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SMPTE STANDARD

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

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Foreword

SMPTE (the Society of Motion Picture and Television Engineers) is an internationally-recognized standards developing organization. Headquartered and incorporated in the United States of America, SMPTE has members in over 80 countries on six continents. SMPTE's Engineering Documents, including Standards, Recommended Practices, and Engineering Guidelines, are prepared by SMPTE's Technology Committees. Participation in these Committees is open to all with a bona fide interest in their work. SMPTE cooperates closely with other standards-developing organizations, including ISO, IEC and ITU.

SMPTE Engineering Documents are drafted in accordance with the rules given in 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.

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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

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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.

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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.

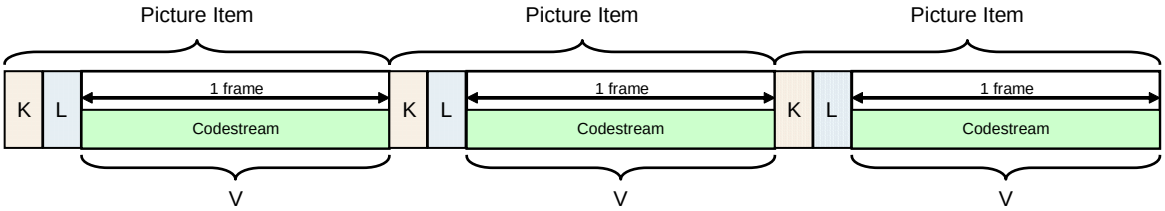

Figure 1 – Frame-based wrapping JPEG 2000 picture elements in the generic container

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.

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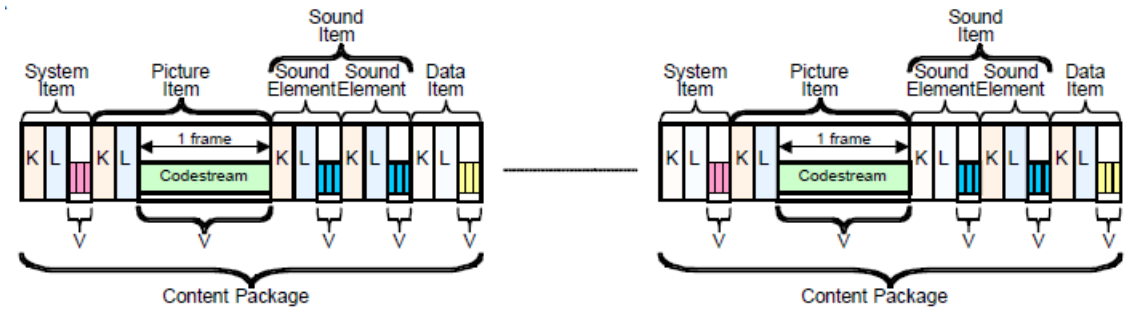

Figure 2 – Frame-based wrapping of interleaved items and elements in the generic container

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.

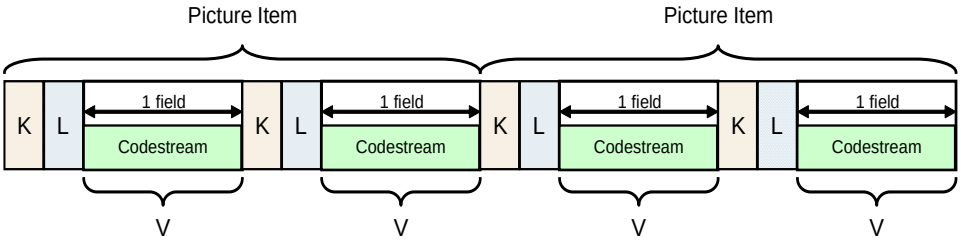

Figure 3 –"I1" Interlace Frame wrapping JPEG 2000 picture elements, 1 field per KLV element

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.

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