SMPTE ST 422:2022
Revision of SMPTE ST 422:2019

SMPTE STANDARD

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

Table of Contents

445 Hamilton Ave., White Plains NY 10601, (914) 761-1100
Approved March 28, 2022

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 specified in its Standards Operations Manual. This SMPTE Engineering Document was prepared by Technology Committee 31FS.

This revision:

- clarifies that the "FU" Undefined Frame-based wrapping is deprecated for new applications but still in use in some applications;
- updates normative references.

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 clause is entirely informative and does not form an integral part of this Engineering Document.

This standard maps JPEG 2000 codestreams, which contain coded still pictures, into the 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 key-length-value (KLV) coding, the essence container and compression label values, and the essence descriptor.

This document does not specify mappings for JPEG 2000 file formats, such as the JP2 file format defined in ISO/IEC 15444-1.

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 conforming to ISO/IEC 15444-1 and ISO/IEC 15444-15 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 clause or subclause 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 377-1:2019, Material Exchange Format (MXF) — File Format Specification

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, Information Technology — JPEG 2000 Image Coding System — Part 1: Core Coding System

ISO/IEC 15444-15, Information Technology — JPEG 2000 Image Coding System — Part 15: High-Throughput JPEG 2000

4 Terms and Definitions

For the purposes of this document, the terms and definitions specified in SMPTE ST 377-1:2019, SMPTE ST 379-1:2009, SMPTE ST 379-2:2010, ISO/IEC 15444-1, and ISO/IEC 15444-15 apply.

In case of conflict, the terms and definitions of SMPTE ST 377-1 shall take precedence.

5 JPEG 2000 mappings

5.1 General

The MXF Generic Container (GC) is fully described in SMPTE ST 379-1:2009 and SMPTE ST 379-2:2010.

This standard specifies the mapping of JPEG 2000 codestreams into the JPEG 2000 Picture Element that may be used in the picture item of the MXF GC. The JPEG 2000 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 Picture Element. This standard also defines the essence container and compression label values and the essence descriptor.

5.2 JPEG 2000 coding summary (informative)

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

A JPEG 2000 coded bitstream, which is defined in ISO/IEC 15444-1, starts with a start of codestream (SOC) marker and ends with an end of codestream (EOC) marker. In between the SOC and EOC markers are other markers for identification of key parts of the codestream together with the compressed image data. The syntax of the JPEG 2000 codestream is defined in ISO/IEC 15444-1. A JPEG 2000 codestream can contain marker segments not defined in ISO/IEC 15444-1, including those specified in ISO/IEC 15444-15.

5.3 High-throughput JPEG 2000 (HTJ2K) coding summary (informative)

ISO/IEC 15444-15 specifies a High-Throughput (HT) block coding algorithm that can be used in place of the block coding algorithm of ISO/IEC 15444-1. The HT block coding algorithm increases decoding and encoding throughput and allows mathematically lossless transcoding to and from the block coding algorithm of ISO/IEC 15444-1. This is achieved at the expense of some loss in coding efficiency and substantial elimination of quality scalability.

5.4 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 379-1:2009 and SMPTE ST 379-2:2010.

The following wrapping modes are defined:

- "FU" Undefined Frame-based wrapping
- "P1" Progressive Frame-based wrapping
- "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 subclauses immediately below.

5.5 "FU" Undefined Frame-based wrapping and "P1" Progressive Frame-based wrapping

The essence container shall be frame-wrapped.

As illustrated in Figure 1, each Content Package shall contain a Picture Item that consists of a single JPEG 2000 Picture Element (see subclause 6.1). A system item is optional in this essence container.

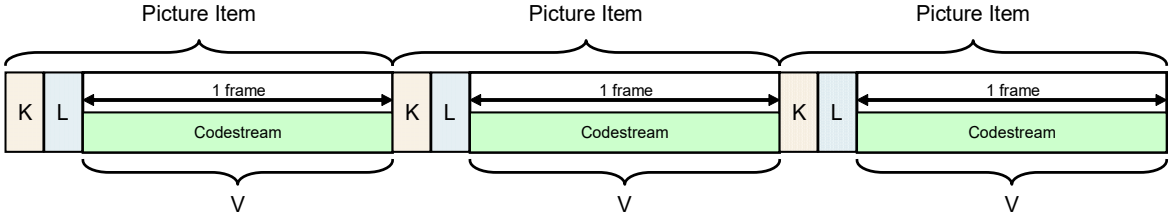

Figure 1 — "FU" Undefined Frame-based wrapping and "P1" Progressive Frame-based wrapping.

Progressive-scanned frames shall be labelled with Essence Container Label "P1", as specified in subclause 6.1.3.7.

Essence Container Label "FU" should not be used in new applications.

NOTE 1 Earlier versions of this standard defined Essence Container Label "FU" (see subclause 6.1.3.2), without specifying sufficient metadata to determine if the pictures were progressive-scanned or interlace-scanned. In such legacy material, the picture scanning parameters are inferred circumstantially or by other means depending on the application.

NOTE 2 D-Cinema applications, as specified in SMPTE ST 429-2, use Essence Container Label "FU" strictly with progressive pictures, i.e., an MXF file referenced by a D-Cinema Composition that conforms to SMPTE ST 429-2 uses progressive pictures.

This essence container may contain other interleaved essence elements, as illustrated in Figure 2. These other essence elements shall be as defined by this or other MXF mapping standards. All essence elements shall be frame wrapped. For simplicity of operation, each frame should contain essence elements that are independent of other frames. Interleaved essence elements that are inter-frame coded are not prohibited, but their inclusion might impact the performance of codecs. All essence elements in each interleaved frame should be time coincident within the limits of human recognition.

NOTE 3 The term "frame-based wrapping" is defined by SMPTE ST 379-1:2009 and SMPTE ST 379-2:2010 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, and can be the result of coding fields from an interlaced scanned picture or frames from a progressively scanned picture.

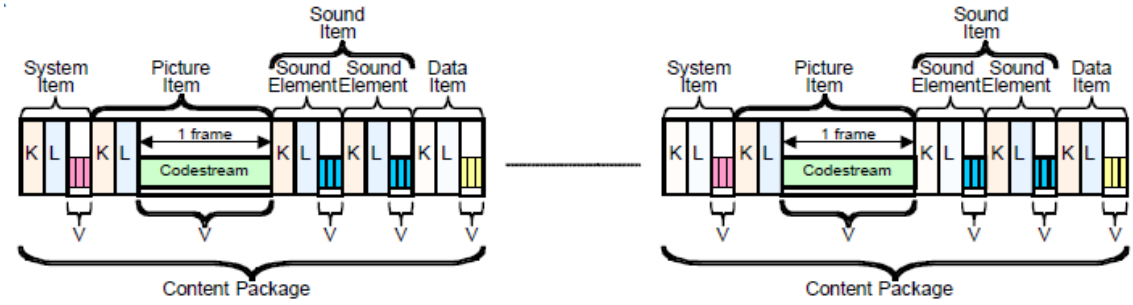

Figure 2 — Frame-based wrapping of interleaved items and elements in the Generic Container.

NOTE 4 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.

5.6 "I1" interlaced Frame wrapping, 1 field per KLV Element

The essence container shall be frame-wrapped.

As illustrated in Figure 3, each Content Package corresponds to a single interlaced picture, and shall contain a Picture Item with two JPEG 2000 Picture Elements (see subclause 6.1), each corresponding to a single interlaced picture field.

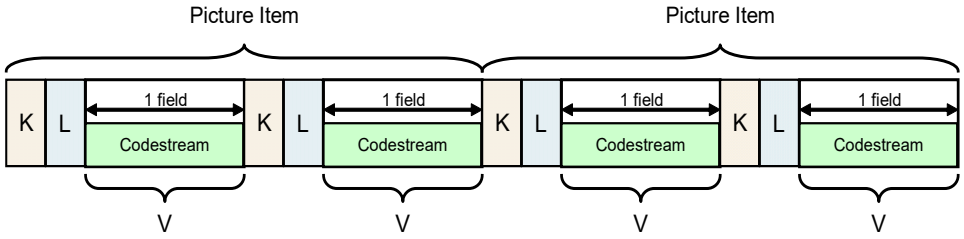

Figure 3 — "I1" Interlace Frame wrapping, 1 field per KLV element.

The first JPEG 2000 Picture Element shall contain the first field of the interlaced picture. The two JPEG 2000 Picture Elements may be separated by a KLV Fill Item.

This essence container may contain other interleaved essence elements.

5.7 "I2" interlaced Frame wrapping, 2 fields per KLV Element

The essence container shall be frame-wrapped.

As illustrated in Figure 4, each Content Package corresponds to a single interlaced picture, and shall contain a Picture Item with one JPEG 2000 Picture Element containing two concatenated JPEG 2000 codestreams, each representing a single picture field.

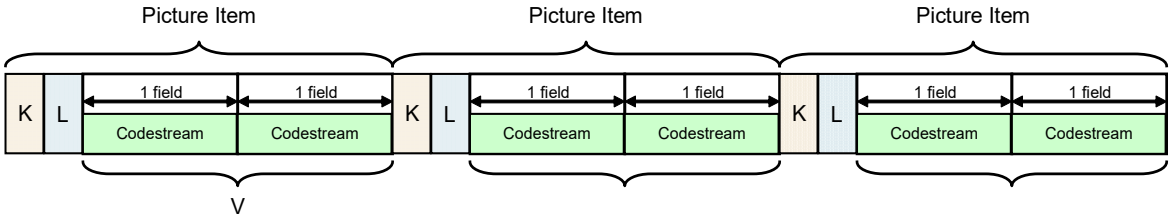

Figure 4 — "I2" Interlace Frame wrapping, 2 fields per KLV element.

This essence container may contain other interleaved essence elements.

5.8 "F1" Field wrapping, 1 field per KLV Element

The essence container shall be frame-wrapped.

As illustrated in Figure 5, each Content Package corresponds to a single field of an interlaced picture, and shall contain a Picture Item with one JPEG 2000 Picture Element (see subclause 6.1) corresponding to the single picture field.

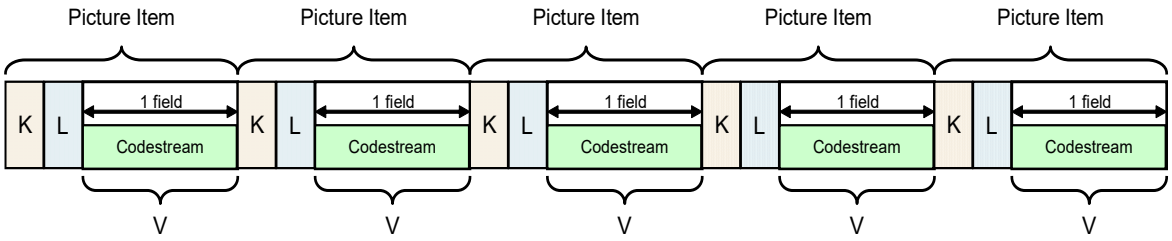

Figure 5 — "F1" Field wrapping, 1 field per KLV element.

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

5.9 "Cn" Clip-based wrapping

The essence container shall be clip-wrapped.

As illustrated in Figure 6, the Content Package shall contain a Picture Item with a single JPEG 2000 Picture Element (see subclause 6.1) whose value is a sequence of concatenated JPEG 2000 codestreams.

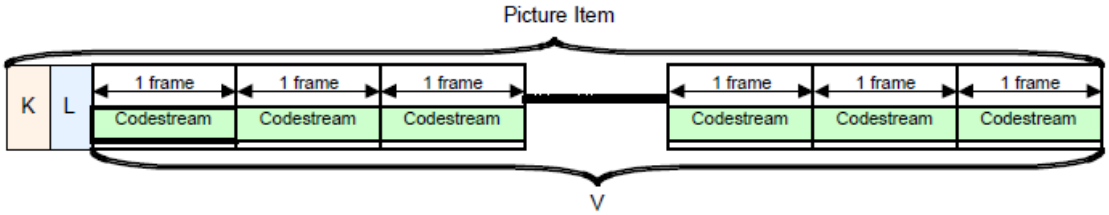

Figure 6 — "Cn" Clip-based wrapping.

The JPEG 2000 Picture Element may be the sole element in the content package.

The JPEG 2000 Picture Element may also be accompanied by other essence elements as illustrated in Figure 7. All essence elements should have identical duration.

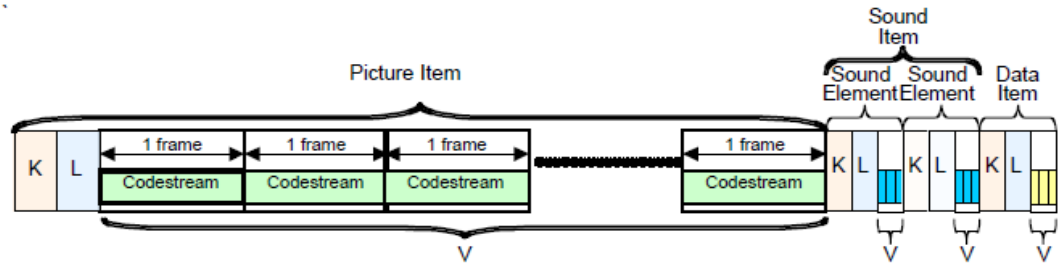

Figure 7 — "Cn" Clip-based wrapping with other essence elements.

6 Key-length-value coding

6.1 JPEG 2000 Picture Element

6.1.1 Key

The values of the first 12 bytes of the essence element key are defined in SMPTE ST 379-1:2009 and SMPTE ST 379-2:2010. 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 by Generic Container		See SMPTE ST 379-1:2009 and SMPTE ST 379-2:2010
13	Item Type Identifier	15h	GC Picture Item, as defined in SMPTE ST 379-1:2009 and SMPTE ST 379-2:2010
14	Essence Element Count	kkh	Count of Picture Elements in the Picture item
15	Essence Element Type	08h	Not Clip-wrapped JPEG 2000 Picture Element
		09h	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

6.1.1.1 Essence element count — Byte 14

This is a count of the number of Picture Elements in the picture item of the Generic Container.

6.1.1.2 Essence element type — Byte 15

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

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

6.1.1.3 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 379-1:2009 and SMPTE ST 379-2:2010, which shall remain constant within the Generic Container.

In the case of "I1" wrapping mode, 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 For an Essence Container with a single Picture Element, Essence Element Count equals 2 and Essence Element Number equals 1.

In all other wrapping modes, one Picture Element is composed of one KLV Element, and the Essence Element Count shall include a count of 1 for each Picture Element.

6.1.2 Length

The length field shall comply with SMPTE ST 379-1:2009 and SMPTE ST 379-2:2010.

6.1.3 Value

6.1.3.1 General

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, as specified in ISO/IEC 15444-1.

NOTE 1 Users are cautioned that the code values for SOC and EOC are not protected and can 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.

NOTE 2 As detailed at ISO/IEC 15444-1, a JPEG 2000 codestream can contain marker segments and parameter values not defined in ISO/IEC 15444-1, including those specified in ISO/IEC 15444-15.

6.1.3.2 "FU" Frame-wrapped, undefined interlace

The value field shall comprise a single JPEG 2000 codestream.

6.1.3.3 "I1" interlaced Frame, 1 field per KLV Element

The value field shall comprise a single JPEG 2000 codestream.

In this case, the Picture Item of the Generic Container shall consist of pairs of essence elements, numbered according to subclause 6.1.1.3 above.

6.1.3.4 "I2" interlaced Frame, 2 fields per KLV Element

The value field shall comprise two concatenated JPEG 2000 codestreams, corresponding to the first field followed by the second field of the interlaced picture.

NOTE Decoders can derive the bytestream offsets of each field by analyzing the code stream format within the essence element as described in ISO/IEC 15444-1.

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

The value field shall comprise a single JPEG 2000 codestream.

6.1.3.6 "Cn" Clip-wrapped

The value field shall comprise a sequence of one or more concatenated JPEG 2000 codestreams.

6.1.3.7 "P1" Frame-wrapped

The value field shall comprise a single JPEG 2000 codestream.

6.2 Essence container UL

The values for the essence container UL, as specified in SMPTE ST 379-1:2009 and SMPTE ST 379-2:2010, are specified 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 379-1:2009 and SMPTE ST 379-2:2010
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	"FU" Frame- wrapped (Undefined interlace) Picture Element
		02h	"Cn" Clip- wrapped Picture Element
		03h	"I1" Interlaced Frame, 1 field/KLV
		04h	"I2" Interlaced Frame, 2 fields/KLV
		05h	"F1" Field-wrapped Picture Element
		06h	"P1" Frame- wrapped Picture Element
16	Reserved	00h	

NOTE 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.

6.3 Picture Essence Coding Labels

Labels intended for use as values for the Picture Essence Coding item of the Generic Picture Essence Descriptor, specified in SMPTE ST 377-1:2019, are specified in Table 3 and Table 4.

Table 3 — Picture Essence Coding Labels for codestreams according to ISO/IEC 15444-1.

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 codestreams according to ISO/IEC 15444-1
		02h	2K IMF Single Tile Lossy Profile (ISO/IEC 15444-1)
		03h	4K IMF Single Tile Lossy Profile (ISO/IEC 15444-1)
		04h	8K IMF Single Tile Lossy Profile (ISO/IEC 15444-1)
		05h	2K IMF Single/Multi-Tile Reversible Profile (ISO/IEC 15444-1)
		06h	4K IMF Single/Multi-Tile Reversible Profile (ISO/IEC 15444-1)
		07h	8K IMF Single/Multi-Tile Reversible Profile (ISO/IEC 15444-1)
16	JPEG 2000 Picture Coding Constraints	See SMPTE Label Register	Identifies coding constraints for the intended application.

Table 4 — Picture Essence Coding Labels for codestreams according to ISO/IEC 15444-15.

Byte No.	Description	Value (hex)	Meaning
1-14	Same as Table 3		
15	JPEG 2000 Picture Coding Variant	08h	Identifies HTJ2K codestreams according to ISO/IEC 15444-15
16	JPEG 2000 Picture Coding Constraints	01h	No application coding constraints indicated.

NOTE 1 Previous versions of this specification stated that the node with the symbol ISOIEC154441JPEG2002 indicates a generic application that has no coding constraints. Using a node as the value of the Picture Essence Coding item is however not recommended.

NOTE 2 The Picture Essence Coding item of the Generic Picture Essence Descriptor is intended to allow a decoder to fast-fail when processing the MXF file. The CAP, SIZ and PRF marker segments present within the JPEG 2000 codestream, and replicated in the JPEG 2000 Picture Sub-Descriptor, provide complete information on the capabilities required to decode the codestream and the profile to which the codestream conforms, if any. For example, the value of the CAP marker segment can indicate that the JPEG 2000 codestream belongs to a constrained codestream set (as specified in ISO/IEC 15444-15) even though the Picture Essence Coding Label indicates no application coding constraints.

7 Application issues

7.1 General

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

7.2 Application of the KAG and the KLV Fill item

MXF encoders and decoders shall comply with the KAG rules defined in SMPTE ST 377-1:2019, subclause 5.4.1.

The default value of the KAG is 1. Other KAG values may be used within the range defined by SMPTE ST 377-1:2019, subclause 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.

7.3 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 EG 377-3 illustrates the use of index tables for both mono and multi-essence mappings and for both constant and variable length edit unit sizes.

7.4 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.

7.5 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 379-1:2009 and SMPTE ST 379-2:2010).

Interlaced Frame, 1 field per KLV Element (see subclause 6.1.3.3) constructs a single Picture Element from two KLV elements, which is not consistent with SMPTE ST 379-2:2010, subclause 4.1, which defines a Content Element to be a single KLV element of any kind belonging to a Content Item.

7.6 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 377-1:2019, subclause 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 377-1:2019) 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 1 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 2 With the exception of those properties that have been defined in SMPTE ST 377-1:2019, all local tag values in descriptors defined in this standard are dynamically allocated (Dyn) as described in SMPTE ST 377-1:2019, subclause 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 377-1:2019, subclause 9.2 (primer pack).

8.2 JPEG 2000 Picture sub-descriptor

8.2.1 General

Essence tracks that use the JPEG 2000 essence mapping may use the values of the JPEG 2000 picture sub-descriptor as defined in Table 7. 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 377-1:2019. In order that the strong reference can be made, the MXF generic descriptor, as defined in SMPTE ST 377-1:2019, has an additional optional property as defined in Table 5.

Table 5 — 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 377-1:2019, 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 1 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.

NOTE 2 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.

NOTE 3 Applications specify requirements for the presence of optional items. Applications can, for instance, require the presence of optional items if the underlying parameters are present in the JPEG 2000 codestreams.

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

8.2.2 Key

The set key of the JPEG 2000 picture sub-descriptor shall be as defined in Table 6.

Table 6 — Key value for the JPEG 2000 picture sub-descriptor.

Byte No.	Description	Value (hex)	Meaning
1~13	As defined in SMPTE ST 377-1:2019, 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

8.2.3 Length

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

8.2.4 Descriptor value

Table 7 — 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	
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	
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. 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.	
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.	
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.	
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.	
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.	
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.	
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.	
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.	

Item Name	Type	Len	Local Tag	UL Designator	Req?	Meaning	Default
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. 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 Component SizingArray	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 Ssizi, XRsizi, YRsizi (as defined in ISO/IEC 15444-1). 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	DataValue	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 and comprises the sequence of Scod (1 byte), SGcod (4 bytes) and Spcod (5 bytes plus 0 or more precinct size bytes).	
Quantization Default	DataValue	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 and comprises the sequence of Sqcd (1 byte) followed by one or more Sqcdi bytes (for the ith sub-band in the defined order in ISO/IEC 15444-1).	
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 377-1:2019, G.2.40.	

Item Name	Type	Len	Local Tag	UL Designator	Req?	Meaning	Default
J2K Extended Capabilities	J2KExtended Capabilities	var	Dyn	06.0e.2b.34 01.01.01.0E 04.01.06.03 0F.00.00.00	Opt	Signals that extended capabilities were used to create (and are recommended or required to decode) a codestream. The value is a record that comprises the Pcap parameter followed by an array of consisting of the Ccap[i] parameters of the CAP Marker Segment, as specified in ISO/IEC 15444-1.	
J2K Profile	UInt16Array	var	Dyn	06.0e.2b.34 01.01.01.0E 04.01.06.03 10.00.00.00	Opt	Signals the profile to which the codestream conforms. Profiles provide limits on the codestream syntax parameters. The value comprises an array of the Pprf[i] parameters of the PRF Marker Segment, as specified in ISO/IEC 15444-1.	
J2K Corresponding Profile	UInt16Array	var	Dyn	06.0e.2b.34 01.01.01.0E 04.01.06.03 11.00.00.00	Opt	Facilitate the reversible transcoding of HTJ2K codestreams, as specified in ISO/IEC 15444-15, to and from codestreams that conform to Rec. ISO/IEC 15444-1. The value comprises an array of the Pcpf[i] parameters of the CPF Marker Segment, as specified in ISO/IEC 15444-15.	

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 is 1 frame.

The format of the source coding shall be specified in the FrameLayout 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 temporally the first field of an interlaced frame.

Also when using separate fields, the appropriate value of the Essence Container UL (see subclause 6.2 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 377-1:2019, subclause 9.4.

NOTE 1 Timecode counts frames, not fields, thus the EditRate of Timecode Tracks will always be the precise frame rate, in all wrapping modes including in mode "F1".

NOTE 2 SMPTE ST 377-1:2019 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 377-1:2019, Annex F.4 and Annex G provide 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 377-1:2019, 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 379-2:2010, Subclause 7.2	Frame Layout SMPTE ST 377-1:2019, Annex G.2.1	Sample Rate SMPTE ST 377-1:2019, Annex G.2.2	Edit Rate SMPTE ST 377-1:2019, Annex B.12	Index Rate SMPTE ST 377-1:2019, Subclause 11.2.3	Aspect Ratio SMPTE ST 377-1:2019, Annex G.2.4	Compatible with
FU	Frame-wrapped Picture Element (Unspecified)	1	1	Undefined	Undefined	Undefined	Undefined	Undefined	SMPTE ST 379-1:2009 and ST 379-2:2010
I1	Interlaced Frame, 1 field KLV Element	1	2	SEPARATE_ FIELDS	Field	Frame	Frame	Frame	SMPTE ST 379-1:2009 only
I2	Interlaced Frame, 2 fields KLV Element	2	1	FULL_FRAME	Frame	Frame	Frame	Frame	SMPTE ST 379-1:2009 and ST 379-2:2010
F1	Field-wrapped Picture Element	1	1	SEPARATE_ FIELDS	Field	Field	Field	Field	SMPTE ST 379-1:2009 and ST 379-2:2010
Cn	Clip- wrapped Picture Element	n/a	n/a	FULL_FRAME	Frame	Frame	Frame	Frame	SMPTE ST 379-1:2009 and ST 379-2:2010
P1	Frame- wrapped Picture Element	1	1	FULL_FRAME	Frame	Frame	Frame	Frame	SMPTE ST 379-1:2009 and ST 379-2:2010

Annex B Illustration of the JPEG 2000 picture sub-descriptor (informative)

Figure B.1 illustrates how the 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 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). More on metadata modelling can be found in SMPTE EG 377-3.

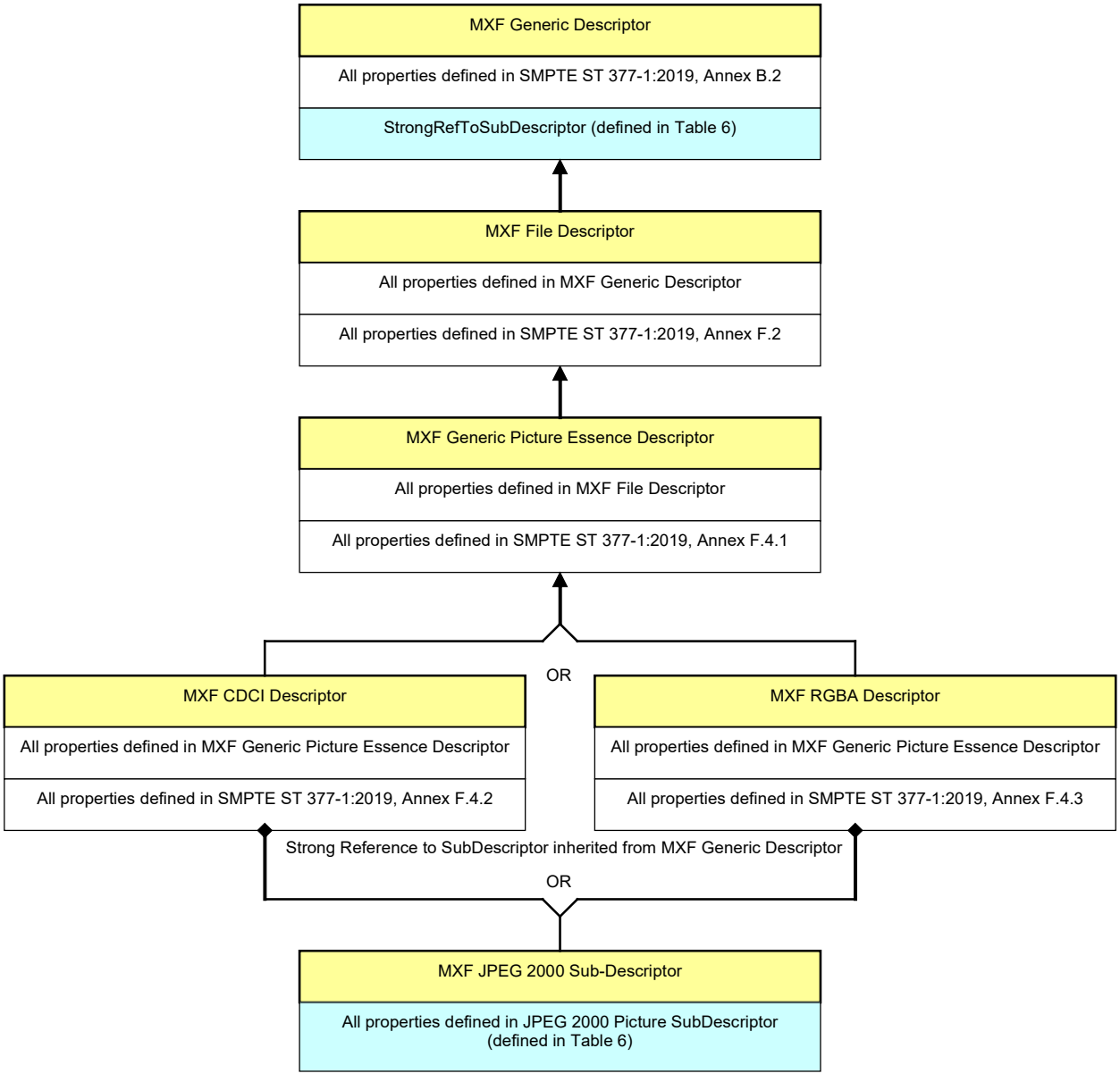

Figure B.1 — JPEG 2000 Picture Sub-Descriptor

Bibliography (informative)

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

SMPTE ST 429-2, D-Cinema Packaging — DCP Operational Constraints