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SMPTE STANDARD

Material Exchange Format — Mapping JPEG 2000 Codestreams into the MXF Generic Container

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Foreword

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SMPTE Engineering Documents are drafted in accordance with the rules given in Part XIII of its Operations Manual.

SMPTE ST 422 was prepared by Technology Committee 31FS.

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.

This standard maps the codestream for each JPEG 2000 (ISO/IEC 15444-1) coded still picture into a MXF generic container. JPEG 2000 is a picture-by-picture coding scheme where each picture is entirely independent and can be extracted as an independent entity. However, the codestreams can be simply concatenated to form a sequence of compressed pictures.

This standard maps the JPEG 2000 codestream as either frame-wrapped where each JPEG 2000 codestream is individually mapped into a frame or clip-wrapped where a sequence of JPEG 2000 codestreams is mapped into a clip. This standard defines the KLV coding, the essence container and compression label values and the essence descriptor.

This standard specifies the mapping of ISO/IEC 15444-1 Annex A codestreams into the MXF generic container. This document does not specify mappings for ISO/IEC 15444-1 Annex I, nor does it specify mappings for any other parts of ISO/IEC 15444.

1 Scope

JPEG 2000 is a picture-by-picture compression coding defined by ISO/IEC 15444-1 and used for both individual pictures and picture sequences. This standard specifies the mapping of JPEG 2000 codestreams into a picture essence track of the MXF generic container in both frame-wrapped and clip-wrapped forms.

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

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; followed by formal languages; then figures; and then any other language forms.

3 Normative References

The following standards contain provisions that, 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 recommended practice are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE ST 335:2012, Metadata Element Dictionary Structure

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 379-1:2009, Material Exchange Format (MXF) — MXF Generic Container

SMPTE ST 379-2:2010, Television — Material Exchange Format (MXF) — MXF Constrained Generic Container

SMPTE ST 400:2012, SMPTE Labels Structure

ISO/IEC 15444-1:2004, Information Technology — JPEG 2000 Image Coding System — Part 1: Core Coding System

4 Glossary of Acronyms, Terms and Data Types

SMPTE ST 379-x: throughout this standard, SMPTE ST 379-x refers to both SMPTE ST 379-1 and ST SMPTE 379-2.

The general glossary of acronyms, terms and data types used in the MXF specification is given in SMPTE ST 377-1 and is supplemented in SMPTE ST 379-x. These glossaries are not repeated here to avoid any divergence of meaning. In this document, terms are used as defined by SMPTE ST 377-1 in preference to any definition specific to SMPTE ST 379-1 or SMPTE ST 379-2.

Definitions of terms, abbreviations and symbols relating to JPEG 2000 are given in ISO/IEC 15444-1.

5 JPEG 2000 Mappings

The MXF generic container (GC) is fully described in SMPTE ST 379-x. This standard specifies the mapping of JPEG 2000 codestreams as a picture element that may be used in the picture item of the MXF GC. The picture element may contain either individual JPEG 2000 codestreams using frame-wrapping or a sequence of JPEG 2000 codestreams using clip-wrapping.

This standard specifies the key, the length, and the value fields of the JPEG 2000 coded picture element. This standard also defines the essence container and compression label values and the essence descriptor.

5.1 JPEG 2000 Coding Summary (Informative)

JPEG 2000 is a picture-by-picture coding scheme, so each picture is independently coded and can be extracted as an independent entity. However, sequences of JPEG 2000 coded bitstreams can be simply concatenated to form a sequence of compressed images.

A JPEG 2000 coded bitstream for a single compressed image is defined as a codestream. This codestream is defined by a start codeword that identifies the start of the codestreams and an end codeword that identifies the end of the codestream. In between the start and end codewords are other codewords for identification of key parts of the codestream together with the raw compressed image data. The syntax of the codestream is fully defined in ISO/IEC15444-1.

This standard specifies only the mapping of ISO/IEC 15444-1 Annex A codestreams into an MXF file. JPEG 2000 codestreams encapsulated in the MPEG-4 base media file format as defined by ISO/IEC 15444-12 and ISO/IEC 15444-3 are known as an ISO/IEC Motion JPEG 2000. Any ISO/IEC Motion JPEG 2000 file that is converted to an MXF file should transfer appropriate file metadata to the MXF file.

5.2 Application in the MXF Generic Container

This mapping shall use the MXF generic container in either the frame-based wrapping or clip-based wrapping mode defined in SMPTE ST 379-x.

The following wrapping cases are defined:

- Frame-based wrapping – “FU” Undefined
- Frame-based wrapping – “P1” Progressive
- “I1” Interlaced Frame Wrapping, 1 field per KLV Element
- “I2” Interlaced Frame Wrapping, 2 fields per KLV Element
- “F1” Field Wrapping, 1 field per KLV Element
- “Cn” Clip-based wrapping

These are described in the sections immediately below.

5.3 Frame-Based Wrapping – “FU” Undefined and “P1” Progressive

An essence container that frame-wraps only JPEG 2000 compressed image data shall comprise one or more KLV triplets each of which shall contain a single JPEG 2000 compressed picture as illustrated in Figure 1. A system item is optional in this essence container.

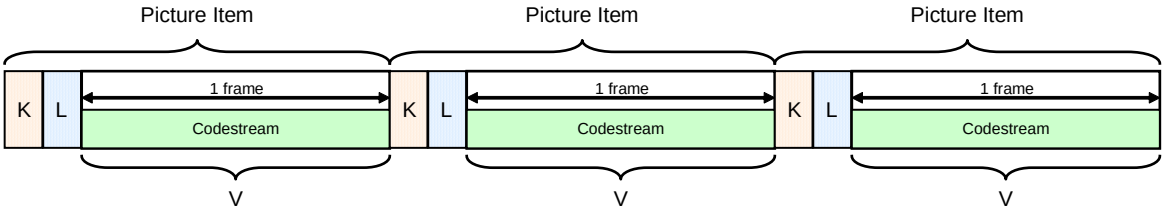


Figure 1 – Frame-based wrapping JPEG 2000 picture elements in the generic container

Progressive-scanned frames shall be labelled with Essence Container Label “P1” (value defined later in this document).

Essence Container Label FU is prohibited in files compliant with this standard.

Note: Earlier versions of this standard required the use of the Essence Container Label “FU” (value defined later in this document), however insufficient metadata was specified to determine if the pictures were progressive-scanned or interlace-scanned. If Decoders encounter such legacy material, they have to infer picture scanning parameters circumstantially. The FU value is deprecated.

The JPEG 2000 compressed images may optionally be interleaved with other essence components in the frame-wrapped essence container as illustrated in Figure 2.

These other essence components shall be as defined by this or other MXF mapping standards. All essence element types shall be frame wrapped. For simplicity of operation, each frame should contain essence data that is independent of adjacent frames. Interleaved essence elements that are inter-frame coded are not prohibited, but their inclusion may impact the performance of codecs. All essence elements in each interleaved frame should be time coincident within the limits of human recognition.

Note: The term ‘frame-based wrapping’ is defined by SMPTE ST 379-x as the individual wrapping of one or more content packages each having a basic sample unit. This basic sample unit is defined by the JPEG 2000 codestream and in television systems, may be the result of coding fields from an interlaced scanned picture or frames from a progressively scanned picture.

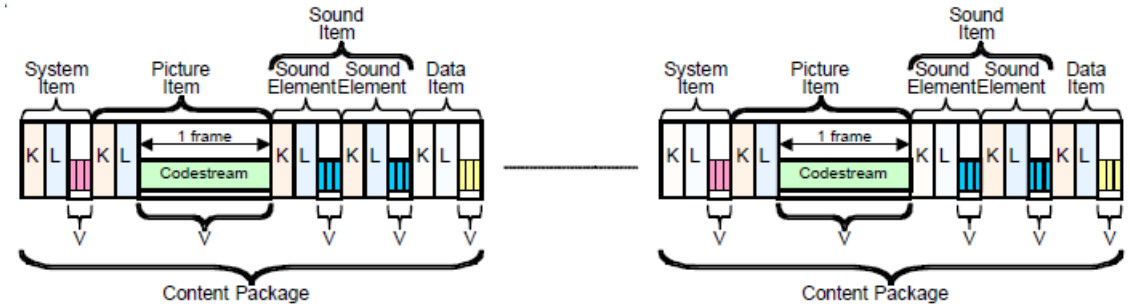


Figure 2 – Frame-based wrapping of interleaved items and elements in the generic container

Note: Interleaving essence elements sometimes involve timing tolerances whose specification is beyond the scope of this standard. However, the design of the frame-based interleaved MXF generic container is predicated on the concept of essentially time-aligned essence elements within each content package.

Individual applications may define the JPEG 2000 picture element as the only element present in each content package.

5.4 "I1" Interlaced Frame Wrapping, 1 Field per KLV Element

An essence container that wraps JPEG 2000 compressed interlaced data with one field per KLV Element and one frame per Content Package shall comprise one or more pairs of KLV triplets each of which shall contain one JPEG 2000 codestream as illustrated in Figure 3.

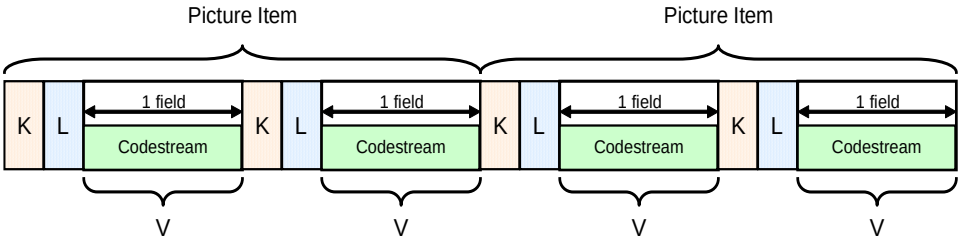


Figure 3 –"I1" Interlace Frame wrapping JPEG 2000 picture elements, 1 field per KLV element

The first KLV triplet in each pair shall contain the first field of the interlaced picture. The two KLV triplets may be separated by a KLV Fill Item.

The JPEG 2000 compressed images may optionally be interleaved with other essence components in the frame-wrapped essence container.

5.5 "I2" Interlaced Frame Wrapping, 2 Fields per KLV Element

An essence container that wraps JPEG 2000 compressed interlaced data with two fields per KLV Element and one frame per Content Package shall comprise one or more KLV triplets each of which shall contain two JPEG 2000 codestreams as illustrated in Figure 4.

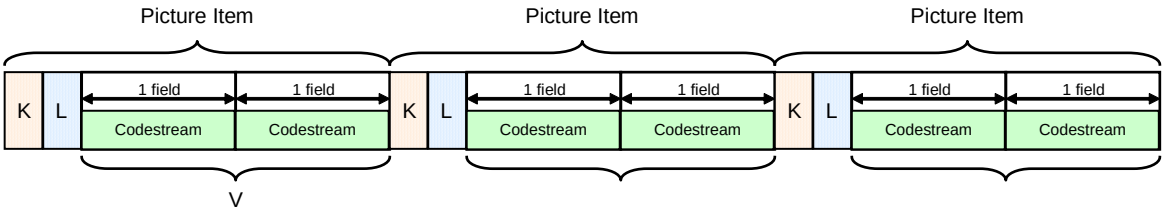


Figure 4 – "I2" Interlace Frame wrapping JPEG 2000 picture elements, 2 fields per KLV element

The JPEG 2000 compressed images may optionally be interleaved with other essence components in the frame-wrapped essence container.

5.6 "F1" Field Wrapping, 1 field per KLV Element

An essence container that wraps JPEG 2000 compressed interlaced data with one field per KLV Element and one field per Content Package shall comprise one or more KLV triplets each of which shall contain one JPEG 2000 codestream as illustrated in Figure 5.

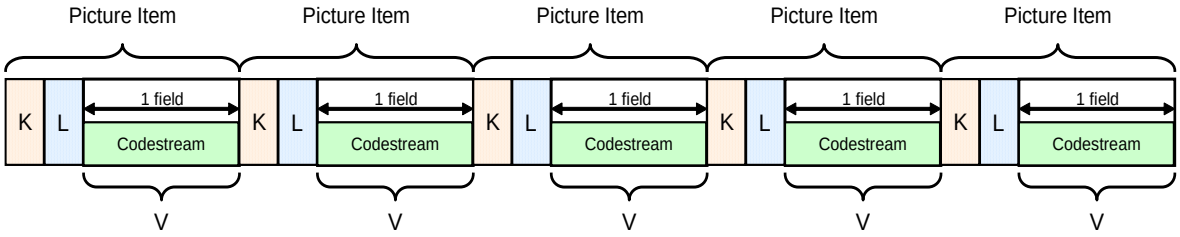


Figure 5 – "F1" Field wrapping JPEG 2000 picture elements, 1 field per KLV element

The JPEG 2000 compressed images may optionally be interleaved with other essence components in the frame-wrapped essence container.

5.7 "Cn" Clip-based wrapping

An essence container that clip-wraps only JPEG 2000 compressed image data shall comprise one KLV triplet containing a sequence of JPEG 2000 codestreams as illustrated in Figure 6.

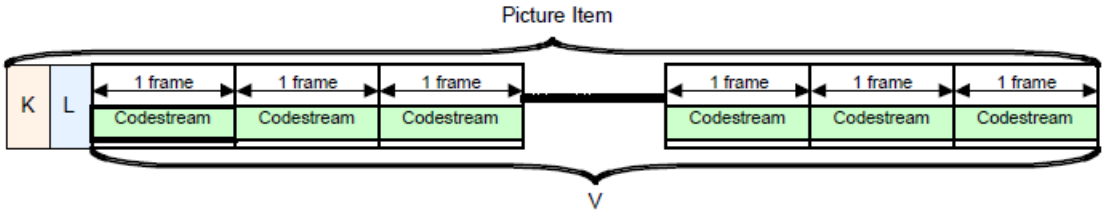


Figure 6 – "Cn" Clip-based wrapping of a sequence of JPEG 2000 codestreams in the generic container

The clip-wrapped JPEG 2000 essence element may be the sole component in the MXF generic container content package.

The clip-wrapped JPEG 2000 essence element may also be used in the MXF generic container content package in sequence with other clip-wrapped essence elements as illustrated in Figure 7. Note that each essence element should have the duration of the entire clip.

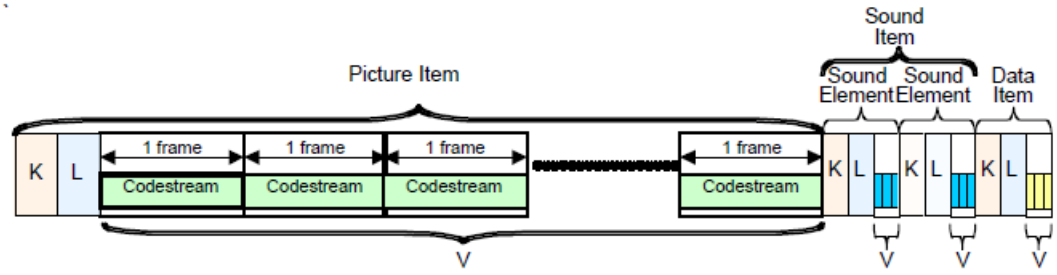


Figure 7 – "Cn" Clip-based wrapping with other essence elements

6 Key-length-value coding

6.1 Essence Element Key

The values of the first 12 bytes of the essence element key are defined in SMPTE ST 379-x. The values of the last four bytes of the picture element key shall be as specified in Table 1.

Table 1 – Key value for the JPEG 2000 picture element

Byte No.	Description	Value (hex)	Meaning
1~12	Defined in SMPTE ST 379-x		See SMPTE ST 379-x
13	Item Type Identifier	15h	GC Picture Item (as defined in SMPTE ST 379-x)
14	Essence Element Count	kkh	Count of Picture Elements in the Picture item
15	Essence Element Type	08h 09h	Not Clip-wrapped JPEG 2000 Picture Element Clip-wrapped JPEG 2000 Picture Element
16	Essence Element Number	nnh	The Number (used as an Index) of this Picture Element in the Picture Item

6.1.1 Essence element count — Byte 14

This is a count of the number of picture elements in the picture item of the generic container.

6.1.2 Essence element type — Byte 15

The value of 08h identifies that each JPEG 2000 codestream is not Clip-wrapped.

The value of 09h identifies that the sequence of JPEG 2000 codestreams are Clip-wrapped.

6.1.3 Essence element number — Byte 16

This is a number used as an index to identify this instance of the element type within the picture item. Each element within an Item shall have a unique value between 00h and 7Fh, as defined by SMPTE ST 379-x, which shall remain constant within the generic container.

In the case of Interlaced Frame, 1 field per KLV Element wrapping mode (see Section 6.3.2 below), one Picture Element is composed of two KLV Elements. Thus:

- Essence Element Keys will occur in pairs
- Essence element numbers shall be identical in the two elements
- The Essence Element Count shall include a count of 2 for each Picture Element.

  Note that for an Essence Container with a single Picture Element, this implies Essence Element Count equal 2 and Essence element number equal 1.

In all other wrapping modes, one Picture Element is composed of one KLV Element.

- The Essence Element Count shall include a count of 1 for each Picture Element.

6.2 Length

The length field shall comply with SMPTE ST 379-x, Section 5.5.1.

6.3 Value

Note: Each JPEG 2000 codestream starts with the unique SOC (start of codestream) 2-byte marker and ends with the unique EOC (end of codestream) 2-byte marker. Users are cautioned that the code values for SOC and EOC are not protected and could accidentally occur within the image size marker segment (SIZ), quantization marker segment (QCD), comment marker segment (COM) and other places. Thus, it is not safe to parse the concatenated JPEG 2000 codestreams by merely scanning for SOC and/or EOC values. The structure of a JPEG 2000 codestream is essentially key-length-value, thus it is easy to read the lengths of the various codestream pieces and compute the length of the entire codestream. But applications which attempt to parse the bitstream at a randomly accessed point within the sequence of codestreams are cautioned that SOC and EOC values are not guaranteed to be absent between the true SOC and EOC markers.

6.3.1 “FU” Frame-wrapped, Undefined Interlace

The value field shall comprise a single JPEG 2000 codestream as defined in ISO/IEC 15444-1, Annex A.

6.3.2 ”I1” Interlaced Frame, 1 field per KLV Element

The value field shall comprise a single JPEG 2000 codestream as defined in ISO/IEC 15444-1, Annex A.

In this case, the Picture Item of the Generic Container shall consist of pairs of Essence Elements, numbered according to Section 6.1.3 above.

6.3.3 “I2” Interlaced Frame, 2 fields per KLV Element

The value field shall comprise two concatenated JPEG 2000 codestream as defined in ISO/IEC 15444-1, Annex A, corresponding to the first field followed by the second field of the interlaced picture.

Note that decoders will need to derive the bytestream offsets of each field by analysing the code stream format within the essence element as described by ISO/IEC 15444-1.

6.3.4 "F1" Field-wrapped, 1 field per KLV Element

The value field shall comprise a single JPEG 2000 codestream as defined in ISO/IEC 15444-1, Annex A.

6.3.5 "Cn" Clip-wrapped

The value field shall comprise a sequence of one or more concatenated JPEG 2000 codestreams where each JPEG 2000 codestream is as defined in ISO/IEC 15444-1, Annex A.

6.3.6 "P1" Frame-wrapped

The value field shall comprise a single JPEG 2000 codestream as defined in ISO/IEC 15444-1, Annex A.

6.4 Essence Container UL

The values for the essence container UL are given in Table 2.

Table 2 – Specification of the essence container label

Byte No.	Description	Value (hex)	Meaning
1-12	Defined by Generic Container		As defined in SMPTE ST 379-x
13	Essence Container Kind	02h	MXF Generic Container
14	Mapping Kind	0Ch	JPEG 2000 Picture Element (as listed in SMPTE RP 224)
15	Content Kind	01h 02h 03h 04h 05h 06h	"FU" Frame- wrapped (Undefined interlace) Picture Element "Cn" Clip- wrapped Picture Element "I1" Interlaced Frame, 1 field/KLV "I2" Interlaced Frame, 2 fields/KLV "F1" Field-wrapped Picture Element "P1" Frame- wrapped Picture Element
16	Reserved	00h	

The essence container UL is used within a batch of ULs in partition packs and the preface set and on its own in the essence descriptor. These UL values are listed in the SMPTE labels registry (SMPTE RP 224).

6.5 Picture Essence Compression UL

Values for the picture essence compression UL are given in Table 3.

Table 3 – Specification of the picture essence compression label

Byte No.	Description	Value (hex)	Meaning
1-8	Registry Designator	See SMPTE ST 400	Designator value is defined in SMPTE ST 400
9	Parametric	04h	Node used to define parametric data
10	Picture Essence	01h	Identifies picture essence coding
11	Picture Coding Characteristics	02h	Identifies picture coding characteristics
12	Compressed Picture Coding	02h	Identifies compressed picture coding
13	Individual Picture Coding	03h	Identifies individual picture coding
14	JPEG 2000 Picture Coding	01h	Identifies JPEG 2000 picture coding
15	JPEG 2000 Picture Coding Variant	01h	Identifies JPEG 2000 coding according to ISO/IEC 15444-1
16	JPEG 2000 Picture Coding Constraints	Xxh	Identifies coding constraints for the intended application. A value of '00h' indicates a generic application that has no coding constraints. Other specifications will define the meaning of non-zero values.

The picture essence compression UL is used in the generic picture essence descriptor. This UL is listed in SMPTE labels registry (SMPTE RP 224).

Note: Applications or constraints specifications that use particular JPEG-2000 profiles are responsible for listing the picture coding constraints and the identifying UL to be registered in SMPTE RP 224.

7 Application Issues

Issues related to coding of television signals, particularly concerning interlaced pictures, are discussed in Annex A.

7.1 Application of the KAG and the KLV Fill Item

MXF encoders and decoders shall comply with the KAG rules defined in SMPTE ST 377-1, Section 5.4.1.

The default value of the KAG is '1'. Other KAG values may be used within the range defined by SMPTE ST 377-1, Section 5.4.1.

The KLV fill item may be used to maintain a constant content package size so permitting the use of a single index table segment.

7.2 Index Table Usage

Since JPEG 2000 coding is frame-based, the KLV fill item can provide for a constant edit unit size for all frames in many applications.

Where the application defines a constant edit unit size, an index table shall be used. This includes the cases where the JPEG 2000 essence element is the sole essence component and where it is interleaved with other essence components.

Where the application has a variable edit unit size an index table should be used wherever possible.

SMPTE ST 377-3 gives examples of how index tables can be created for both mono and multi-essence mappings and for both constant and variable length edit unit sizes.

7.3 Operational Pattern Usage

This essence mapping may be used with any generalized operational pattern.

Note: This does not preclude the use of specialized operational patterns.

7.4 Mapping Track Numbers to Generic Container Elements

Each track number value for an essence element defined in this standard shall be derived as described in the MXF generic container specification (SMPTE ST 379-x).

Interlaced Frame, 1 field per KLV Element (see Section 6.3.2) constructs a single Picture Element from two KLV elements, which is not consistent with SMPTE ST 379-2, in which Section 4.1 defines a Content Element to be a single KLV element of any kind belonging to a Content Item.

7.5 Essence Container Partitions

Frame wrapping maintains each content package of the generic container as a separate editable unit with the contents of the system, picture, sound and data items in synchronism. If a frame-wrapped essence container is partitioned, then individual content packages should not be fragmented by the partitioning process.

If the essence container is clip wrapped it is recommended that each essence element be multiplexed in a sequence of partitions.

Note: SMPTE ST 377-1, Section 5.2.2 (Partition Rules Summary) summarizes the use of partitions in MXF files.

8 Essence Descriptors

8.1 File Descriptor Sets

The file descriptor sets are those structural metadata sets in the header metadata that describe the essence and metadata elements defined in this standard. The structure of these sets is defined in the MXF file format specification (SMPTE ST 377-1) and in some generic container mapping specifications.

The values of the metadata defined in the sub-descriptor defined below are copies of values used in the syntax of the JPEG 2000 codestream. If there is any discrepancy between values, those in the codestream shall take precedence and the values in the sub-descriptor should be updated.

Note: Applications or constraints specifications that use particular JPEG-2000 profiles are responsible for determining the values of required and best efforts properties of MXF Descriptors.

Note: With the exception of those properties that have been defined in SMPTE ST 377-1, all local tag values in descriptors defined in this standard are dynamically allocated (Dyn) as described in SMPTE ST 377-1, Section 9.2.2 (local tag values). The translation from each dynamically allocated local tag value to its full UL value can be found using the primer pack mechanism defined in SMPTE ST 377-1, Section 9.2 (primer pack). The full 16-byte UL values are defined in SMPTE RP 210.

8.2 JPEG 2000 Picture Sub-Descriptor

Essence tracks that use the JPEG 2000 essence mapping may use the values of the JPEG 2000 picture sub-descriptor as defined in Table 6. The JPEG 2000 picture sub-descriptor is coded as a local set using 2-byte tag values and 2-byte length values consistent with all MXF descriptors.

This sub-descriptor is a supplementary essence descriptor that can be strongly referenced by any file descriptor. It is intended that this JPEG 2000 sub-descriptor be referenced either by the CDCI picture

essence descriptor or the RGBA picture essence descriptor both of which are defined by SMPTE ST 377-1. In order that the strong reference can be made, the MXF generic descriptor (as defined in SMPTE ST 377-1) has an additional optional property as defined in Table 4.

Table 4 – Additional optional property for the MXF generic descriptor

Item Name	Type	Len	UL Designator	Req	Meaning	Default
All elements from the Generic Descriptor defined in SMPTE ST 377-1 Table 17						
Sub Descriptors	StrongRefArray (Sub Descriptors)	8+16n	06.01.01.04 06.10.00.00	Opt	Ordered array of strong references to sub descriptor sets	

Note: The JPEG 2000 picture sub-descriptor is a sub-class of the MXF header metadata abstract superclass and inherits only the InstanceUID and GenerationUID properties. In order to use this set, the new “sub-descriptors” property in the MXF generic descriptor allows both the CDCI and RGBA picture essence descriptors to inherit this property and thus either can make a strong reference to the JPEG 2000 picture sub-descriptor.

The JPEG 2000 picture sub-descriptor includes only those properties from the main header of the codestream that are required in ISO/IEC 15444-1, Annex A, Table A.2.

Note that the JPEG 2000 picture sub-descriptor can only be used when the required properties are consistent for all JPEG 2000 codestreams in the essence container.

Annex B illustrates the chain of MXF descriptors and their relationships.

8.2.1 Key

The set key of the JPEG 2000 picture sub-descriptor shall be as defined in Table 5.

Table 5 – Key value for the JPEG 2000 picture sub-descriptor

Byte No.	Description	Value (hex)	Meaning
1~13	As defined in SMPTE ST 377-1, Table 17		Values for all MXF structural metadata sets
14~15	Set Kind	01.5Ah	Defines the Key value for the JPEG 2000 Picture Sub Descriptor
16	Reserved	00h	Reserved value

8.2.2 Length

The set length shall be BER long form encoded. It is preferred that the length field uses 4 bytes.

8.2.3 Descriptor Value

Table 6 – Specification of the values of the JPEG 2000 picture sub-descriptor

Item Name	Type	Len	Local Tag	UL Designator	Req?	Meaning	Default
Instance UID	UUID	16	3C.0A	06.0e.2b.34 01.01.01.01 01.01.15.02 00.00.00.00	Req	Unique ID of this instance [SMPTE RP 210 The ISO/IEC 11578 (Annex A) 16 byte Globally Unique Identifier]	
Generation UID	UUID	16	01.02	06.0e.2b.34 01.01.01.02 05.20.07.01 08.00.00.00	Opt	Generation Identifier [SMPTE RP210 Specifies the reference to an overall modification]	
Rsiz	UInt16	2 bytes	Dyn	06.0e.2b.34 01.01.01.0a 04.01.06.03 01.00.00.00	Req	An enumerated value that defines the decoder capabilities. Values are defined in ISO/IEC 15444-1 Annex A.5 Table A-10. Other values may be defined in amendments to ISO/IEC 15444-1 or in related international standards documents.	
Xsiz	UInt32	4 bytes	Dyn	06.0e.2b.34 01.01.01.0a 04.01.06.03 02.00.00.00	Req	Width of the reference grid, as defined in ISO/IEC 15444-1 Annex A.5.1.	
Ysiz	UInt32	4 bytes	Dyn	06.0e.2b.34 01.01.01.0a 04.01.06.03 03.00.00.00	Req	Height of the reference grid, as defined in ISO/IEC 15444-1 Annex A.5.1.	
XOsiz	UInt32	4 bytes	Dyn	06.0e.2b.34 01.01.01.0a 04.01.06.03 04.00.00.00	Req	Horizontal offset from the origin of the reference grid to the left side of the image area, as defined in ISO/IEC 15444-1 Annex A.5.1.	
YOsiz	UInt32	4 bytes	Dyn	06.0e.2b.34 01.01.01.0a 04.01.06.03 05.00.00.00	Req	Vertical offset from the origin of the reference grid to the top side of the image area, as defined in ISO/IEC 15444-1 Annex A.5.1.	
XTsiz	UInt32	4 bytes	Dyn	06.0e.2b.34 01.01.01.0a 04.01.06.03 06.00.00.00	Req	Width of one reference tile with respect to the reference grid, as defined in ISO/IEC 15444-1 Annex A.5.1.	
YTsiz	UInt32	4 bytes	Dyn	06.0e.2b.34 01.01.01.0a 04.01.06.03 07.00.00.00	Req	Height of one reference tile with respect to the reference grid, as defined in ISO/IEC 15444-1 Annex A.5.1.	

Item Name	Type	Len	Local Tag	UL Designator	Req?	Meaning	Default
XTOsiz	UInt32	4 bytes	Dyn	06.0e.2b.34 01.01.01.0a 04.01.06.03 08.00.00.00	Req	Horizontal offset from the origin of the reference grid to the left side of the first tile, as defined in ISO/IEC 15444-1 Annex A.5.1.	
YTOsiz	UInt32	4 bytes	Dyn	06.0e.2b.34 01.01.01.0a 04.01.06.03 09.00.00.00	Req	Vertical offset from the origin of the reference grid to the top side of the first tile, as defined in ISO/IEC 15444-1 Annex A.5.1.	
Csiz	UInt16	2 bytes	Dyn	06.0e.2b.34 01.01.01.0a 04.01.06.03 0A.00.00.00	Req	The number of components in the picture as defined in ISO/IEC 15444-1 Annex A.5.1. If this Sub Descriptor is referenced by the CDCI Descriptor, the order and kind of components shall be as defined by the Essence Container UL in the MXF File Descriptor. If this Sub Descriptor is referenced by the RGBA Descriptor, the order and kind of components shall be as defined by the Pixel Layout property of the RGBA Descriptor.	
Picture Component Sizing	J2K ComponentSizingArray	8+3n bytes	Dyn	06.0e.2b.34 01.01.01.0a 04.01.06.03 0B.00.00.00	Req	Array of picture components where each component comprises 3 bytes named $Ssiz^i$, $XRSiz^i$, $YRSiz^i$ (as defined in ISO/IEC 15444-1 Annex A.5.1). The array of 3-byte groups is preceded by the array header comprising a 4-byte value of the number of components followed by a 4-byte value of ‘3’.	
Coding Style Default	J2K CodingStyleDefault	var	Dyn	06.0e.2b.34 01.01.01.0a 04.01.06.03 0C.00.00.00	Opt	Default coding style for all components. Use this value only if static for all pictures in the Essence Container. The data format is as defined in ISO/IEC 15444-1, Annex A.6.1 and comprises the sequence of Scod (1 byte per table A-12), SGcod (4 bytes per Table A.12) and Spcod (5 bytes plus 0 or more precinct size bytes per Table A.12)	

Item Name	Type	Len	Local Tag	UL Designator	Req?	Meaning	Default
Quantization Default	J2K QuantizationDefault	var	Dyn	06.0e.2b.34 01.01.01.0a 04.01.06.03 0D.00.00.00	Opt	Default quantization style for all components. Use this value only if static for all pictures in the Essence Container. The data format is as defined in ISO/IEC 15444-1, Annex A.6.4 and comprises the sequence of Sqcd (1 byte per Table A.27) followed by one or more $Sqcd^{i}$ bytes (for the i^{th} sub-band in the defined order per Table A.27).	
J2CLayout	RGBALayout	var	Dyn	06.0e.2b.34 01.01.01.0E 04.01.06.03 0E.00.00.00	Opt	The nature and order of the image components in the compressed domain as carried in the J2C codestream. The RGBALayout data type is defined in SMPTE ST 377-1 G.2.40	

Annex A JPEG 2000 Coding of Television Signals (Normative)

JPEG 2000 may be used to compress any known television standard. With interlaced scanning, the duration of the JPEG 2000 codestream may be 1 frame or 1 field. With progressive and segmented frame scanning, the duration of the JPEG 2000 codestream will be 1 frame.

The format of the source coding shall be specified in the 'frame layout' property in the generic picture essence descriptor. This indicates whether the source picture was full frame (for Progressive), separate fields (for Interlaced), segmented frame, or any other permitted layout value.

When using separate fields, the optional 'FieldDominance' property, also in the generic picture essence descriptor, shall indicate the field number (1 or 2) which is considered to be temporally the first field of an interlaced frame.

Also when using separate fields, the appropriate value of the Essence Container UL (see Section 6.4 above) shall be specified.

The values of other Properties in the MXF Header Metadata shall be chosen as specified in Table A.1 below.

For "I1" Interlaced frame, 1 field per KLV, Index Table Entries shall index the first field of each frame only.

The EditRate of other Essence Tracks in MXF Header Metadata is defined in SMPTE ST 377-1 Section 9.4.

Note: Timecode counts Frames, not Fields, thus the EditRate of Timecode Tracks will always be the precise frame rate, in all Modes including in mode "F1".

Note: SMPTE ST 377-1 does not define how to reconstruct SMPTE ST 12-1 timecode values from a Timecode Track whose EditRate is measured in Fields, thus decoders cannot determine synchronization from such Tracks.

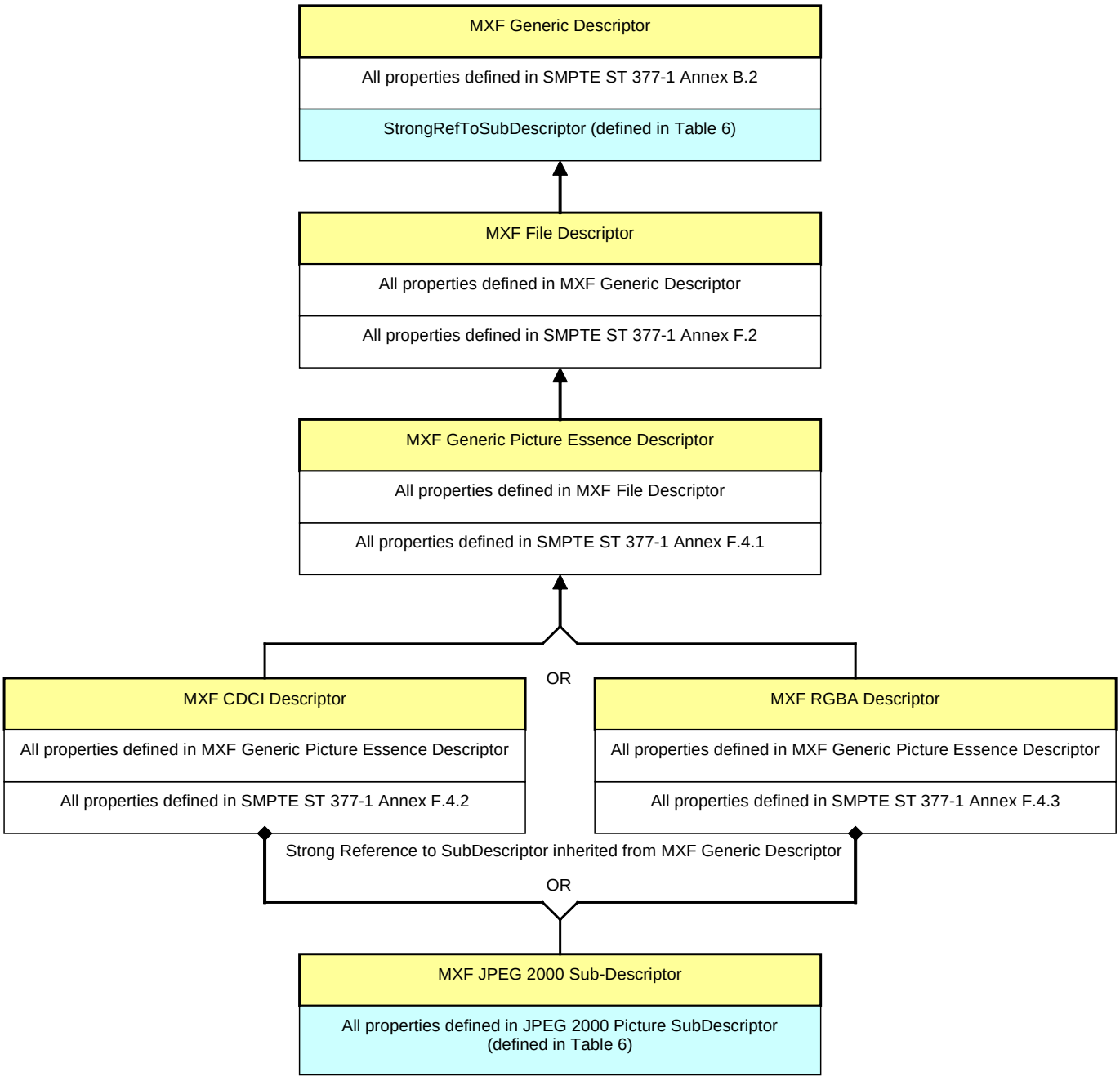
SMPTE ST 377-1 Annex F.4 and Annex G give normative provisions for specifying the values of other properties of the Picture Essence Descriptor, including Video Line Map, Stored Height and Width, Sampled Height and Width, and Display Height and Width. The correspondence between the values of these and frame or field is implied by the value of the FrameLayout property, as tabulated in SMPTE ST 377-1 Annex G.2.7, G.2.9 and G.2.14.

Table A.1 – MXF Header Metadata Property Values

Mode	Essence Container	J2C per KLV Element	Elements per Content Package SMPTE ST 379-2 Section 7.2	Frame Layout SMPTE ST 377-1 Annex G.2.1	Sample Rate SMPTE ST 377-1 Annex G.2.2	Edit Rate SMPTE ST 377-1 Annex B.12	Index Rate SMPTE ST 377-1 Section 11.2.3	Aspect Ratio SMPTE ST 377-1 Annex G.2.4	Compatible with
FU	Frame-wrapped Picture Element (Unspecified)	1	1	Undefined	Undefined	Undefined	Undefined	Undefined	SMPTE ST 379-1 and -2
I1	Interlaced Frame, 1 field KLV Element	1	2	SEPARATE_ FIELDS	Field	Frame	Frame	Frame	SMPTE ST 379-1 only
I2	Interlaced Frame, 2 fields KLV Element	2	1	FULL_FRAME	Frame	Frame	Frame	Frame	SMPTE ST 379-1 and -2
F1	Field-wrapped Picture Element	1	1	SEPARATE_ FIELDS	Field	Field	Field	Field	SMPTE ST 379-1 and -2
Cn	Clip- wrapped Picture Element	n/a	n/a	FULL_FRAME	Frame	Frame	Frame	Frame	SMPTE ST 379-1 and -2
P1	Frame- wrapped Picture Element	1	1	FULL_FRAME	Frame	Frame	Frame	Frame	SMPTE ST 379-1 and -2

Annex B Illustration of the JPEG 2000 Picture Sub-Descriptor (Informative)

The figure below illustrates how the MXF JPEG 2000 sub-descriptor can be the target of a strong reference from either the CDCI descriptor or the RGBA descriptor. The distinction between the arrow and diamond symbol symbols is that the arrow symbol represents inheritance (dependency) and the diamond symbol represents ownership (composition). The modelling method used in this illustration is based on the Unified Modelling Language (UML) and more on metadata modelling can be found in SMPTE EG 377-3



Annex C Bibliography (Informative)

Note: All references in this document to other SMPTE documents use the current numbering style (e.g. SMPTE ST 274:2008) although, during a transitional phase, the document as published (printed or PDF) may bear an older designation (such as SMPTE 274M-2008). Documents with the same root number (e.g. 274) and publication year (e.g. 2008) are functionally identical.

A bibliography of other standards is provided here for information purposes. Other standards not listed may also be relevant.

SMPTE ST 274:2008, Television — 1920 × 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates

SMPTE ST 296:2012, 1280 × 720 Progressive Image 4:2:2 and 4:4:4 Sample Structure — Analog and Digital Representation and Analog Interface

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

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

SMPTE RP 210, Metadata Element Dictionary

SMPTE RP 224, SMPTE Labels Register

SMPTE EG 42:2004, Television — Material Exchange Format (MXF) — MXF Descriptive Metadata

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

ISO/IEC 15444-3:2007, Information Technology — JPEG 2000 Image Coding System — Part 3: Motion JPEG 2000, Amendment 2: Motion JPEG 2000 Derived from ISO Base Media File Format

ISO/IEC 15444-12:2012, Information Technology — JPEG 2000 Image Coding System — Part 12: ISO Base Media File Format

Recommendation ITU-R BT.601 (03/11), Studio Encoding Parameters of Digital Television for Standard 4:3 and Wide Screen 16:9 Aspect Ratios

Revision Notes

This version incorporates Amendment #1 to SMPTE ST 422:2013 approved May 13, 2014. The purpose of the revision is to fill in a value, left as TBD, in Table 6 of Section 8.2.3.

Change the last row of Table 6 as follows:

From:

J2CLayout	RGBALayout	var	Dyn	TBD	Opt	The nature and order of the image components in the compressed domain as carried in the J2C codestream. The RGBALayout data type is defined in SMPTE ST 377-1 G.2.40	

To:

J2CLayout	RGBALayout	var	Dyn	06.0e.2b.34 01.01.01.0E 04.01.06.03 0E.00.00.00	Opt	The nature and order of the image components in the compressed domain as carried in the J2C codestream. The RGBALayout data type is defined in SMPTE ST 377-1 G.2.40	