Proposed SMPTE Standard for Television —

SMPTE 393M

Material Exchange Format (MXF)

Operational Pattern 2b (Play-List Items, Ganged Packages)

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1 Scope

This document defines Operational Pattern 2b for the exchange of an MXF file which represents a playlist of ganged (synchronized) Essence Containers. The Essence Containers may be internal or external to the file. This document defines the operating restrictions, structural metadata objects and individual attributes that shall be applied to the MXF File Format Specification to achieve interoperability when exchanging an MXF file as a playlist of ganged Essence Containers.

Operational Pattern 2b is intended to meet the requirements of acquisition, storage and interchange applications where more than one essence component is required and it is wished to carry these in four or more Essence Containers. Operational Pattern 2b does require the use of Body Partitions for Internal Essence Containers. Subdivision of each Essence Container by using Body Partitions is optional.

2 Normative References

The following normative documents contain provisions that, through reference in this text, constitute provisions of this Document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative documents referred to applies.

SMPTE 377M-2003, Television: MXF File Format Specification

3 Glossary of Acronyms, Terms and Data Types

The full glossary of acronyms, terms and data types used in the MXF specification is given in the MXF File Format Specification. It is not repeated here to avoid any divergence of meaning.

Essence Element — An Essence Container may contain many Essence Elements interleaved together. An Essence Element in this document corresponds to a separable part of the interleave which is described by an MXF Essence Track, such as a Picture Track, a Sound Track or a Data Track.

4 Introduction

This document defines MXF Operational Pattern 2b. In SMPTE 377M the properties of the generalized Operational Patterns are defined. In the MXF Engineering Guideline SMPTE EG41, the concepts of Operational Patterns and the general conditions for audio-visual material interchange and interoperability are described in outline form. The introductory sections of these documents are not repeated here.

4.1 Operational Pattern 2b Overview

Generalized MXF Operational Patterns are defined as a combination of the two dimensions as defined in SMPTE 377M. This Operational Pattern shall be defined as follows:

4.1.1 Item complexity

Play-list Items: The file contains several concatenated items. Each item is defined by ganged top-level File Packages. Each and every Material Package Track shall comprise an identical number of SourceClips. The normalized Start Position of the Nth SourceClip in each and every track shall be the same (normalized Start Position$_N$= *(Start Position of SourceClip$_N$ + Origin of Track)/Edit Rate of Track)*). Each Material Package Track shall have an identical duration.

4.1.2 Package complexity

Ganged Packages: The Material Package references multiple top-level File Packages that are ‘played’ together against a common output timeline. The ‘ganged’ essence streams can be regarded as a single stream that represents a continuous recording as indicated in below.

These two dimensions are broadly illustrated in informative Figure 1 below.

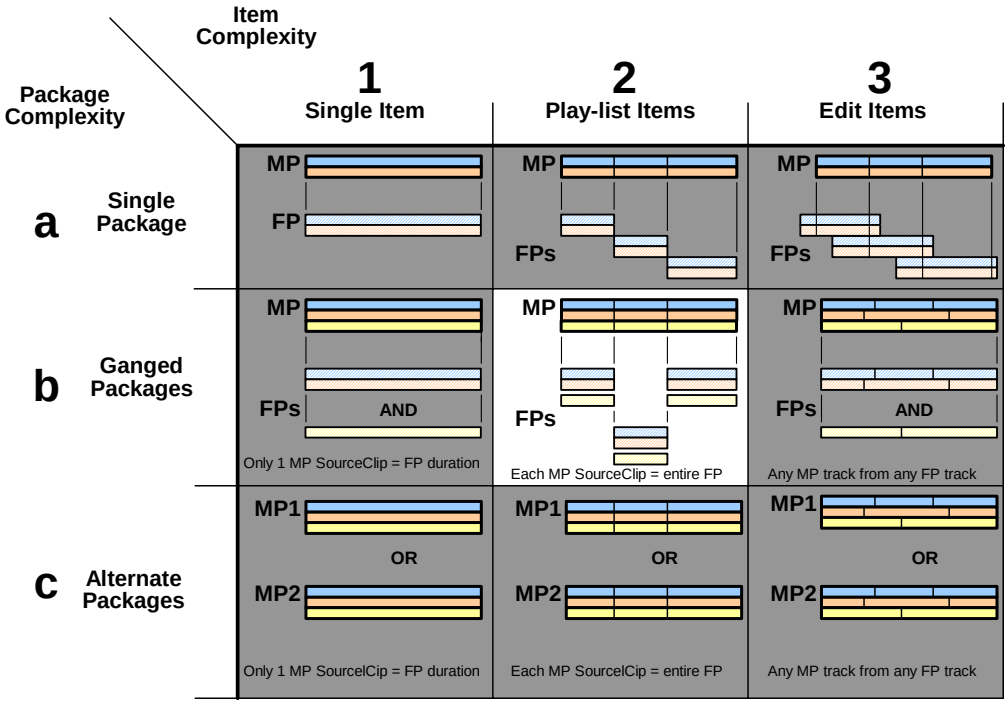

Figure 1 (informative): Item & Package Complexity

This Operational pattern defines an MXF file of Play-List Items, with each Item comprising a Ganged Package as illustrated in the centre box of Figure 1.

4.2 Material, File and Source Package Relationships

This Operational Pattern has two or more Essence Containers that are intended to be played synchronously. Each Essence Container is comprised of either a single essence element or interleaved essence elements. The Essence Containers comprise essence stream data that represents a continuous recording as indicated in Figure 2 below.

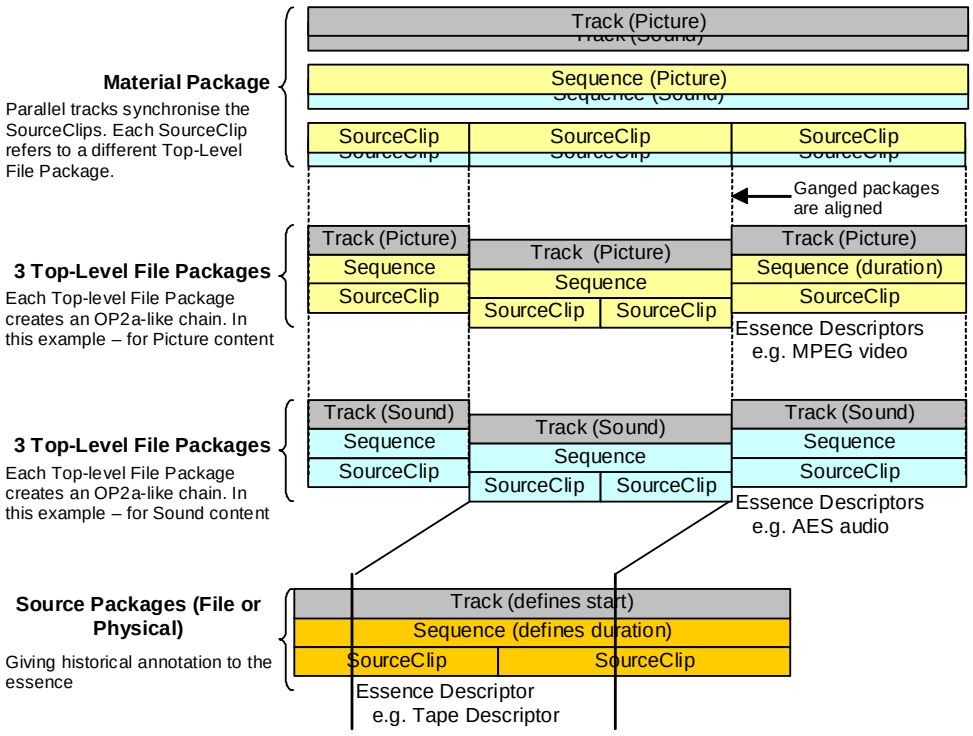

Figure 2 (informative): Outline of Operational Pattern 2b

5 Application

Operational Pattern 2b is an extension of Operational Patterns 1b and 2a where the output comprises a playlist (contiguous sequence) of multiple ganged (synchronized) Essence Containers containing the audio-visual items. The ganged Essence Containers may contain a play-list of shots, a single clip or a single item of program material. Any Track of a Material Package shall only create references to Essence Containers of a single type. All Essence Containers shall provide for the continuous decoding of contiguous essence elements.

The minimum implementation of Operational Pattern 2b will satisfy the requirement for a concatenation of multiple clips as a programme, with metadata support for each clip as well as metadata support for the programme as a whole.

Informative note: an example of the use of this operational pattern is where a video data stream is carried by one set of Essence Containers with another (synchronized) set of Essence Containers carrying the associated audio data stream. The final file may be a playlist of a logo/identifier, followed by the content, followed by some black / silence. This may be needed where production of the video and audio are carried out by separate facilities or where audio is produced in both stereo and multi-channel formats. Operational Pattern 2b constrains all the splice points between SourceClips to be synchronous – no “jaggy cut points” are allowed.

5.1 Constraints

A list of general constraints for this Operational Pattern is given in Table 1

Table 1: General Constraints for Operational Pattern 2b

File Kind	**MXF**
"Operational Pattern"	2b: (Play-list of items with multiple ganged Essence Containers)
Role	Continuous Recording, interchange of production items as a bundled playlist of entities.
Essence	Multiple Ganged Essence Containers, Operational Pattern Qualifiers apply (see MXF Format document SMPTE 377M)
Material Packages	1
Number of Material Package SourceClips for each Essence Track	>1
Top-level File Packages	>=4 (up to number of material package SourceClips times number of material package tracks) Zero or more top-level File Packages may be external to the file.
Number of Essence Container Types	1 or more
Lower-level Source Packages	0 or more
Partition limits	None
Body Partitions	Required. If there are ***N*** internal Essence Containers, a file shall have at least ***N-1*** Body Partitions within it.
Index Tables	Optional, but recommended
Editing Support	Simple play-list output
Streaming Support	According to Operational Pattern Qualifiers (see section 6.4.2)

Note that the "Number of Material Package SourceClips" in Table 1 above refers only to Essence Tracks. Operational Patterns are intended to constrain the Essence handling of an MXF application, so in the case where the essence is continuous and only the Metadata in a file has multiple SourceClips, it is likely that the file is an Operational Pattern lower than 2b.

Note that "1 or more" Essence Container Types is also subject to the continuity of essence condition in 7.2.3. When using the MXF Generic Container, it is possible that there will be several different Essence Container Labels being signaled in a file (e.g. one for the audio, another for the video). Each and every track is subject to the continuity conditions in 7.2.3.

6 Header Metadata Specification

6.1 General

The Structural Metadata sets and the normative Universal Label used to identify this Operational Pattern are defined in the MXF File Format Specification document with specific constraints and additions detailed below.

6.2 Constraints on the MXF Packages

- The Material Package shall have more than one SourceClip per essence track.
- Each top-level File Package shall have one track for each essence element in the Essence Container.
- The Material Package SourceClips shall start and end synchronously across each and every Material Package Track.

- The Material Package may have a different start time to the top-level File Package start times to allow a change to the initial timecode on playback
- Lower-level Source packages, when present, shall be used to define the historical context of editing

6.3 Universal Label for Operational Pattern 2b

The Universal Label value to define this Operational Pattern shall be as defined in the table below.

Table 2: Value of the MXF Operational Pattern Identification Universal Label

Byte No.	Description	Value (hex)
1-12	Defined in the MXF File Format Specification Operational Patterns Section	-
13	Operational Pattern: Item Complexity	02h
14	Operational Pattern: Package Complexity	02h
15	Operational Pattern :Qualifiers (application dependent)	(see SMPTE 377M)
16	Operational Pattern: OP2b qualifiers	(see Table 3)

The meanings of the bytes in this Label are specified in the Operational Pattern section of the MXF File Format Specification. Bytes 13 and 14 uniquely identify this Operational Pattern specification and Byte 15 contains generic qualifiers which are defined in the MXF File Format Specification. Byte 16 contains a qualifier which is specific to this Operational Pattern.

6.4 Operational Pattern Qualifiers

This Operational Pattern shall support the qualifiers as specified in byte 15 of the Operational Pattern Universal Label. Each bit of byte 15 shall be correctly set, as defined by SMPTE 377M, to reflect the status of the Essence Container.

6.4.1 Essence Container Location

The Essence Containers should be embedded in the File Body for interchange applications.

The Essence Containers may be externally referenced for certain specialized applications. Example applications might include shared-storage networks, archives and other applications where the access to an Essence Container is localized and the locator value (defined by a Locator Set in SMPTE 377M) is persistent.

If all the Essence Containers are internal to the file, then bit 1 shall be set to zero. Guidance on external essence is given in SMPTE EG41, the MXF Engineering Guideline.

6.4.2 Interleaving of Multiple Essence Tracks

Essence Containers used in this Operational Pattern should be streamable.

If all the Essence Containers are streamable, and have been multiplexed in a way that makes the overall file streamable, then bit 2 shall be set to zero. If the Primary Package references any external Essence then the file shall not be made streamable. Guidance on streamability is given in SMPTE EG41, the MXF Engineering Guideline.

6.4.3 Number of Essence Tracks

This Operational Pattern supports multiple Essence Containers, each with one or more essence tracks.

If all the Essence Containers have a single essence track, then bit 3 shall be set to zero.

6.4.4 Qualifiers specific to this Operational Pattern

Each bit of byte 16 shall be correctly set, as defined in Table 3 and in the subsections which follow.

Table 3: Byte 16 of the Operational Pattern label

Bit number	Values and Descriptions
0-3	Reserved for future use, encoder should set to zero
4	=0 no inter-SourceClip processing needed At the join of 2 Material Package SourceClips, no special processing is required. An essence decoder will be able to decode the stream which results from the data from the first SourceClip butted onto the second SourceClip. =1 no knowledge of the inter-SourceClip processing is available No assumptions can be made about the processing required to butt edit the essence streams. A Long GOP MPEG stream may require extra frames to pre-charge the decoder. Other essence types may require other processing.
5-7	Reserved for future use, encoder should set to zero

6.5 Minimum Implementation Recommendation

All constraints given in the MXF File Format Specification shall apply unless specifically overridden or extended in this document. The minimum implementation of Operational Pattern 2b is recommended to have the following limits in reference to the MXF File Format Specification. This section is a recommendation because the exact structure of the sets depends on how many of the top-level File Packages reference external data

1 Preface set, 1 or more Identification sets and 1 Content Storage set and 2 or more Essence Container Data Sets

One Material Package including:

- the sets for the Timecode track
- the sets for each Picture track as required by the Essence Container
- the sets for each Sound track as required by the Essence Container
- the sets for each Data track as required by the Essence Container

Four or more top-level File Packages each including:

- the sets for each Picture track as required by the Essence Container
- the sets for each Sound track as required by the Essence Container
- the sets for each Data track as required by the Essence Container

Informative Note: Support for Descriptive Metadata is optional but at least one scheme should be included in order to get the best from an MXF file.

The Annexes of the MXF Format Specification give the properties of the sets which should be implemented. All required set properties should be supported by MXF encoders that comply with this Operational Pattern.

7 MXF File Interchange: Essence Container issues

7.1 Essence Container Identification

The value of the Essence Container Universal Label shall be defined by the appropriate Essence Container Specification document. This value shall be recorded in the Essence Containers property of the Preface Set and all Partition Packs and in the Essence Container property of the appropriate Essence Descriptor set.

7.2 Essence Container requirements in Operational Pattern 2b

7.2.1 Number of essence elements

There are no constraints on the number of essence elements in an individual Essence Container.

7.2.2 Interleaving of essence elements

For Operational Pattern 2b, interleaving of essence elements within an Essence Container is optional.

7.2.3 Continuity of essence elements

As stated in section 5, each Essence Container shall provide for the continuous decoding of contiguous essence elements. The Essence Container or essence element specifications may add extra restrictions to this condition.

For each Material Package track, the boundary between Essence Containers shall provide for the continuous decoding of contiguous essence elements.

In the case of compression algorithms involving Temporal Prediction (for example long GOP MPEG), it is likely that context information is needed at the start and end points of each SourceClip in order to pre-charge the Essence Decoder. Including this context information in an Operational Pattern 2b file is permitted. The number of extra frames included should be the minimum number required to represent the context information without breaking any of the normative requirements of the underlying Essence Type.

An important phrase in this specification is “continuous decoding of contiguous Essence Containers”. When this condition is not met at the junction of 2 Material Package SourceClips, bit 4 of byte 16 shall be set according to Table 3. An obvious example is when context information is required as described in the paragraph above. A more subtle example could be the case of butting together, two closed GOP MPEG sequences. In principle, there is no context information required between the butting points, but unless the buffer conditions in each clip are matched, then processing shall be required for continuous decoding of contiguous Essence Containers and so bit 4 of byte 16 in Table 3 shall be set to 1.

An example of this principle is given in an informative annex of SMPTE 392M - Operational Pattern 2a.

The audio tracks at Essence Container boundaries may be processed on the output decoder to prevent clicks and to reduce listener fatigue. The Essence Container or essence element specifications may add further restrictions.

The Essence Container specification contains Essence Descriptor sets which define the source coding and any compression coding. Each Essence Descriptor property value which could otherwise prevent continuous decoding shall be constant for the duration of the Material Package track.

7.2.4 Number of essence tracks

The number of picture, sound and data essence tracks is defined by the number of picture, sound and data essence elements in each Essence Container.

7.2.5 Use of Body Partitions

This Operation Pattern requires the use of at least one Partition for each internal Essence Container. If there are N internal Essence Containers, there will be at least N-1 Body Partitions within the file.

Annex A (Informative)
Bibliography

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5. SMPTE 392M, Operational Pattern 2a
6. SMPTE 312M-2001, Television : Splice Points for MPEG-2 Transport Streams