchange | Authoring Interchange |
|---------------|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------|----------------------|-----------------------|
| <b>A List</b> |                                                                                                               |                                                             |                                           |                      |                       |
| A++           | Must be easy to understand & apply and standardized                                                           | Y                                                           | Y                                         | Y                    | Not easy              |
|               | Low implementation overhead                                                                                   | Y                                                           | E.g. Could be complex if editing required | Y                    | No                    |
| A             | Must be open (as per ITU definition)                                                                          | Y                                                           | Y                                         | Y                    | Y                     |
| A             | Must provide Identification of the metadata scheme                                                            | Y                                                           | Y                                         | Y                    | Y                     |
| A             | Must provide for normative templates                                                                          | Y                                                           | Y                                         | Y                    | Y                     |
| A             | Must be extensible in header and body (by KLV coding?)<br>(E.g. from one frame to many frames)                | Y                                                           | Y                                         | Y                    | Y                     |
| A             | Scalability (small file/single frame to large file)                                                           | Y                                                           | Y                                         | Y                    | Y                     |
| A             | Must provide synchronization for multiple essence types<br>e.g. Audio/Video/Data Essence and certain Metadata | Y                                                           | Y                                         | Y                    | Y                     |
| A             | Must be usable on major platforms/OSs                                                                         | Y                                                           | Y                                         | Y                    | Y                     |
| A             | Must be application independent                                                                               | Y                                                           | Y                                         | Y                    | Y                     |
| A             | Must be transport and storage mechanism independent                                                           | Y                                                           | Y                                         | Y                    | Y                     |
| A             | Simple and complex template (backward-forward compatibility?)                                                 | Y<br>simple                                                 | Y<br>Both                                 | Y<br>simple          | Y<br>complex          |

| Priority        | User Requirement                                                                                                                                                              | Publication (Emission, Transmission, Store & Forward, etc.) | Content Repository | Finished Interchange | Authoring Interchange |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|--------------------|----------------------|-----------------------|
| A               | Extensibility to include non-predefined data (e.g. dark Metadata)                                                                                                             | Undesirable                                                 | Undesirable        | Undesirable          | Y                     |
| <b>B List</b>   |                                                                                                                                                                               |                                                             |                    |                      |                       |
| B               | Link Metadata to structural composition information                                                                                                                           | N                                                           | Y                  | Maybe                | Y                     |
| B               | Can accommodate a range of GoPs (e.g. MPEG)                                                                                                                                   | Y                                                           | Y                  | Y                    | Y                     |
| B               | Assignable granularity of Metadata (field, frame/clip/file)                                                                                                                   | Y                                                           | Y                  | Y                    | Y                     |
| <b>C List</b>   |                                                                                                                                                                               |                                                             |                    |                      |                       |
| C               | Extensible for internet. Metadata as binary and text format                                                                                                                   | Y                                                           | Y                  | Y                    | Y                     |
| C               | Allow externally referenced essence files for certain applications such as Archiving. A proper standardisation/documentation is prerequisite if external references are used. | N                                                           | Undesirable        | N                    | Y                     |
| <b>X/U List</b> |                                                                                                                                                                               |                                                             |                    |                      |                       |
| X               | Allow proprietary vendor created templates                                                                                                                                    | ?                                                           | ?                  | ?                    | Maybe                 |

## 5 Relating descriptive metadata to essence

The MXF format specification includes a standardized mechanism to link descriptive metadata to any individual essence track, a defined group of essence tracks or all the essence tracks. Furthermore, this mechanism defines the start and stop points along the essence track(s) where the descriptive metadata applies.

### 5.1 Provisions of the MXF structural metadata

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. All the descriptors defined so far are file descriptors. In MXF, each track may 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 apply for descriptive metadata tracks.

MXF has extended the AAF object model to introduce descriptive metadata tracks that can be used to describe the content of 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 326M and SMPTE 331M).

## 5.2 DM tracks

Descriptive metadata tracks may be timeline, event or static. The MXF format standard defines the use of these track types for descriptive metadata. This use is summarized as follows:

### 5.2.1 Timeline track

There may be multiple DM segments on a timeline track and the sum of the segments must 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 one 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.

### 5.2.2 Event track

There may be multiple DM segments on an event track and the segments are unconstrained along the time axis. Thus adjacent segments may overlap or they may leave gaps where no descriptive metadata applies. This is the default kind of descriptive metadata track and allows the greatest flexibility as illustrated in Figure 1.

### 5.2.3 Static track

If the 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 are inherently static 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 is describing a static essence element such as JPEG, then a static track would be used.

## 5.3 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 timecode track with the exception that the time-code track always defines the time for all the other essence tracks.

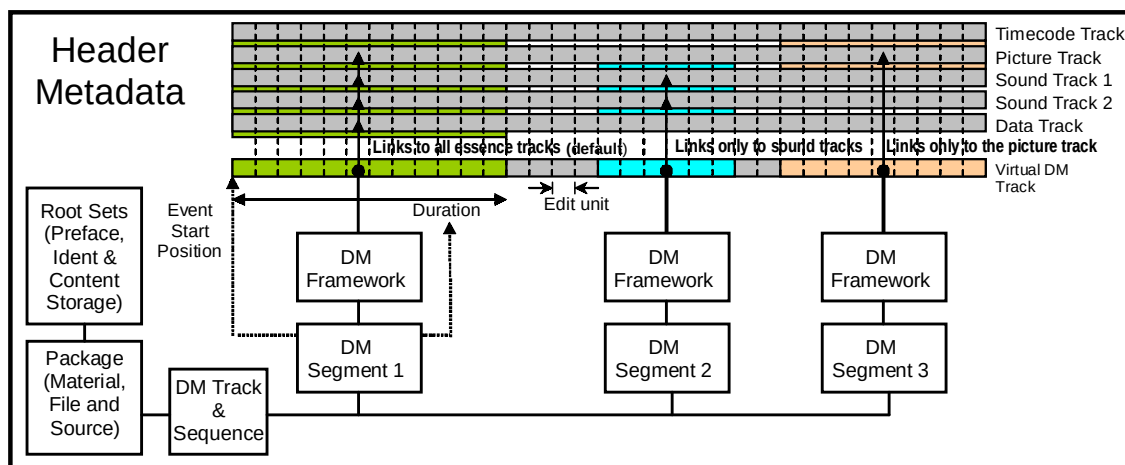


**Figure 1 – Descriptive metadata track segments and their relationship to the content of an MXF essence container**

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).

### 5.3.1 Summary of operation

The description above is of the plug-in mechanism used 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.

### 5.4 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 must use only a timeline track and are not supported for use in event tracks or static tracks.

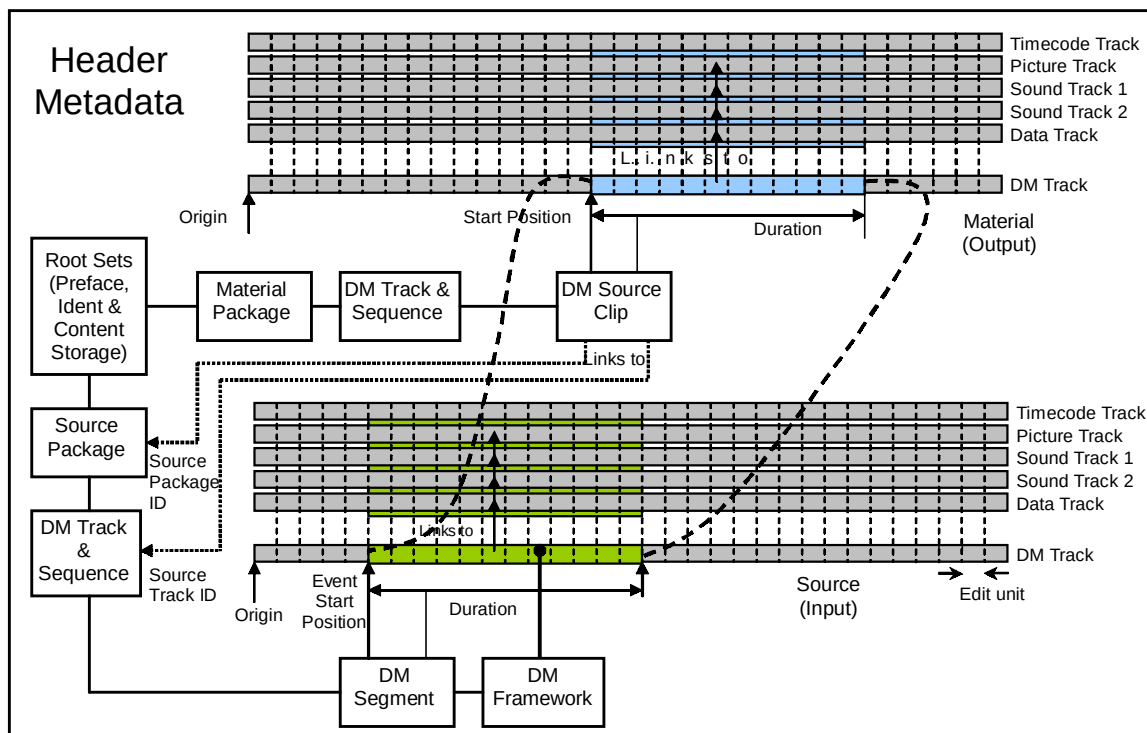


**Figure 2 – Descriptive metadata track source clips and their relationship to the content of an MXF essence container**

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 included a true 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 actual metadata track.

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

## 5.5 Identification through the UL

The MXF format provides the template for a SMPTE label (SMPTE 298M) to identify the DM scheme in use. This is recorded in the preface set of the structural metadata so that decoders may have an early warning that descriptive metadata exists and understand whether it is a recognized scheme.

### 5.5.1 Identification of MXF descriptive metadata schemes

MXF DM schemes are those standardized schemes which use the plug-in mechanism provided by the MXF structural metadata as described above. MXF DM schemes must be 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 must be publicly registered in order that the scheme may become known to the decoder. 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 local set that implements any MXF DM scheme has bytes 1~12 of every 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.

### 5.5.2 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 must differ in bytes 1~12 in order that they are recognizably non-MXF schemes. Furthermore, the keys used must all differ from those defined for MXF DM schemes.

## 6 Issues relating to MXF and AAF

This section outlines some of the considerations that need to be made in creating a MXF and AAF compatible DM scheme.

Annex B describes some metadata modeling techniques that may be used to develop descriptive metadata.

### 6.1 Issues relating to MXF

#### 6.1.1 Using the instance and generation UID properties

MXF DM schemes should use the “instance UID” property as defined in the MXF format specification to provide an object ID for referencing between objects.

MXF DM schemes should also use the generation UID property as defined in the MXF format specification (section 6.6.2) to link to the identification set that was created at the point of creation or change. MXF DM schemes can use the same mechanism for identifying changes by adding the optional generation UID property to each descriptive metadata set.

The UL and local tag values of both the instance and generation UID properties are defined in the MXF format specification.

### 6.2 Issues relating to AAF

MXF descriptive metadata can be used by AAF implementations if it follows certain rules. Annex B of the MXF format specification defines the DM sets which MXF descriptive metadata can use in order that it can be made visible to both MXF and AAF implementations. Note that not all AAF implementations will support the encoding and decoding of MXF descriptive metadata.

The MXF format specification provides a “DM segment” set (described in section 5.2) which can be used to (strongly) reference a descriptive metadata framework. This framework and all its metadata thus relates to the package, the tracks and the timing defined for the segment. This set is new to AAF version 1 and is a sub-class of the AAF “comment marker” class.

The MXF format specification further provides a “DM SourceClip” set (described in section 5.4) which can be used to link to a metadata track in another package. This is a very useful set in that it allows a copy of descriptive metadata to be made as an alias rather than a simple duplication. Where this method is applied, it can save on unnecessary duplications of descriptive metadata. However, when processing header metadata, the alias link must be followed in order to derive the actual location of the descriptive metadata. The DM SourceClip is a sub-class of the AAF “source clip” class.