

for Television — Material Exchange Format (MXF) — Mapping of Uncompressed Pictures into the Generic Container



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1 Scope

This standard specifies the mapping of uncompressed pictures into the MXF generic container. This MXF body is suitable for the mapping of all sampling grids and sampling formats including but not limited to those defined by ITU-R BT.601, ITU-R BT 656, ITU-R BT 709, SMPTE 125M, SMPTE 267M, SMPTE 274M, and SMPTE 296M. Provision is made for mapping of the active picture area alone or of larger sampling grids, including some or all of the horizontal and vertical ancillary data areas. Provision is made for alignment of the stored sampling grid to memory block size boundaries. This standard defines SMPTE universal labels that uniquely identify specific uncompressed implementations.

This standard defines uncompressed picture essence elements that may be used as elements in content packages within an MXF generic container.

In order to achieve interoperability within any given operational pattern, restrictions may be placed on the way in which this essence container can be implemented. The reader is advised to carefully study the appropriate operational pattern document before implementation.

2 Normative references

SMPTE 291M-1998, Television — Ancillary Data Packet and Space Formatting

SMPTE 336M-2001, Television — Data Encoding Protocol Using Key-Length-Value

SMPTE 352M-2002, Television (Dynamic) — Video Payload Identification for Digital Television Interfaces

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

SMPTE RP 224, Registry of SMPTE Universal Labels

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 format specification. A supplementary glossary of acronyms and terms is defined in SMPTE 379M. They are not repeated here to avoid any divergence of meaning. Terms defined in this specification:

DID	Data Identification (see SMPTE 291M)
SDID	Secondary Data Identification (see SMPTE 291M)

4 Introduction

This standard is concerned primarily with the wrapping of uncompressed pictures so that they may be carried in MXF. This primarily involves the arrangement of the physical bytes within the essence container and the values for KLV keys and labels. The parameters that may be used to describe the picture information, in terms of the picture dimensions, sampling, pixel data representation and underlying signal standard are fully described in the MXF format document annexes D and E. The principles of wrapping and underlying concepts of the generic container as well as the outline key values are defined in the generic container specification. Indeed the principle of signaling with the essence container UL is outlined in these two documents and is used in this standard to signal that a well known uncompressed picture format is being transported within the essence container. To fully understand this document, both the MXF format specification and generic container specification need to be understood.

This standard uses the generic term "uncompressed picture" to refer to any variant of picture sampling (horizontal, vertical and temporal), sampling structure, and picture color space, including but not limited to those defined by ITU-R BT.601, ITU-R BT 656, ITU-R BT 709, SMPTE 125M, SMPTE 267M, SMPTE 274M, and SMPTE 296M.

This standard uses the term "ancillary data area" to refer to any sampled data within the captured signal that is outside the active image area defined for the uncompressed picture. This standard and all MXF documents use the phrase "sampling grid" is used to mean a captured spatial arrangement of pixels, usually specified in a standard.

This standard defines uncompressed picture essence elements that may be used as elements in content packages within an MXF generic container.

Provision is made for mapping of the active picture area alone, or of larger sampling grids including some or all of the horizontal and vertical ancillary data areas. Provision is made for padding of the stored data to memory block size boundaries in order to accommodate picture formats that are already in use.

When uncompressed pictures are used within an MXF generic container, the essence shall be divided into elements of equal duration, corresponding to one sample unit. The duration of the sample unit is determined by the sample rate property of the essence descriptor. The relationship between sample units and the stored image rectangle is defined by the frame layout property of the essence descriptor and covers progressive frame, interlaced fields, and segmented frame. It is possible that an MXF file may contain a single picture or a sequence of two or more pictures.

5 Mapping uncompressed pictures to a file structure (informative)

5.1 Basic mapping of uncompressed pictures

Each uncompressed picture is mapped into a content package of the essence container where each content package has the duration of one edit unit. The uncompressed picture can be made up of fill data, ancillary information, picture information and other data. The terminology used is defined in an annex of the MXF format specification.

The essence container may comprise a single content package (where the single uncompressed picture is a still) or a continuous sequence of two or more content packages. In the latter case, the format of each uncompressed picture should be consistent if continuous decoding of the essence is required. Note that fill data and ancillary data may vary from content package to content package while maintaining continuous decoding.

Figure 1 is reproduced from the MXF file format specification in order to help the reader of this standard with some of the terminology. The definition of the terms in the diagram is extensively discussed in the MXF format specification.

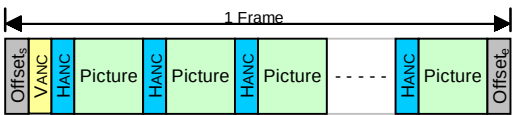


Figure 2 – Simple representation of an uncompressed frame

6.1 Frame-based wrapping

SMPTE 379M defines frame-based mapping. The "frame wrapping" method for uncompressed pictures is shown in figure 3. This figure shows each picture wrapped in a content package with no other elements in the container.

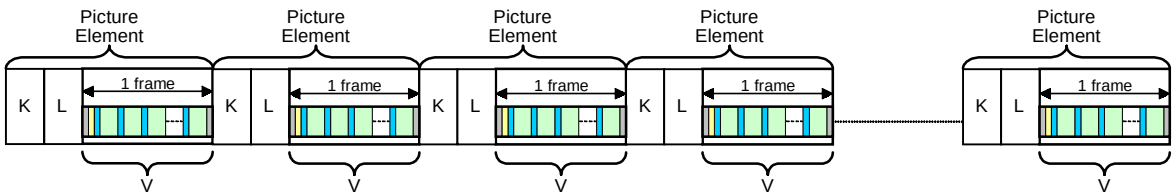


Figure 3 – Simple representation of frame wrapping

The frame wrapping method enables frame-by-frame access by MXF applications that process at the KLV level. This can be particularly useful for applications that support multiple generic container mapping types. Sufficient Information is provided to allow individual frames to be identified at the KLV level without an MXF decoder having to parse or decode the essence data. Each frame of uncompressed picture data is KLV wrapped using a GC picture element key.

In some applications, the frame wrapped uncompressed picture information will exist in content packages with other elements such as sound and data elements. An example generic container is shown in figure 4.

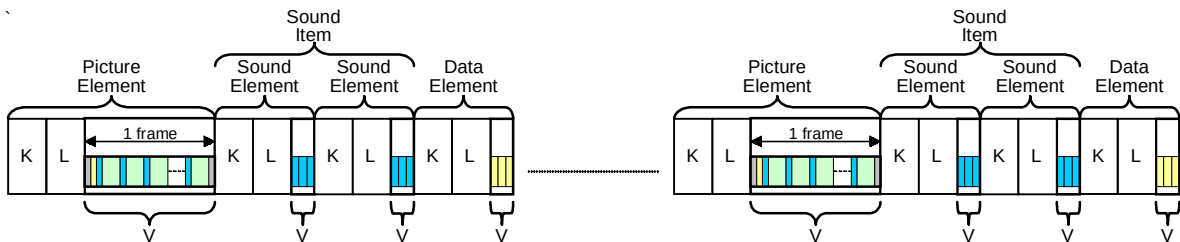


Figure 4 – Frame wrapping with other GC elements

The generic container mapping specifications for the sound and data elements define the key values and format of the data within the elements. Note that in this wrapping mode, the sound and data elements should have a duration of one frame. This is different to the line wrapping mode below that is intended to KLV wrap the individual components of the uncompressed picture data in the order in which they are stored/transmitted.

6.2 Clip-based wrapping

SMPTE 379M defines clip-based mapping. The clip wrapping method for uncompressed pictures is shown in figure 5. KLV encoding wraps the whole of the MXF uncompressed picture body that may contain one or more frames (maybe thousands). Any other elements in this generic container should also be clip wrapped.

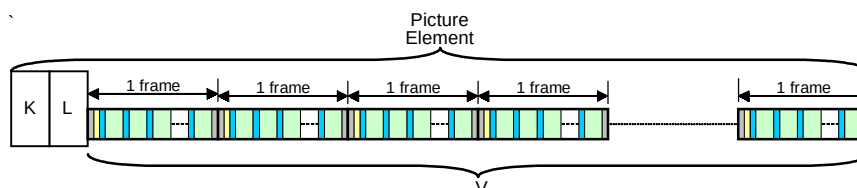


Figure 5 – Simple representation of clip wrapping

The clip wrapping method is for applications that carry the uncompressed picture data as a single large entity. This can be very useful applications such as store and forward servers that process whole files and also in applications where it is desired to use the rich metadata structures of MXF as an annotation to uncompressed picture data. The clip of uncompressed picture data is KLV wrapped using a picture element key. When uncompressed picture data is clip wrapped, there shall be only one clip per generic container body. Multiple clips can be concatenated and edited using the operational pattern mechanism detailed in the MXF format document.

In some applications, the clip wrapped uncompressed picture data will exist in a content package with other elements such as sound and data elements. An example generic container is shown in figure 6.

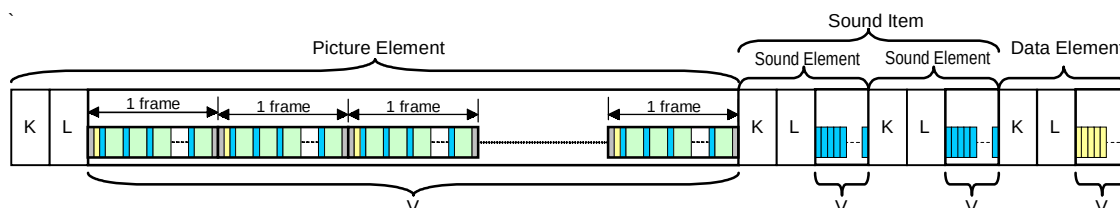


Figure 6 – Clip wrapping with other GC elements

The generic container mapping specifications for the sound and data elements shall detail the key values and format of the data within the elements. Note that in this wrapping mode, the sound and data elements should have a duration of the entire clip.

6.3 Line-based wrapping

Line-based mapping is defined in this standard. In line-based wrapping, KLV encoding wraps each individual component of each line of the MXF uncompressed picture. This identifies fills and ancillary data separately from lines within the stored data. Care must be taken when using this mode to ensure that the resulting file is generic container compliant. The generic container rules constraining the grouping of elements into items shall be met.

The uncompressed picture from figure 2 is shown line wrapped in figure 7. The generic container recommends that the data within each content package should represent a similar time duration. In this wrapping mode, each content package shall correspond to a single line of picture data. Note that extra data

before the first line is associated with the first line's content package. Extra data after the last line shall be associated with the last line of the picture.

The generic container requires that all elements of any item in a content package shall be uniquely identified. It is also strongly recommended that elements within an item are adjacent within any content package. There are occasions when this might not be possible, for example the HANC data element and Offset_e data element in the final content package in figure 7. When the individual elements are wrapped, care must be taken to comply with this recommendation.

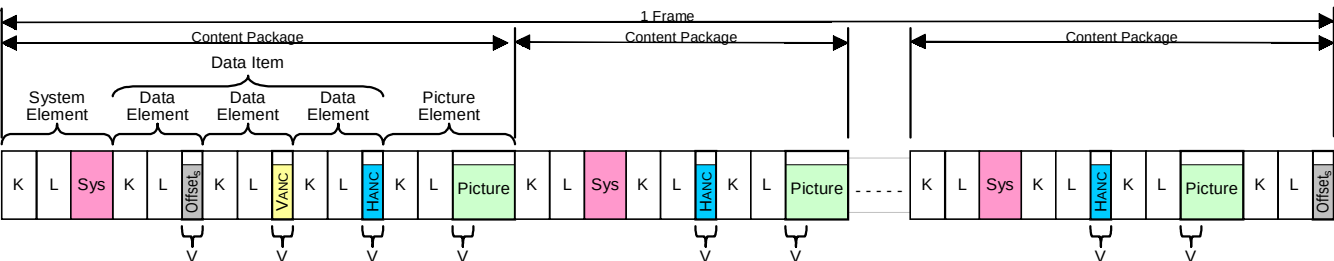


Figure 7 – Line wrapping of an uncompressed picture

If the type of ancillary data is known then the key shall be correctly set. If the ancillary data does not conform to a known standard, or cannot be identified when the file is created, then the line wrapped data element type value in table 2 shall be used.

Line-based wrapping is very likely to result in a generic container with content packages comprising different numbers of elements. This dynamic structure may make it difficult to uniquely identify the start of a content package. For this reason, a simple system item is defined that identifies the start of each line.

7 Keys for GC elements when wrapping uncompressed pictures

As can be seen from section 6, there is always a picture element in the three wrapping modes. In line-wrapping mode, there may additionally be extra GC elements. The keys for these elements are defined in table 2 in section 7.2.

7.1 Picture element key

The values of the last four bytes of the essence element key are defined in table 1.

Table 1 – Key value for the uncompressed picture element

Byte No.	Description	Value (hex)	Meaning
1-12	See MXF Generic Container Specification		
13	Item Type Identifier	15h	Picture Item
14	Essence Element Count	kkh	Count of Picture Elements in this Item
15	Essence Element Type	02h 03h 04h	Frame Wrapped Picture Element Clip Wrapped Picture Element Line Wrapped Picture Element (as listed in SMPTE RP 224)
16	Essence Element Number	nnh	The Number (used as an Index) of this Picture Element in this Item

7.1.1 Picture element length

The length field of the KLV coded element shall be 4 bytes BER long-form encoded (i.e., 83h.xx.yy.zz) for frame or line-based wrapping. The length field of the KLV coded element shall be 8 bytes BER long-form encoded (i.e., 87h.aa.bb.cc.dd.ee.ff.gg) for clip wrapping.

7.1.2 Essence element count — Byte 14

This is a count of the number of elements in the picture item of the content package.

7.1.3 Essence element type — Byte 15

For frame wrapped uncompressed pictures, the value shall be 02h. For clip wrapped uncompressed pictures, the value shall be 03h. For line wrapped uncompressed pictures, the value shall be 04h.

7.1.4 Essence element number — Byte 16

This is a number used as an index to identify this instance of the element type within the item in each content package. The generic container specification requires that this byte be unique within each item of a content package. Each and every instance of the uncompressed picture element shall retain a consistent essence element number throughout the entire generic container.

7.2 Line-wrapped data element keys

These keys shall only be used for the line wrapping mode. There are many different types of data that may be mapped into the HANC and VANC regions of an uncompressed picture. Generic keys are provided for broad categorization of this data. The values of the last four bytes of the essence element key are defined in table 2.

Table 2 – Key value for the line-wrapped uncompressed picture data element

Byte No.	Description	Value (hex)	Meaning
1-12	See MXF Generic Container Specification		
13	Item Type Identifier	17h	GC Data Item
14	Essence Element Count	kkh	Count of Data Elements in this Item
15	Essence Element Type	08h 09h 0Ah	Line Wrapped Data Element Line Wrapped VANC Data Element Line Wrapped HANC Data Element (as listed in SMPTE RP 224)
16	Essence Element Number	nnh	The Number (used as an Index) of this Data Element in this Item

When line wrapping is used and SMPTE 291M compliant ancillary data is found, the MXF encoder shall insert a new data element key for every ancillary data flag found. For each combination of DID and SDID found in the stream, there shall be a single, unique data element key value.

Note that there may be some pathological cases where the arrangement of video, audio and data in the uncompressed stored data prevents this rule from being followed. In such extremely rare cases, generic container compliant line wrapped files cannot be constructed. A different wrapping mechanism shall be employed to be compliant with the specification.