AMWA Draft Document

AS-07 MXF Archive and Preservation Format

REVIEW DRAFT, September 23, 2014

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Recipients of this review document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

The review period ends on November 10, 2014. Send comments to Carl Fleischhauer (Library of Congress; cfle@loc.gov).

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Executive Summary

The AS-07 Application Specification, when published, will specify a vendor-neutral subset of the MXF file format for the long-term archiving and preservation of moving image and other audiovisual content together with associated materials. Among other features, AS-07 defines a means for the carriage of multiple timecodes; the handling of captions, subtitles, and Timed Text; a minimal core metadata set; program segmentation metadata; and embedded content integrity data.

The overall application specification has been written broadly, to cover a wide range of audiovisual content. One shim has been prepared for release with the initial publication of the specification and several additional shims have been identified for future development including *born digital* (retain and rewrap essence as acquired), *scanned film* and other content types with RGB- and XYZ-based picture essences, and *audio-only*. Interest has also been expressed in some additional content types, including telemetry data, HDR imagery, and multi- and hyper-spectral imagery.

The shim included in the initial release is the *AS-07 Baseband Shim: Single Items from Baseband Video*, which is intended to serve the most critical current needs of many archives: the reformatting of older analog and digital videotapes and, for some organizations, the encoding and packaging of "live" video streams sent to an archive via a serial interface. The AS-07 Baseband Shim is Appendix J in this document and has also been compiled as a separate document, available at the AMWA Web site [URL].

Document Status

AS-07 is based on AS-AP, drafted from 2009-2012 by the Audio-Visual Working Group of the Federal Agencies Digitization Guidelines Initiative (FADGI; earlier and related documents linked from this page: http://www.digitizationguidelines.gov/guidelines/MXF_app_spec.html). Working from the 2012 version of AS-AP, the specification evolved under the auspices of the Advanced Media Workflow Association (AMWA; http://www.amwa.tv). This 2014 draft is being presented for community review; interested persons should send comments to Carl Fleischhauer (cfle@loc.gov). Please send comments by Monday, November 10, 2014. At that time, the AS-07 development team will begin the process of revising the draft specification.

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Contents

1 Scope (informative)

This document describes a vendor-neutral subset of the MXF file format to use for long-term archiving and preservation of moving image content and associated materials including audio, captions and metadata.

AS-07 files may contain a single item, or an entire series of items.

AS-07 files are not intended for direct online access, however they may include renditions intended for viewing without further processing.

AS-07 files are intended to be used in combination with external finding aids or catalog records. The external finding aids are used for day to day access to the archive collection. At the same time, AS-07 files must stand alone, so they would retain their value even if they were the only extant copy of an item.

AS-07 will be extended and revised over time, and new editions will be published. In this draft, the Baseband Shim specified in appendix J is an important element. The Baseband Shim is intended to serve the most critical current use case for memory institutions: the reformatting of existing and obsolescent videotapes in their collections. The Baseband Shim is also intended to serve memory institutions (and others) who may be acquiring digital video ingested via serial interfaces, e.g., congressional high definition video transferred to the Library of Congress via HD-SDI or its equivalent. In both of these use cases, memory institutions wish to archive the highest possible quality of image and sound (uncompressed or losslessly compressed), as well as retaining source data such as multiple timecodes, captions and subtitles, and also embed metadata that will support authentication and management of the content for the long term.

2 Conformance Language

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 Reference Documents

The following standards contain provisions which, through reference in this text, constitute provisions of this recommended practice. 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.

AMWA AS-02	MXF Versioning
AMWA AS-03	MXF Program Delivery
AMWA AS-04	Language Tagging
AMWA AS-xx	Content Integrity [forthcoming]
AMWA AS-11	MXF Contribution Format

EBU R 48	Allocation of audio tracks on digital television recorders
EBU R 123	Audio Track Allocation for File Exchange
EBU R 122	Material Exchange Format Timecode Implementation
EBU 3264	Subtitling data exchange format
EBU 3285	Specification of the Broadcast Wave Format (BWF) - Version 2 - (2011)
EBU 3299	High Definition (HD) Image Formats for Television Production

SMPTE EG 42:2004	Material Exchange Format (MXF) — MXF Descriptive Metadata
SMPTE RP 224	SMPTE Universal Labels Register
SMPTE RP 2008:2011	Material Exchange Format — Mapping AVC Streams into the MXF Generic Container
SMPTE RP 2027:2011	AVC Intra-Frame Coding Specification for SSM Card Applications
SMPTE RP 2057:2011	Text-Based Metadata Carriage in MXF
SMPTE 12-1:2014	Time and Control Code
SMPTE 12-2:2014	Transmission of Time Code in the Ancillary Data Space
SMPTE ST 298:2008	Universal Labels for Unique Identification of Digital Data
SMPTE ST 330:2004	Unique Material Identifier (UMID)
SMPTE ST 331:2011	Element and Metadata Definitions for the SDTI-CP
SMPTE ST 334-1:2007	Vertical Ancillary Data Mapping of Caption Data and Other Related Data
SMPTE ST 334-2:2007	Caption Distribution Packet (CDP) Definition
SMPTE ST 337:2008	Format for Non-PCM Audio and Data in an AES3 Serial Digital Audio Interface
SMPTE ST 336:2007	Data Encoding Protocol Using Key-Length-Value
SMPTE ST 338:2010	Format for Non-PCM Audio and Data in AES3 — Data Types
SMPTE ST 339:2008	Format for Non-PCM Audio and Data in AES3 — Generic Data Types
SMPTE ST 340:2008	Format for Non-PCM Audio and Data in AES3 — ATSC A/52B Digital Audio Compression Standard for AC-3 and Enhanced AC-3 Data Types
SMPTE ST 356:2001	Type D-10 Stream Specifications — MPEG-2 4:2:2P @ ML for 525/60 and 625/50
SMPTE ST 365:2001	12.65-mm Type D-10 Format for MPEG-2 Compressed Video — 525/60 and 625/50
SMPTE ST 377-1:2011	Material Exchange Format (MXF) — File Format Specification
SMPTE ST 377-4:2012	MXF Multichannel Audio Labeling Framework
SMPTE ST 378:2004	MXF Operational pattern 1A (Single Item, Single Package)
SMPTE ST 379-1:2010	MXF Generic Container
SMPTE ST 379-2:2010	MXF Constrained Generic Container
SMPTE ST 381-1:2005	Mapping MPEG Streams into the MXF Generic Container
SMPTE ST 382:2007	Mapping AES3 and Broadcast Wave Audio into the MXF Generic Container
SMPTE ST 384:2005	Mapping of Uncompressed Pictures into the MXF Generic Container
SMPTE ST 385:2004	Material Exchange Format (MXF) Mapping SDTI-CP Essence and Metadata into the MXF Generic Container
SMPTE ST 386:2004	Mapping Type D-10 Essence Data to the MXF Generic Container
SMPTE ST 391:2004	MXF Operational Pattern 1b (Single Item, Ganged Packages)
SMPTE ST 392:2004	MXF Operational Pattern OP2a
SMPTE ST 405:2006	Material Exchange Format (MXF) Elements and Individual Data Items for the MXF Generic Container System Scheme 1
SMPTE ST 408:2006	MXF Operational Patterns 1c, 2c, and 3c
SMPTE ST 410:2008	MXF Generic Stream Partition
SMPTE ST 422:2014	Mapping of JPEG 200 Codestreams into the MXF Generic Container

SMPTE ST 429-6:2006   D-Cinema Packaging – MXF Track File Essence Encryption
SMPTE ST 436:2006   MXF Mappings for VBI Lines and Ancillary Data Packets
SMPTE ST 2016-1:2009 Format for Active Format Description and Bar Data
SMPTE ST 2016-2:2007 Format for Pan-Scan Information
SMPTE ST 2016-3:2007 Vertical Ancillary Data Mapping of Active Format Description and Bar Data
SMPTE ST 2016-4:2007 Vertical Ancillary Data Mapping of Pan-Scan Information
SMPTE ST 2035:2009   Audio Channel Assignments for Digital Television Recorders (DTRs)

CEA 608E   Closed Captioning Data on line 21
CEA 708E   DTV Closed Captioning

ISO 13818 (several parts)   MPEG-2
ISO 15444-1:2004   JPEG 2000 Core Coding
ISO/IEC 15444-1:2004/Amd 3:2010
                      JPEG 2000 Core Coding Broadcast Profiles

ITU H.264   Advanced Video Coding (a.k.a. ISO 14496-10 MPEG-4 part 10)

IETF RFC 5646 (2009) Tags for Identifying Languages

SCTE 35   Splice Point Markers

4   Glossary: Acronyms and Terms

Acronym or Term	Description
AES3	Professional digital audio transport standard (Audio Engineering Society 3).
AFD	Active Format Description.
Ancillary Data	Any Essence data other than Video or Audio that may be embedded in a bit stream that carries Video and Audio and may be contained in the AS-07 file.
Associated Materials	Embedded digital representations of materials closely associated with the file's essences, e.g., scanned images and documents, video trailers, scripts, etc. These are items that are unrelated to the timeline or that are unevenly distributed along the timeline and that will be stored in Generic Stream Partitions (SMPTE ST 410-2008).
Audio	Essence data of any type contained in the AS-07 file that contains audio data.
Audio Item	Component of the MXF Content Package that stores the package-level sound data, e.g., the data for one frame of audio when essences are frame-wrapped. There is only a single Audio Item per content package; each Audio Item is comprised of one or more Audio Elements. *See also Content Package, Data Item, Generic Container, Picture Item, and System Item.*
Audio Services	Audio tracks that include elements other than the soundtrack for picture. Examples include Descriptive Video Services (DVS), Secondary Audio Program (SAP), annotations (like a director's commentary for a dramatic program), as well as other types of multiple language content or other versioning elements. Sound tracks on certain videotape formats may also carry timecode data, e.g., the carriage of LTC on track three of the 1-inch type C format. *See also Descriptive Video Services (DVS) and Secondary Audio Program (SAP).*
AVC-Intra	A video compression standard that is compliant with H.264 but uses intraframe only coding.
Clip-wrapping	Essence carriage in which a single Content Package contains all of the essence data for the file. Each individual essence (video, audio, timecode, etc.) is presented in its entirety, followed by the next essence type. Does not support efficient playout since picture, audio, and other essence data are stored separately and a decoder must wait for all of the video to be delivered before

	beginning to receive audio and other elements. *See also Frame-wrapping and Content Package.*
Closed Caption	Text transcription or description of the audio/video data. In this specification, synonymous with subtitling.
Collection Files (AS-07)	AS-07 Collection Files contain essences that are organized as Operational Pattern OP3c. AS-07 Collection Files have multiple Material Packages and permit external references, the targets of which must be AS-07 Item Files. Content example: multiple episodes or instances in a series for which an organization wishes to archive an MXF file that "virtually binds" the collection. *See also Item Files (AS-07) and Segmentation.*
Content Integrity Data	Data that supports monitoring of the condition of stored data or files, typically by means of comparisons of past and present fixity information, i.e., hash values or checksums. Sometimes called *Message Integrity Code* (MIC) or *Media Integrity Check* (MIC) data. In a file format specification, the focus is on content integrity data embedded in the file. *See also Content Integrity Data, Cryptographic Context Set, Cryptographic Framework, Encrypted Triplet Variable Length Pack, and MIC.*
Content Package	The main component of MXF's essence-carrying Generic Container. Each Content Package carries a portion of the overall essence payload, and the packages are sequentially stored in the Generic Container until all of the essence has been stored. Content Packages are divided into essence items, each of which represents one type of material in the package: picture, audio, or other data, including compound essence items. *See also Audio Item, Content Package, Data Item, Generic Container, Picture Item, and System Item.*
Cryptographic Context Set	Similar to MXF Descriptive Metadata Schemes (DMS), Cryptographic Context Sets are part of the digital cinema security structure and are standardized in SMPTE ST 429-6:2006. Cryptographic Context Sets are included in AS-07 to support consistency with ST 429-6 in terms of Content Integrity practices. *See also Content Integrity Data, Cryptographic Framework, and Encrypted Triplet Variable Length Pack.*
Cryptographic Framework	Similar to MXF Descriptive Metadata (DM) Frameworks, Cryptographic Frameworks are part of the digital cinema security structure and are standardized in SMPTE ST 429-6:2006. Cryptographic Frameworks are included in AS-07 to support consistency with ST 429-6 in terms of Content Integrity practices. *See also Content Integrity Data, Cryptographic Context Set, Encrypted Triplet Variable Length Pack, and MIC.*
Cryptographic Framework DM Tracks	*See Cryptographic Framework.*
Data Item	Component of the MXF Content Package that stores continuous package-level data that is neither picture nor audio, e.g., Ancillary Data such as subtitles and other VBI data. There is only a single Data Item per content package; each Data Item is comprised of one or more Data Elements. *See also Ancillary Data, Audio Item, Content Package, Generic Container, Picture Item, and System Item.*
Descriptive Metadata	Generic term used for descriptive data stored in MXF files whose purpose is to describe Essence data.
Descriptive Metadata Track	An MXF Track that contains Descriptive Metadata.
Descriptive Video Services (DVS)	Additional narration track intended primarily for blind and visually impaired consumers of visual media, also called audio description, video description, or visual description. DVS consists of a narrator describing what is happening on the screen during pauses in the audio and/or during dialog if necessary. *See*

	also Audio Services
Descriptors	A family of metadata entities defined in the SMPTE standards that govern the MXF format. SMPTE standard ST 377-1:2011 defines an abstract generic descriptor superclass as well as a number of specific subclass instances, including descriptors for picture essences, audio essences, and data essences, each of which carries important parametric information about the essences. Another important example, related to timecode, is the Date/Time Descriptor specified in SMPTE ST 385:2012. *See also Subdescriptors.*
Digital Provenance Metadata	See *Process Metadata* and *Sampling Metadata*.
DAM	Digital Asset Management, often a system.
DM	See *Descriptive Metadata*.
DM Scheme Label	The value stored in an MXF file's Preface:DMSchemes property. See SMPTE EG 42:2004.
DM Segment	An MXF structure used to generically contain Descriptive Metadata on a Track. See SMPTE ST 377-1:2011.
DMS Segmentation	Descriptive Metadata Scheme for Segmentation. See *Segmentation.*
Dolby E	Professional audio encoding standard developed by Dolby Laboratories.
D-10	A video compression standard that is compliant with MPEG2 but uses intraframe only coding.
Edit Unit	Generally used to name the smallest portion of an essence stream that can be edited, e.g., a field or frame of a picture, or an audio sample. In the glossary for the SMPTE ST 377-1:2011, the preceding definition is linked to the term *Editable Unit*, with Edit Unit defined in temporal terms and related to Edit Rate. Customary usage, however, associates *Edit Unit* with entities like video frames.
EBU STL	EBU R 3264 subtitling specification. *See also closed caption.*
Encrypted Triplet Variable Length Pack	Part of the digital cinema security structure standardized in SMPTE ST 429-6:2006, the Encrypted Triplet Variable Length Pack carries MIC hash values and encryption data. *See also Cryptographic Context Set, Cryptographic Framework, Content Integrity Data, and MIC.*
Essence	The bitstreams that contain video, audio, or ancillary data, the presence of which will influence the designation of the file's Operational Pattern, meaning that the elements categorized as essence will be part of the content playout expressed in the file's Material Package. In non-MXF contexts, the term essence may carry different meanings.
Essence Partition	An MXF file Partition that is dedicated to storing Essence data.
Essence Element	An Essence stream within an Essence Container.
Filler	An MXF structure used to describe empty space on a Timeline Track. See SMPTE ST 377-1:2011.
Frame-wrapping	Essence carriage in which each Content Package contains all of the data for a single frame of the file. Permits efficient playout since picture, audio, and other time-based elements are available simultaneously. *See also Clip-wrapping and Content Package.*
Generic Container	MXF data structure used to store Essence data in an MXF file as specified in SMPTE ST 379-2:2010. The Generic Container is a contiguous sequence of Content Packages. *See Content Package.*
Generic Stream Partition	Partition that can be used to carry text-based data (e.g., Timed Text) or binary data, specified in SMPTE ST 410:2008.
Hard-Parted Program	A type of Segmentation. Breaks between segments are required. *See also Segmentation, Single-Part Program, and Soft-Parted Program.*
Header Metadata	MXF data structures that collectively describe the data in the Essence data in an MXF file. See SMPTE ST 377-1:2011.
Header Partition	The MXF file Partition that contains the Header Metadata.

Historical Source Timecode (AS-07)	AS-07 Historical Source Timecode is legacy timecode from source items, e.g., a videotape being reformatted, including but not limited to LTC, VITC and ATC. The term is taken from EBU R 122. AS-07 Historical Source Timecode may be discontinuous and shall not be used as the AS-07 Master Timecode.
Index Partition	An MXF file Partition that is dedicated to storing an Index Table.
Index Table	A structure in an MXF file used to efficiently access Essence data. See SMPTE ST 377-1:2011.
Intimate Metadata	Metadata that contains information to be synchronized with the essence, e.g., for analysis or at playout time. For example, some *process metadata* (*q.v.*) about the source stream uses timecode to document the time-location of certain readings or events that occurred when the stream was reformatted or analyzed.
Item Files (AS-07)	AS-07 Item Files contain internal essences organized as Operational Patterns 1a or 1b, featuring a single Material Package. Essences may be represented as segments using AS_07_Segmentation_DMS. See also *Collection Files (AS-07)* and *Segmentation.*
KLV Fill	Refers to the well-defined means of inserting empty, "fill", data in an MXF file. See SMPTE ST 377-1:2011.
KLV Triplet	Triple units of data encoded using the KLV (Key-Length-Value) structure specified in SMPTE ST 336:2007. *Key* identifies the data via a code, *Length* specifies the data's length, and *Value* is the data itself.
Logging Metadata	See *Process Metadata*.
Manifest	XML data structure that provides an overview of the files parts and content together with other data such as optional content integrity checksums.
Master Timecode (AS-07)	AS-07 Master Timecode is represented using MXF Structural Metadata, specifically using a Timecode Track; the canonical and continuous representation of timecode, providing references into the essence for all timecode-dependent activities. Sometimes referred to as synthetic timecode.
Material Package	An MXF data structure that contains Tracks and identifiers that describe the file's content. See SMPTE ST 377-1:2011.
Metadata	Data about data. See *Descriptive Metadata*, *Descriptive Metadata Track*, *Metadata Scheme Definition*, *Process Metadata*, and *Supplementary Metadata*.
MIC	Variously glossed as Message Integrity Code (digital cinema, SMPTE ST 428-6:2006) and Media Integrity Check (AMWA MXF application specification AS-02), this refers to a fixity or hash value used to monitor the condition of stored data. *See also Content Integrity Data.*
MPEG-2	ISO/IEC 13818 video compression
Operational Patterns OP1a, OP1b, and OP3c.	Constrained applications of MXF, pertaining to the number and relationship between essence elements, as specified in SMPTE ST 378:2004, SMPTE ST 391:2004, and SMPTE ST 408:2006.
Package	*See Source Package and Material Package.*
Partition	A division that exists in MXF files to divide and separate Essence data, Generic Streams, Index Table data, or Header Metadata; specified in SMPTE ST 377-1:2011. *See also Generic Stream Partition*.
PCM	Pulse Code Modulation audio encoding.
Picture Item	Component of the MXF Content Package that stores the package-level picture data, e.g., the data for one frame of picture when essences are frame-wrapped. There is only a single Picture Item per content package; each Picture Item is comprised of one or more Picture Elements. *See also Audio Item, Content Package, Data Item, Generic Container, and System Item.*
Picture Track	An MXF Track that references Video essence.
Process Metadata	Metadata that documents the general facts about the system, settings, facility, and operator when a video signal is transferred, e.g., in a reformatting (tape to file) activity. Often produced on a frame-by-frame or even sample-by-sample

	basis. Sometimes called *Sampling Metadata*. In the digital library community, this is part of *digital provenance metadata*. In AS-07, Process Metadata will often be a form of Supplementary Metadata, carried in a Generic Stream Partition.
Sampling Metadata	See *Process Metadata*.
Secondary Audio Program (SAP)	Also called Separate Audio Program or Second Audio Program, SAP is an auxiliary audio channel that can be broadcast or transmitted both over-the-air and by cable television. SAP is part of the multichannel television sound (MTS) standard originally set by the National Television Systems Committee (NTSC) in 1984 in the United States, and it is often used to provide audio tracks in languages other than the main language of a given program. It may also carry Descriptive Video Service (DVS) in the U.S. *See also Audio Services, Descriptive Video Service.*
Segmentation	The description of regions in a program's Essence data that contain non-program content or points where the program content may be interrupted to insert non-program content at broadcast time. In AS-07, segmentation descriptions are incorporated in AS_07_Segmentation_DMS and related elements. *See also Hard-Parted Program, Single-Part Program, and Soft-Parted Program.*
Segmentation Track	An MXF Track that contains Segmentation metadata.
Shim	An application specific constraints set that constrains an Application Specification in order to tailor the general specification to a specific purpose.
Shim parameter tags	Entities developed by AMWA to support automation in the production or use of MXF files constrained by Application Specifications and their shims. These tags identify content elements beyond the level provided by SMPTE ST 377-1, Material Exchange Format (MXF) — File Format Specification. Tables listing provisional AS-07 values for *shim parameter tags* are provided in this specification and in the shims presented as appendixes.
SID	See *Stream Identifier*.
Single-Part Program	A type of Segmentation. *See also Hard-Parted Program, Segmentation, and Soft-Parted Program.*
SMPTE 12M Timecode	Traditional timecode as specified by SMPTE 12-1:2014.
Soft-Parted Program	A type of Segmentation. Segment breaks are not required. *See also Hard-Parted Program, Segmentation and Single-Part Program.*
Source Essence	Essence data referenced by a Source Package.
Source Package	MXF data structure that describes source video, audio, or ancillary Essence data in an MXF file. See SMPTE ST 377-1:2011.
Source Timecode	Deprecated for AS-07. This term is used broadly in EBU R 122 to cover a range of timecode entities that include the ones named by the preferred AS-07 terms *Master Timecode* and *Historical Source Timecode*.
Stream Identifier	Unique identifier for a stream of bytes in an MXF file, abbreviated as SID.
Subdescriptors	One method to extend MXF Descriptors (a form of metadata). The subdescriptor superclass is defined in SMPTE ST 377-1:2011. In AS-07, for example, appendix C.2 builds on the superclass to define a subdescriptor for the timecode header label. *See also Descriptors.*
Supplementary Metadata	Metadata that supplements the metadata required by the MXF standards as specified in AS-07 (e.g., metadata in headers, DM Schemes, etc.). Supplementary Metadata may be represented by organization-specific descriptive ("cataloging") or administrative metadata, or by specialized forms of Process Metadata. In AS-07 files, Supplementary Metadata is carried in Generic Stream Partitions.
Synthetic Timecode	See *Master Timecode (AS-07).*

System Item	Component of the MXF Content Package that stores package-level metadata about the essence, e.g., frame-by-frame timecode values. There is only a single System Item per content package; each System Item is comprised of one or more System Elements. *See also Audio Item, Content Package, Data Item, Generic Container, and Picture Item.*
Timed Text	XML-based format for captions and subtitles derived from the W3C Timed Text standard, standardized by SMPTE and EBU and, in the U.S., required for Web dissemination by the Federal Communication Commission (FCC).
Timecode Component	An MXF structure that stores timecode information, specified in SMPTE ST 377-1:2011.
Timecode Track	An MXF Track that stores one or more Timecode Components.
Timeline Track	A specialized MXF track that describes a timeline by specifying an origin and rate, specified in SMPTE ST 377-1:2011.
Track::TrackNumber	A property in an MXF Timeline Track, specified in SMPTE ST 377-1:2011.
Track	MXF data structure used to describe the content structure, specified in SMPTE ST 377-1:2011.
Track::TrackName	The property that is the descriptive name of a Track, specified in SMPTE ST 377-1:2011.
Universal Label	Unique identifiers for metadata items, specified in SMPTE ST 298:2008.
Video	Essence data of any form contained in the AS-07 file that contains video data.

5   Overview (informative)

5.1 Summary of File Format Requirements

5.1.1 General

AS-07 files may contain a single item, a segmented series of items, or (via external reference) a collection of items. Detailed specifications are provided in sections 6.3 (Operational Patterns), 6.7.5 (Program Segmentation), and elsewhere.

AS-07 files may include one or several renditions of the items. Different renditions may arise from different original sources of the item; different renditions may also be created from multiple encodings of the original source using different image compression or encoding schemes. AS-07 files are not intended for direct online access, however they may include renditions intended for viewing without further processing.

5.1.2 Metadata

AS-07 files may contain metadata in several locations: in the MXF header; in DM tracks; in the form of closed captioning, other forms of Timed Text, and/or other ancillary data; and as text-based data (called AS-07 Supplementary Metadata) in Generic Stream Partitions (see 6.2.4). Supplementary Metadata will employ structures from other authorities (e.g., for MARC library cataloging) or follow an archive's local requirements. Such structures and requirement will be adopted or developed by archiving organizations and are not part of the AS-07 specification.

For many archiving organizations, the metadata embedded in AS-07 files will have a dynamic relationship to external metadata resources, e.g., databases associated with digital asset management (DAM) systems, external archival finding aids in machine-readable form, or library catalog records in a searchable cataloging system. Often, the metadata extracted from AS-07 files, e.g., at the time of ingestion, will populate elements or fields within the DAM databases, finding aids, or catalogs. Meanwhile, the external databases, finding aids, and catalogs support day-to-day access to items in the archived collection and may also provide additional or updated metadata elements to be inserted or appended in AS-07 files in the archival storage system.

At the same time, the AS-07 specification will permit files to stand alone, for the archives that choose to embed a full set of metadata in the file. For such implementations, AS-07 files will retain their full informational value

even if they were the only extant copy of an item, and in against the catastrophic loss of an archive's other metadata resources.

The metadata in AS-07 files will often represent information as it existed at the time of ingest or subsequent refresh of the item, including a reference to the source of the metadata and an audit trail of modifications to the metadata. The metadata in the files will often include an identifier that links to the external metadata, which in some cases will be more current than the embedded metadata. In some circumstances, as noted in the preceding paragraph, the embedded metadata could be used to regenerate external databases, finding aids, or catalog records when needed. As with any database re-creation activity, there is a risk that versions will not remain in sync and the usual data-updating precautions should be taken.

5.2 AS-07 General Specifications and Shim Specifications

To maximize commonality across applications, this specification is divided into general provisions that apply to all applications and specific constraint sets (called "shims") that apply to defined applications.

General provisions apply to all AS-07 files and thus represent the maximum required capability of cache and playout servers and transcoder operations.

Each shim provides a further set of constraints that reduce the range of variability that may be needed in well-defined categories of applications. These categories may address particular types of sources (e.g., from baseband streams, from motion picture film, or the ingestion of born-digital media), or they may address requirements of particular archive collections and uses (which may, for instance, dictate specific encoding formats or specific metadata).

5.3 Use-cases for Shims

The purpose of a shim is to describe the content that may be present in a particular variant of AS-07 files. This knowledge has several practical applications in archival systems, for example:

- To guide encoding equipment as to how to convert and condition original sources as they are prepared for submission, or after time has passed, as they are migrated to new formats for dissemination or continued preservation

- To guide quality assurance equipment that is used to verify input submissions or, as time passes, to monitor file integrity or other aspects relevant to long-term content preservation

- To guide cataloguers (both archivists and automated scanners) as to what metadata to expect in examining an input submission, and to indicate which types of metadata to expect as embedded in the file

5.4 Derivation of Shims

Shims do not add new capability to the general provisions. They are constraints on the general provisions. Thus, the general provisions are intentionally non-restrictive in some areas.

Shims may express stronger constraints than the general specification by strengthening the conformance language, e.g. strengthening "should" to "shall." Shims may also constrain parameter values to a set of permissible values that is a sub-set of those defined in the general specification. Shims may directly constrain the general provisions, or they may add further constraints to other less specialized shims. For ease of use, shims list the less-specialized shim from which they are derived. Shims can only add constraints to or remove choices from the shims from which they are derived; they cannot relax constraints or provide alternative parameters.

5.5 Combinations of Shims

In some cases an application needs to permit several different kinds of content, each with their own sets of constraints. Shims may express this by declaring an explicit choice between different, less-specialized shims.

6 Parameters and Constraints

6.1 Shim parameters and constraints

6.1.1 Shim parameters and constraints (informative)

MXF Application Specifications are statements of constraints. Each section or subsection not labeled as informative articulates a constraint. Formatting elements that are not stated or defined in this specification may be construed to be unconstrained, meaning that AS-07 encoders may employ all parts of those elements as permitted by SMPTE 377-1:2011, *Material Exchange Format (MXF) — File Format Specification*.

Shim parameter tags are entities developed by AMWA to support automation in the production or use of MXF files constrained by Application Specifications and their shims. These tags identify content elements beyond the level provided by SMPTE ST 377-1. The five-column tables in the main specification provide a set of permitted values that can further constrained in a shim, and they also state the strength of the constraint. For a given shim, the tables are extended with two additional columns that articulate the strength of the constraint for the shim and state the values that may be employed in files that conform to that shim's specifications.

6.1.2 Shim parameter constraint strengths and related terms

Within the shim parameter tables, the strength of shim parameters is categorized as follows:
- Gentle - a range of values or choices that individual shims may further restrict. An example of a gentle constraint pertains to the selection of identifier type for the program in an AS-07 file.
- Moderate - a set of values or choices that individual shims should choose between. An example of a moderate constraint pertains to the tagging of languages in soundtracks and captions or subtitles.
- Strong - the strongest constraints, i.e., a firm requirement that the value (or one of the approved values) be employed. An example of a strong constraint is the requirement that Timed Text conform to the SMPTE ST 2075:2013 or EBU Tech 3350 standards.

Some parameters may define the allowed presence of content elements. This is expressed using narrative conformance terms ("shall", "shall not", "may") and numerical parameters "minOccurs" and "maxOccurs" (as in XML Schema).

6.2 Essence Track Parameters and Constraints

6.2.1 General (informative)

AS-07 files shall contain moving image content ("video"), program audio (soundtrack), audio services (e.g., SAP, DVS), closed captioning, content integrity data and other ancillary data including binary data such as Associated Materials (still images, scripts, etc.), and text-based data such as XML-based Supplementary Metadata (other than DMS). The range of types of programs is specified in the sections pertaining to Operational Patterns (6.3) and Segmentation (6.7.5).

Incidentally, if a multi-program Transport Stream is received by an organization, the presumption is that each program in the Transport Stream will assume the role of primary essence in an MXF file. Organizations may choose to retain the original Transport Stream as an associated essence. The Manifest (6.7.1) will list everything in a given file.

6.2.2 Interleaving, Frame-, and Clip-wrapping

6.2.2.1 Interleaving, Frame-, and Clip-wrapping (informative)

Many AS-07 essences (e.g., from a digitized videotape) will be interleaved. Interleaving normally implies frame-wrapping, and interleaving with clip-wrapping would only apply to imported essence like MPEG TS or DV DIF, so will be uncommon. In any case, DV DIF is usually represented in a different way: "compound items." See section 6.2.10.4 (Retain Source Encoding as Acquired) for discussion of wrapping born digital content by importing but not transcoding certain selected essence formats.

The following section identifies two exceptions to the general rule that AS-07 be frame-wrapped. Another exception for audio-only files may emerge in future versions of AS-07.

6.2.2.2 Interleaving, Frame-, and Clip-wrapping requirements

Essence in each Generic Container in AS-07 Files may be interleaved or non-interleaved frame-by-frame. AS-07 encoders shall interleave or non-interleave Essence in AS-07 Files in accordance with the specifications for each shim.

AS-07 encoders shall framewrap Essences, with two exceptions:
- NICAM audio (see section 6.2.1.8).
- Custom wrapping may be explicitly required by a shim. Interleaving and wrapping shall be declared in KLV metadata keys as part of the essence container syntax.

6.2.3 Partitions

Essence in AS-07 Files may optionally be divided into Partitions. If Partitions are employed, encoders shall start new Partitions at the following intervals in terms of program time: each approximately 10 seconds (plus/minus 1 second) interval or approximate 1 minute (plus/minus 5 seconds) interval. Constraints to single or multiple partitions may be required by a shim.

If partition structures are inherited from pre-existing MXF-wrapped video, encoders shall respect and retain those pre-existing partitions, provided that that the pre-existing Partitions are not longer than 10 minutes of program time. Encoders shall insert new Partitions to meet this requirement. This requirement extends to D-10 essences that, in other contexts and as described in SMPTE RDD 3:2008, are not to be partitioned. Decoders shall be capable of reading files with Partitions as described in this section.

The Header Partition shall be marked closed and complete.

6.2.3.1 Shim Parameter Table for Essence Partitions

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
Essence Partition Strategy	Defines whether the essence is a single partition or divided into multiple partitions.	essence_partition_strategy	Strong	Single Multiple

6.2.4 Generic Stream Partitions

6.2.4.1 Generic Stream Partitions (informative)

Generic Stream Partitions (SMPTE ST 410:2008) are containers for generic data streams that may or may not be continuous or tied to the timeline, including classes of metadata that cannot be referenced from MXF Header Metadata. Each instance of a Generic Stream Partition will be associated with an instance of a Descriptive Metadata Scheme (DMS), as specified below.

Data streams in AS-07 Generic Stream Partitions that consist of Timed Text or EBU STL (both specified in section 6.2.12) will be considered to be essences, will be referenced in tracks in the file's Material Package, and will influence the determination of the file's Operational Pattern. Other text-based and binary data in AS-07 files will generally not be considered to be essences and will not influence the determination of an AS-07 file's Operational Pattern.

The three informative sections that follow provide information about entities that may be carried in AS-07 Generic Stream Partitions.

6.2.4.1.1 AS-07 Embedded Binary Data Objects: EBU STL and Associated Materials (informative)

Generic Stream Partitions (SMPTE ST 410-2008) can hold two types of embedded binary data objects: EBU STL and Associated Materials.

EBU STL is the European Broadcast Union (EBU) binary subtitling format standardized in EBU Tech 3264 (1991), and it is related to the timeline. Starting in 2013, EBU is encouraging members to adopt XML-based EBU Timed Text or EBU TT as a replacement for EBU STL, a form of encouragement reinforced in AS-07 in sections 6.2.12.1.8 (below).

Associated Materials are binary representations of materials closely associated with the file's primary essences, e.g., scanned images and documents, video trailers, etc. Associated Materials are unrelated to the timeline or may be unevenly distributed along the timeline. Associated Materials contribute to the completeness, comprehensibility, or usability of the information object represented by the AS-07 file. Associated Materials will often take the form of data files such as TIFF, JPEG, MP4, PDF, and the like.

6.2.4.1.2 AS-07 Embedded Text-Based Data Objects: Timed Text and Supplementary Metadata (informative)

Generic Stream Partitions (SMPTE ST 410-2008) in AS-07 files can hold three types of embedded text-based data objects: XML-structured Timed Text (SMPTE or EBU), Supplementary Metadata, and the AS-07 Manifest.

The carriage of Closed Captions or subtitles in the form of SMPTE ST 2052-1 Timed Text is important to organizations that use AS-07 files. Among other benefits, this carriage will permit the easy extraction and subsequent indexing of the textual data, thereby supporting the creation of a rich layer of searchable data in a moving image archive or library. Additional information and requirements pertaining to Timed Text will be found in section 6.2.12.1.

Supplementary Metadata augments the metadata required by the MXF standards as specified in AS-07 (e.g., metadata in headers, Descriptive Metadata Schemes, etc.). Supplementary Metadata may be represented by organization-specific descriptive ("cataloging") or administrative metadata, or by specialized forms of Process Metadata. It is often structured as XML.

The AS-07 Manifest, specified in section 6.7.1, provides summary information about the AS-07 file and its provenance, an inventory of the AS-07 file's parts and expresses the relationships between them, as well as a structure to contain part-level Message Integrity Codes (MIC, also called Media Integrity Check) data at the level of the edit unit (generally the same as a frame), as specified in section 6.7.2.

6.2.4.1.3 Descriptive Information About Entities Carried in Generic Stream Partitions (informative)

SMPTE ST 410-2008 states that, in some applications, "the precise nature of the stream data [carried in Generic Stream Partitions] will be unknown or 'dark.'" Although such carriage conforms to the standard and is acceptable in AS-07 files, organizations are encouraged to provide descriptions of the entities that are so carried. As noted, embedded binary data objects and embedded text-based data objects carried in AS-07 Generic Stream Partition Descriptive Metadata Scheme specified in section 6.6 and appendix F.1 as well as the AS-07 GSP Text-Based Data Descriptive Metadata Scheme specified in section 6.5 and appendix F.3 and the AS-07 GSP Binary Data Descriptive Metadata Scheme specified in section 6.6 and appendix F.2.

6.2.4.2 Generic Stream Partition Encoder Requirements

Encoders shall be capable of producing AS-07 files that contain Generic Stream Partitions (SMPTE ST 410-2008) within MXF Body Partitions and included in the Random Index Pack. Encoders shall be able to receive a Generic Steam Payload and write it to a valid Generic Stream Partition. Encoders shall accommodate any of the data stream types defined in Annex A of SMPTE ST 410-2008. Depending on the type of data contained, Generic Stream data may be distributed over several Generic Stream Partitions but each Generic Stream Partition shall contain only data from a single Generic Stream.

Encoders shall treat data streams in AS-07 Generic Stream Partitions that consist of Timed Text or EBU STL (both specified in section 6.2.12) as essences, and shall reference them in tracks in the file's Material Package, and use them to determine the file's Operational Pattern (OP1b when Timed Text is present).

For each instance of a Generic Stream Partition, encoders shall create an instance of Descriptive Metadata that adheres to a Descriptive Metadata Scheme or DMS. Encoders shall assign each Generic Stream Partition a StreamID (SID) that is unique within the file. Encoders shall construct Descriptive Metadata tracks as specified in section 6.6. AS-07's DMS structures are specified in appendixes D, E and F.

6.2.4.3 Generic Stream Partition Decoder Requirements

Decoders have no responsibility to understand or decode Generic Stream Partition payload content but shall recognize that a given file contains Generic Stream Partitions.

Decoders shall identify and extract the Generic Stream Partition payload and make them available to external applications.

Decoders shall be capable of identifying and reading all Descriptive Metadata tracks as specified in section 6.6.

6.2.5 Index Tables

If AS-07 files use Partitions, then encoders shall also write full MXF Index Tables, compliant with SMPTE ST 377-1:2009, including amd 2:2012. The full Index Tables shall index every frame of every Track in the file.

At each partition point in a given frame wrapped Essence component file, the Index Partition shall follow one of the patterns specified in SMPTE ST 377-1:2011 amd 2:2012 (table 26). This shall be specified by the shim.

The zero position of the Index corresponds to the start of the essence including pre-charge as specified in SMPTE ST 377-1:2011 (section 11, Index Table). Therefore, the first IndexTableSegment indicates an IndexStartPosition equal to zero. Shims may require a particular combination of Index Tables.

Decoders shall be capable of reading files with Index Tables as described in this section.

6.2.5.1 Shim Parameter Table for Index Tables

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
Index Strategy Frame	Defines the position of the index tables in the MXF file (frame wrapped essences); value terminology from SMPTE ST 377-1:2011 amd 2:2012.	index_strategy_frame	Moderate	Single index location Single essence location Forward index direction

6.2.6 Generic Container

AS-07 encoders shall map essences to the frame-based wrapping mode defined in ST 379-x (throughout this standard, ST 379-x refers to both ST 379-1 and ST 379-2), except for the clip-wrap exceptions identified in section 6.2.2.2 above.

JPEG 2000 broadcast-profile codestreams (ISO/IEC 15444-1:2004/Amd 3:2010) shall be carried in a SMPTE ST 422:2014-compliant GC Element, mapped as specified in 6.2.10.2 (below).

AS-07 files that encode D-10 shall map Essence into the MXF Generic Container as specified by SMPTE ST 386:2004 (Mapping Type D-10 Essence Data to the MXF Generic Container).

6.2.7 System Item

AS-07 encoders shall create System Items in Essence Containers following the requirements of SMPTE ST 379-1 or ST 379-2. AS-07 decoders shall be capable of decoding the Master Timecode as carried in System Items of AS-07 files.

6.2.8 Random Index Pack

AS-07 encoders shall write a Random Index Pack per SMPTE ST 377-1:2011 into a closed and complete AS-07 file. Decoders may use a Random Index Pack if one is present. When reading an AS-07 file, decoders may use other means, such as building data structures equivalent to a Random Index Pack, instead.

6.2.9 KAG Size

AS-07 encoders shall write files with the default KLV Alignment Grid of 1 unless this value conflicts with an underlying essence container specification. When a conflict exists, the value in that essence container specification shall be used. AS-07 files may contain more than one KLV Alignment Grid Size value but that value shall be constant (no variation) for each essence container. For ST 386:2004 "Mapping Type D-10 Essence Data to the MXF Generic Container," the KLV Alignment Grid is 512.

Decoders shall not rely upon any specific KAG Size.

6.2.10 Picture Essence Encoding

6.2.10.1 Broad Range of Picture Essences Possible (informative)

Moving image picture content that is wrapped by AS-07 will include a wide range of types: uncompressed, lossless compressed, or lossy compressed. The rasters may range to sizes as great as 8Kx8K, and picture may be in any bit depth, color mode or space, and interlaced or progressive In the future, organizations that archive or preserve moving image content wrapped in AS-07 may include 3D and high frame rate content and such elements as synchronized multiple picture tracks, and other formats still in development at this writing Some of these types of picture essences are still emergent and have not been defined and specified in this initial edition of AS-07.

The initial edition of AS-07 is intended to serve the needs of memory institution and other archives with a long term mission. Thus the first shim to be drafted is the Baseband Shim specified in appendix J, and designed to support one key priority for such archives: the reformatting of older analog and digital videotapes and the encoding and packaging of "live" video streams. AS-07 Baseband Shim files are for items derived from baseband video, understood to encompass both analog baseband and uncompressed digital video, and encoders will typically process a baseband (uncompressed) signal. For high picture quality the required preferred picture encodings for the baseband shim are those described in sections 6.2.10.2 (JPEG 2000 picture encoding) and 6.2.10.3 (uncompressed picture).

An additional priority, anticipated for the second shim and the second edition of AS-07, concerns the packaging and archiving of born digital content items in their lossy acquisition encodings, e.g., MPEG-2, DV, and the like. Such picture encodings are described in section 6.2.10.4 ("retain lossy encoding as acquired").

Additional future shims will focus on moving image content that results from film scanning or digital theatrical motion picture production.

6.2.10.2 Picture Essence – JPEG 2000 Compressed (Lossless or Lossy)

6.2.10.2.1 JPEG 2000 Essences and SMPTE ST 422 (informative)
This encoding, especially in the lossless or reversible mode, is typically selected by an archive that is formatting or reformatting content as a part of its own pre-ingest or ingest activity, e.g., transferring content from a videotape carrier, or scanning film, and also prefers to store a reduced-data file as compared to an uncompressed file. Although archives with a focus on the reformatting of old videotapes will employ only YUV-based components (e.g., YCbCr), use cases relevant for other archives will require the use of RGB- or XYZ-based components.

The required carriage for JPEG 2000 essences in section 6.2.10.2.2 references the 2013 revision of SMPTE ST 422, which specifies the mapping for six possible cases, three of which are permitted in AS-07 files:

> *Case P1*. Progressive scan frame wrapping, 1 frame per KLV element.

> *Case I1*. Interlaced scan frame wrapping, 1 field per KLV Element. An essence container that wraps JPEG 2000 compressed interlaced data with one field per KLVElement and one frame per Content Package shall comprise one or more pairs of KLVtriplets each of which shall contain one JPEG 2000 codestream.

> *Case I2*. Interlaced scan 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.

6.2.10.2.2   JPEG 2000 Essences and SMPTE ST 422

AS-07 encoders shall place JPEG 2000 picture essences in a SMPTE ST 422-compliant GC Element. AS-07 encoders shall produce YUV, RGB, or XYZ essence components unless the range of component types is further constrained by a shim. Progressive-scan picture data in JPEG 2000 encodings shall be formatted in accordance with case *P1* as specified in SMPTE ST 422:2014, section 6.3, and labeled *06h* as specified in section 6.4 table 2. Interlaced picture data in JPEG 2000 encodings shall be formatted in accordance with case *I1* or case *I2* as specified in SMPTE ST 422:2014, section 6.3, and labeled *03h* or *04h* respectively as specified in section 6.4 table 2.

The *pixel layout* may be any permitted by ISO/IEC 15444-1:2004 (JPEG 2000 core coding), but this may be constrained by a shim. The *essence descriptors* shall conform to the CDCIDescriptor (Color Difference Component Image Picture Essence Descriptor) specified in SMPTE ST 377-1:2011 annex F.4.2 or to the RGBADescriptor (Red Green Blue Alpha Picture Essence Descriptor) specified in SMPTE ST 377-1:2011 annex F.4.3 (and referenced in ST 422:2013 in table 6) but this may be constrained by a shim. The *essence container label* shall be provided as indicated in the preceding paragraph.

Carriage of JPEG 2000 essences in a GC Element shall also employ SMPTE ST 422-compliant tagging of the component ordering sequence.

6.2.10.2.3   JPEG 2000 decoder requirement

AS-07 decoders shall be capable of decoding essences as specified in section 6.2.10.2.2.

6.2.10.2.4   Shim Parameter Table for Picture Essence – JPEG 2000 Compressed

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
Picture family for JPEG 2000	Picture signal schemes (compression or sampling or other)	picture_family	Gentle	Conform to ISO/IEC 15444-1:2004/Amd 3:2010; JPEG 2000 Core Coding Broadcast Profiles: Profile levels 6 and 7 (lossless) and levels 1 through 5 (lossy). Conform to ISO/IEC 15444-1:2004/Amd 1:2006; JPEG 2000 Core Coding Profiles for digital cinema applications: Profiles for 4K and 2K (lossy)
Picture raster format	Picture raster and aspect ratio.	picture_format	Moderate	In the following list, if interlaced video, then 59.94 Hz or 50 Hz field frequency. If progressive video, then 59.94 Hz, 50 Hz, 29.97 Hz, 25 Hz, or 23.98 frame frequency. 480p 4:3 486i 4:3 486i/p 16:9 576i/p 4:3, 576i/p 16:9 720p 16:9 1080i/p
Picture bitrate	Maximum bits per second in real time	picture_bitrate	Gentle	SD 360 Mbps* HD 1.5 Gbps*
Permitted pixel layout	*PixelLayout* and/or *J2CLayout* types that may be present in the file	permitted_pixel_layout	Moderate	Any
Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor
Permitted containers	Essence container types that may be present in the file.	permitted_essence_container	Moderate	Any of MXFGCJP2K_P1 MXFGCJP2K_I1 MXFGCJP2K_I2

* Informative note: These values represent the maximum possible bit rates needed to encode an SDI-based stream as JPEG 2000. In rare instances, e.g., with complex imagery, the JPEG 2000 bit rate can exceed that of the SDI stream itself.

6.2.10.2.5   Shim Parameter Table for Picture Essence – JPEG 2000 Compressed (informative)

The following values (or value categories) are anticipated to be added to AS-07 as it is extended in future editions:

Dimension	AS-07 Values to be refined and added in future edition
Picture family for JPEG 2000	Additional to-be-published ISO/IEC JPEG 2000 broadcast profiles. Other, non-ISO/IEC JPEG 2000 profiles.
Picture raster format	2K 4K 8K
Picture bitrate	Higher rates for rasters greater than 1080p, HFR, HDR, 3D, etc.

6.2.10.3   Picture Essence – Uncompressed

6.2.10.3.1   Uncompressed picture essences (informative)

This encoding is typically selected by an archive that prefers to store an uncompressed file, and that is formatting or reformatting content as a part of its own pre-ingest or ingest activity, e.g., transferring content from a videotape carrier, or scanning film. Although archives with a focus on the reformatting of old videotapes will employ only YUV-based components (e.g., YCbCr), use cases relevant for other archives will require the use of RGB- or XYZ-based components.

In order to accommodate AS-07 timecode (section 6.4), VBI and ancillary data (6.2.12.2), and content integrity (6.7.2) elements, essence containers must use frame-wrapping rather than clip-wrapping.

6.2.10.3.2   Uncompressed Essences and SMPTE ST 384

AS-07 encoders shall place frame-wrapped uncompressed essences in a SMPTE ST 384:2005-compliant GC Element. The *pixel layout* may be any permitted by SMPTE ST 384:2005, but this may be constrained by a shim. The *essence descriptors* shall conform to the CDCIDescriptor (Color Difference Component Image Picture Essence Descriptor) specified in SMPTE ST 377-1:2011 annex F.4.2 or to the RGBADescriptor (Red Green Blue Alpha Picture Essence Descriptor) specified in SMPTE ST 377-1:2011 annex F.4.3 but this may be constrained by a shim. The *essence container label* shall conform to the requirements in section 8 of SMPTE ST 384:2005.

6.2.10.3.3   Uncompressed essence decoder requirement

AS-07 decoders shall be capable of decoding essences as specified in section 6.2.10.3.2.

6.2.10.3.4   Shim Parameter Table for Picture Essence – Uncompressed

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
Picture family for uncompressed	Picture signal schemes (compression or sampling or other)	picture_family	Gentle	Uncompressed carried in a SMPTE ST 384-compliant GC Element, using bitstream codings as specified in SMPTE ST 377-1:2009 (or later), annex G.2.25.
Picture raster format	Picture raster and aspect ratio.	picture_format	Moderate	In the following list, if interlaced video, then 59.94 Hz or 50 Hz field frequency. If progressive video, then 59.94 Hz, 50 Hz, 29.97 Hz, 25 Hz, or 23.98 frame frequency. 480p 4:3 486i 4:3 486i/p 16:9 576i/p 4:3, 576i/p 16:9 720p 16:9 1080i/p
Picture bitrate	Maximum bits per second in real time	picture_bitrate	Gentle	SD 360 Mbps HD 1.5 Gbps

Permitted pixel layout	*PixelLayout* types that may be present in the file	permitted_pixel_layout	Moderate	Any permitted by SMPTE ST 384:2005.
Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor
Permitted containers	*EssenceContainerLabel* types that may be present in the file.	permitted_essence_container	Moderate	Any frame-wrapped container permitted by SMPTE ST 384:2005.

6.2.10.3.5   Shim Parameter Table for Picture Essence – Uncompressed (informative)

The following values (or value categories) are anticipated to be added to AS-07 as it is extended in future editions:

Dimension	AS-07 Values to be refined and added in future edition
Picture family for uncompressed	Digital cinema picture and color spaces (e.g., ACES, X′Y′Z′, etc.) Other TBD
Picture raster format	2K 4K 8K
Picture bitrate	Higher rates for rasters greater than 1080p, HFR, HDR, 3D, etc.

6.2.10.4   *Picture Essence – Retain Source Encoding as Acquired (informative)*

6.2.10.4.1   Retain source encoding (informative)

This parameter is typically selected by an archive that judges the native encoding to be reasonably stable, or that has other reasons to retain content in the form in which has been received, and wishes to wrap and store that encoded "native" bitstream in a standardized manner.

In addition to the picture essence types listed in section 6.2.10.4.2, an archive may also acquire and wish to retain essences that employ JPEG 2000 encodings as native bitstreams. For AS-07, these shall be wrapped to conform to the preceding picture essence section (6.2.10.2).

6.2.10.4.2   Retain Source Encoding Essences and MXF GC Mapping

AS-07 encoders shall place encoded essences in GC Elements compliant with the following standards:

- MPEG Streams: SMPTE ST 381-1:2005 and SMPTE ST 381-2:2011
- DV-DIF Data: SMPTE ST 383:2008
- SDTI-CP Essence and Metadata: SMPTE ST 385:2004
- Type D-10 Essence Data: SMPTE ST 386:2004 (Archived 2010)
- Type D-11 Essence Data: SMPTE ST 387:2004 (Archived 2010)
- VC-3 Coding Units: SMPTE ST 2019-4:2009
- VC-1: SMPTE ST 2037:2009
- AVC Streams: SMPTE ST 381-3 (anticipated in 2014)

In order to accommodate AS-07 timecode (section 6.4), VBI and ancillary data (6.2.12.2), and content integrity (6.7.2) elements, essence containers from the preceding standards must use frame-wrapping rather than clip-wrapping.

6.2.10.4.3   Retained source encoding decoder requirement

AS-07 decoders shall be capable of decoding essences as specified in section 6.2.10.4.2.

6.2.10.4.4   Retain Source Encoding Essences and MXF GC Mapping   (informative)

Additional picture encodings will be added to the preceding set as additional MXF mapping standards are published by SMPTE.

6.2.10.4.5   Shim Parameter Table for Picture Essence – Retain Source Encoding as Acquired

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
Picture family for retain born digital as acquired	Picture signal schemes (compression or sampling or other)	picture_family	Gentle	MPEG (ST 381-1 and 381-2) DV-DIF (ST 383) SDTI-CP (ST 385) D-10 (ST 386)

				D-11 (ST 387) VC-3 (ST 2019) VC-1 (ST 2037) AVC (ST 381-3) Forbidden
Picture format	Picture raster and aspect ratio	picture_format	Moderate	480p 4:3 486i 4:3 486i/p 16:9 576i/p 4:3, 576i/p 16:9 720p 16:9 1080i/p Forbidden
Picture bitrate	Maximum bits per second in real time	picture_bitrate	Gentle	Up to 1.5 Gbps Forbidden
Permitted pixel layout	*PixelLayout* types that may be present in the file	pixel_layout	Moderate	Any permitted by the following MXF mapping standards: SMPTE ST 381-1:2005 SMPTE ST 381-2:2011 SMPTE ST 383:2008 SMPTE ST 385:2004 SMPTE ST 386:2004 SMPTE ST 387:2004 SMPTE ST 2019-1:2009 SMPTE ST 2037: 2009 SMPTE ST 381-3 (forthcoming) Forbidden
Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor Forbidden
Permitted containers	Essence container types that may be present in the file.	permitted_essence_container	Moderate	Any frame-wrapped container permitted by the following MXF mapping standards: SMPTE ST 381-1:2005 SMPTE ST 381-2:2011 SMPTE ST 383:2008 SMPTE ST 385:2004 SMPTE ST 386:2004 SMPTE ST 387:2004 SMPTE ST 2019-1:2009 SMPTE ST 2037: 2009 SMPTE ST 381-3 (forthcoming) Forbidden

6.2.11 Audio Essence Encoding

6.2.11.1   *MXF options for carriage of waveform audio (informative)*

The mapping of audio to the MXF Generic Container is governed by SMPTE ST 382:2007, *Material Exchange Format — Mapping AES3 and Broadcast Wave Audio into the MXF Generic Container*. This standard defines the mapping of digital audio data, ancillary data and metadata from the Broadcast Wave Format (BWF) and from AES3 digital audio data into sound essence elements. Several options for audio type and carriage are specified. Waveform data may be uncompressed PCM audio data, compressed data or raw data as in BWF, AES3, or SMPTE 337M carried in a single AES3 stream. As specified below, AS-07 requires the use of the BWF container. Many archiving organizations strongly endorse linear PCM encoding and, at this writing, favor 48 kHz sampling with 24 bits per sample.

In addition to the familiar linear PCM sampling rates of 32 (for DV content), 44.1, 48, 96, and 192 kHz, the AS-07 specification allows for additional "pull-down" and "pull-up" frequencies for fractional frame rates: 31968, 32032, 44056, 44144, 47952, 48048, 88112, 88288, 95904, 96096, 191808, and 192192 Hz. These are listed for completeness and to accommodate the future rewrapping of certain types of born digital content. The initial AS-07 Baseband Shim (appendix J), however, is limited to two sampling frequencies: 48 kHz (24 and 16 bits) and 96 (24 bits).

6.2.11.2   Multiple Audio Encodings and Wrappings Permitted (non-D-10 Essences)

The provisions in this section shall apply except when using D-10 Essence Data.

Audio shall be PCM, AC-3, or Dolby E. The number of channels is unlimited, and as many tracks shall be employed as needed to represent the number of channels. PCM Audio may have any values up to 192kHz at 24 bit word length.

For PCM audio data, AS-07 encoders shall create files that carry each PCM track (mono or stereo pair) in a SMPTE ST 382:2007-compliant MXF GC Element within a BWF Container, as described in ST382.

For AC-3 audio data, AS-07 encoders shall create files that carry each AC-3 track in a SMPTE 337/338/339/340 container in a SMPTE 382M:2007-compliant MXF GC Element.

Regarding interleaving and frame- or clip-wrapping, audio essences shall be treated as specified in section 6.1.2.2 (Interleaving, Frame-, and Clip-wrapping). Audio data that accompanies picture shall be treated in a manner that permits synchronization with the picture information.

6.2.11.3   Audio Encoding for D-10 Essences

In order to accommodate legacy 8 channel AES audio (PCM channels) and other audio formats when wrapping D-10 essence data, encoders shall adhere to ST 386:2004, *Mapping Type D-10 Essence Data to the MXF Generic Container*.

6.2.11.4   Language repertoire and tagging (informative)

AS-07 shims may restrict files to certain languages in the soundtrack, sometimes called the language repertoire. In general, users are encouraged to tag languages (primary and secondary) in AS_07_Core_DMS (section 6.6.1) but this is optional unless required by a shim. However, when a shim does restrict soundtracks to certain languages, tagging is a requirement. As indicated in appendix D.1, two tags are provided for AS_07_Core_DMS: *AS_07_Core_AudioTrackPrimaryLanguage* and *AS_07_Core_AudioTrackSecondaryLanguage*. Many organizations will provide encoders with default language values to insert. In the U.S., for example, this will often be the code value for American English ("en-US").

6.2.11.5   Language repertoire and tagging

AS-07 producers are encouraged to tag soundtrack languages (primary and secondary) in AS_07_Core_DMS (section 6.6.1) but this is optional unless required by a shim. The range of languages may be constrained by a shim, where the shim's language specification shall employ the codes provided in RFC 5646 (2009; Tags for Identifying Languages). When a shim does constrain AS-07 soundtracks to certain languages, tags are required.

6.2.11.6   Shim Parameter Table for Audio Essences

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
Sound family	Sound signal schemes (compression or sampling or other)	sound_family	Moderate	PCM 192 kHz 24 bit PCM 96 kHz 24 bit PCM 88.2 kHz 24 bit PCM 48 kHz 24 bit PCM 48 kHz 16 bit PCM 44.1 kHz 16 bit PCM 32 kHz 12 bit

				Additional pull-down and pull-up PCM sampling frequencies for fractional frame rates: 192192, 191808, 96096, 95904, 88112, 88288, 48048, 47952, 44144, 44056, 32032, and 31968 Hz. AC-3 Other MPEG schemes, e.g., layer 2 or layer 3 (MP3), or AAC (ST 338)
Sound language tagging	Tagging of soundtrack languages that may be present, to be identified in AS_07_Core_DMS using codes from RFC 5646 (2009), e.g., en-US, fr-CA. Tagging mandated when languages are required.	sound_language_tagging	Moderate	Mandated, Forbidden, Encouraged, Permitted
Sound language repertoire	Soundtrack languages required by a shim	sound_language_repertoire	Moderate	Identifiers selected from RFC 5646 Null

6.2.11.7   Audio Track Layout

6.2.11.7.1   Audio Track Layout (informative)

AS-07 preservation and archiving files generally carry reformatted, transcoded, or transwrapped audiovisual content from a wide variety of source material with widely varying sound tracks. In terms of sound or aural field, examples range from silent research footage to monaural oral history recordings to performances with stereo, surround, or multichannel audio. In other cases, the tracks on a source item will include Descriptive Video Service (DVS), Second (or Separate) Audio Program (SAP), annotations (like a director's commentary for a dramatic program), as well as other types of multiple language content or other versioning elements. Sound tracks on certain videotape formats may also carry timecode data, e.g., the carriage of LTC on track three of the 1-inch type C format. Archivists wish to retain this source data in AS-07 files and require metadata that labels the tracks in a manner that will serve future users.

Source material audio tracks may or may not be labeled according to a standard or industry convention. When so labeled, the tagging may be in terms of such standards as SMPTE Multi-Channel Audio (MCA; SMPTE ST 377-4), the EBU track allocation templates specified by EBU R 48 or EBU R 123, or by an industry convention promulgated by a broadcast network, such as the PBS Audio Configuration specification cited in AS-03.

Appendix B in this initial publication of AS-07 provides identifiers for certain audio layouts. Users of AS-07 should note that these identifiers may be modified or extended in the future in order to keep pace with layout-specification developments within the community.

AS-07 files that conform to the requirements that follow will carry identifiers in the AS_07_Core_DMS_AudioTrackLayout element and may also carry comments in the AS_07_Core_DMS_AudioTrackLayoutComment element (Section 6.6.1 and appendix D.1). When carrying SMPTE ST 377-4 MCA, AS-07 files are additionally required to carry descriptors and subdescriptors that conform to SMPTE ST 377-1:2011 and SMPTE ST 377-4:2012. Some of the AS_07_Core_DMS_AudioTrackLayout values listed in appendix B cover configurations that are detected by the encoder but for which little information can be provided. Other values cover layouts for which identification can be provided to the encoder (or added in a post-process), ranging from common two-, three-, and four-track variants to the classes specified for SMPTE MCA and in EBU R 48/EBU R 123. Many organizations will permit the encoder to provide minimal information when initially producing files and will subsequently update these values in a post-process.

The option of adding comments in the AS_07_Core_DMS_AudioTrackLayoutComment element (section 6.6.1 and appendix D.1) is intended to support technical information about a track and is not intended for description of the "intellectual" or provenance aspects of the track. That is, a comment might report that a given track is dual mono when the left channel of a stereo signal would be expected. But the comments are not intended to carry information like "track from soundtrack enhancement and re-recording session in 1967."

6.2.11.7.2 Audio Track Layout Identification in AS_07_Core_DMS

AS-07 encoders shall identify audio track layouts by placing the coded values listed in appendix B in the AS_07_Core_DMS_AudioTrackLayout element (Section 6.6.1 and appendix D.1). Encoding devices shall provide a method to permit archive organizations to input the coded value prior to encoding. If organizations do not provide values in advance, the encoder shall make a best effort to identify the tracks and to use codes as defined in tables 0 through 5 in appendix B.

6.2.11.7.3 Audio Track Layout Comments in AS_07_Core_DMS

AS-07 encoders shall provide a method for encoding organization to input comments in the AS_07_Core_DMS_AudioTrackLayoutComment element (Section 6.6.1 and appendix D.1).

6.2.11.7.4 Audio Track Layout Descriptors and Subdescriptors for SMPTE MCA

When the video content in an AS-07 file consists of SMPTE Multi-Channel Audio (MCA; SMPTE ST 377-4:2012), and when such information is provided by the encoding organization, AS-07 encoders shall provide the Descriptors specified in SMPTE ST 377-1 and the Subdescriptors specified for MCA in SMPTE ST 377-4. Additional relevant information is provided in SMPTE ST 2035:2009, Audio Channel Assignments for Digital Television Recorders (DTRs).

6.2.11.7.5 Audio Track Layout Decoder Requirements

AS-07 decoders shall present sound track data as a labeled output so that it can be received and processed by downstream devices.

6.2.11.8 Other Provisions

NICAM audio (when encountered in historical recordings) shall be clipwrapped. If the input to the MXF-file production system includes DialNorm metadata, this DialNorm data shall be included in the MXF Sound Descriptor GenericSoundEssenceDescriptor:DialNorm.

6.2.12 Closed Captioning, Subtitles, Timed Texts and Other Ancillary Data

6.2.12.1 Captions, Subtitles, and Timed Text

6.2.12.1.1 Terminology: Captions, Subtitles, and Timed Text (informative)

This specification uses the terms Captions and Subtitles more or less interchangeably, to mean non-XML text intended for display over a timeline, in synchronization with image and sound essence. The term Timed Text carries the same meaning with the added constraint that such text is structured to comply with either the SMPTE or EBU Timed Text XML schema.

6.2.12.1.2 Line 21 Data, CEA-608, and CEA-708 (informative)

The sections that follow provide the AS-07 requirements for handling Closed Captions, the binary-format textual data long associated with standard definition NTSC video. When present, the captions governed by the Consumer Electronics Association standard CEA-608 are generally encoded into line 21, considered to be part of the vertical blanking interval and also considered to be part of the active picture area. The preceding statement uses the adverb generally to allow for some variation in past practice. For example, regarding legacy standard definition video sources, analog instances will carry CEA-608 in line 21 while digital instances may vary, including CEA-608 as a digital representation ("dots and dashes") of line 21 or as VANC caption data or even as both. Meanwhile, video servers may employ various semi-proprietary formats to carry vertical interval ancillary data (VANC) and digital line 21. Beyond that, digital legacy MPEG-2 compressed sources may have CEA-608 embedded in the MPEG "Video User Private" bits, while legacy MXF files may have VANC or digital line 21 in ST 436 packets in the essence container. For ATSC (digital television) programming, three streams are encoded in the video: two are backward compatible "line 21" captions, and the third is a set of up to 63 additional caption streams encoded in EIA-708 format.

CEA-708 is the standard for closed captioning for ATSC digital television (DTV) streams in the United States and Canada. CEA-708 captions consist of binary-format textual data but this data is not carried on line 21 and must be pre-rendered by the receiver. CEA-708 also includes more of the Latin-1 character set as well as stubs to support full UTF-32 captions, and downloadable fonts.

The presence of captions in the file is recorded in the AS_07_Core_DMS_Captions item in the AS-07 Core Descriptive Metadata Scheme. See section 6.6.1.1.

6.2.12.1.3   Preservation and Archiving Goals for Caption Data (informative)

Archivists, especially in memory institutions, wish to produce authentic copies of the material they reformat for preservation. This means that they wish to retain data like closed captioning or subtitles in its original form, to the degree practical. As noted above, this will often be in a binary format, often encoded in the essence stream.

At the same time, file-based carriage of XML-structured Timed Text is very important to archivists. Many archival organizations will want to extract this text and load it into related applications, especially indexing systems that support search-and-retrieval. This desire for easily re-usable XML underpins this specification's request that the "tunneling" approach, so convenient for broadcaster handling of Timed Text, not be employed for AS-07 archive files.

6.2.12.1.4   Retain Line 21, CEA-608, and CEA-708 data as Delivered

If either CEA-608 line 21 (CC and XDS) data or CEA-708B DTV captioning data are present in the source material, AS-07 encoders shall preserve CEA-608 and CEA-708 in the form in which they are delivered.

6.2.12.1.5   ANC Packet Carriage of CEA-608 or -708 data

If either CEA-608 line 21 (CC and XDS) data or CEA-708B DTV captioning data are present in the source material, and unless already in the following format, AS-07 encoders shall carry such data in a SMPTE ST 334-1/-2:2007 compliant ANC packet within a SMPTE ST 436:2006-compliant VBI/ANC GC Element, using 8 bit encoding. This carriage is in addition to the carriage specified in section 6.1.12.1.4.

The preceding provisions shall not apply when using ST 386:2004 "Mapping Type D-10 Essence Data to the MXF Generic Container." In that case, the CEA-608 or -708 caption data shall be retained in the form in which it is delivered.

6.2.12.1.6   Translation of CEA-608, and -708 to SMPTE Timed Text

AS-07 encoders should translate line 21, CEA-608, and -708 data to SMPTE ST 2052-1 Timed Text in the Preserve Translation Mode (ST 2052-1, section 5.1.2.1), although they may translate to the Enhance Translation Mode (ST 2052-1, section 5.1.2.2). In order to avoid confusion with the binary data as delivered, AS-07 encoders shall not translate to provide Carriage of Binary Data "tunneling," as described in ST 2052-1, section 5.4, and in ST 2052-0:2013 (now in final draft). Translations need not be accomplished using methods outlined in SMPTE RP 2052-10 and RP 2052-11.

When the CEA-608 or -708 source data includes caption service descriptors that identify languages, encoders shall embed the appropriate language code in the AS_07_GSP_TD_DMS (section 6.6.1) associated with Generic Stream Partition that carries the Timed Text.

6.2.12.1.7   Carriage of SMPTE Timed Text

6.2.12.1.7.1   *Carriage of SMPTE Timed Text (informative)*

The AS-07 specification provided in section 6.2.12.1.7 (Carriage of SMPTE Timed Text) calls for Timed Text to be carried in a Generic Stream Partition, citing SMPTE RP 2057:2011 as the relevant authority. In addition to the carriage require in AS-07, RP 2057 also offers a second method: to carry text-based metadata in the MXF Header Metadata by defining a DM Framework that includes Text-based Sets.

6.2.12.1.7.2   *Carriage of SMPTE Timed Text (requirements)*

AS-07 encoders shall store any Timed Text using the Generic Stream Partition method recommended in SMPTE RP 2057:2011, including Am1:2013. See also sections 6.2.4 (Generic Stream Partitions) and 6.6 (DMS),

especially AS_07_GSP_TD_DMS (section 6.6.1). Each instance of a Generic Stream Partition carrying text-based data shall be associated with an instance of AS_07_GSP_TD_DMS.

When SMPTE Timed Text is present in an AS-07 file, in accord with SMPTE ST 377-1, encoders shall ensure that a Data Track that points to the Timed Text is included in the Material Package and that the operational pattern is designated as OP1b.

6.2.12.1.8   EBU STL and EBU Timed Text

6.2.12.1.8.1   EBU STL and EBU Timed Text (informative)

In 2013, the European Broadcast Union began to push its members away from the currently widely used binary EBU STL (subtitling) format, standardized in EBU Tech 3264 (1991). The replacement standard is called EBU-TT or EBU Timed Text, an XML-based subtitling format. In 2012, version 1.0 of EBU-TT part 1 was published as EBU Tech 3350. Like the similar SMPTE TT standard, this specification builds on the W3C Timed text Markup Language (TTML) 1.0 standard. To support the conversion process, EBU has drafted EBU-TT part 2 (EBU Tech 3360), a guide on how to map EBU STL files to EBU-TT. EBU Tech 3360 was published in June 2013 as a v0.9 for comments.

Since files to be archived benefit from Timed Text (see 6.2.12.1.3 above), when placed in AS-07 files, EBU-based content must provide subtitling data as Timed Text. Thus, when source material offers only EBU STL, AS-07 requires that it must be converted to EBU-TT. Meanwhile however, in 2013, SMPTE published ST 2075:2013 that specifies the mapping of binary EBU STL files to the MXF Generic Stream, and such carriage may be employed in AS-07 files but not in lieu of conversion and carriage as Timed Text.

6.2.12.1.8.2   AS-07 Encoder Requirements for EBU STL

AS-07 encoders shall convert EBU STL data to EBU-TT following the mapping provisions of EBU-TT part 2 (EBU Tech 3360, v.0.9 for comment, June 2013). Additionally, AS-07 encoders may place EBU STL (EBU Tech 3264) data in Generic Stream Partitions in accordance with SMPTE ST 2075:2013.

When EBU STL is present in an AS-07 file, in accord with SMPTE ST 377-1, encoders shall ensure that a Data Track that points to the Timed Text is included in the Material Package and that the operational pattern is designated as OP1b.

6.2.12.1.8.3   AS-07 Encoder Requirements for EBU TT

AS-07 encoders shall store EBU-TT, as acquired with a source item (EBU Tech 3350) or as converted (section 6.2.12.1.7.2 above), using the Generic Stream Partition method recommended in SMPTE RP 2057:2011, including Am1:2013. As is also specified in 6.2.12.1.7.2 above, AS-07 encoders shall ensure that a Data Track that points to the Timed Text is included in the Material Package and that the operational pattern is designated as OP1b. Each instance of a Generic Stream Partition carrying text-based data shall be associated with an instance of AS_07_GSP_TD_DMS (section 6.6.1).

When EBU Timed Text is present in an AS-07 file, in accord with SMPTE ST 377-1, encoders shall ensure that a Data Track that points to the Timed Text is included in the Material Package and that the operational pattern is designated as OP1b.

6.2.12.1.9   Encoder Provision of Timed Text to External Applications

AS-07 encoders shall be capable of providing a copy of SMPTE or EBU Timed Text (if any) to connected applications, i.e., indexers, databases, and readers. See also section 6.2.12.1.12 below, pertaining to AS-07 decoders.

6.2.12.1.10   Language Repertoire and Tagging

6.2.12.1.10.1 Language Repertoire and Tagging (informative)

AS-07 shims may restrict files to certain Timed Text languages, sometimes called the language repertoire. In order to conform to SMPTE RP 2057:2011, including Am1:2013, users must tag the primary language in AS_07_GSP_TD_DMS (section 6.5.1). Tagging of secondary languages, is optional. As indicated in appendix F.3, two tags are provided for AS_07_GSP_TD_DMS: AS_07_GSP_TD_DMS_PrimaryRFC5646LanguageCode and AS_07_GSP_TD_DMS_SecondaryRFC5646LanguageCode. Many organizations will provide encoders with default

language values to insert. In the U.S., for example, this will often be the code value for American English ("en-US"). The tag code authority is RFC 5646 (2009; Tags for Identifying Languages).

In addition, language tagging may be present in caption and subtitle source material that is incorporated in AS-07 files, notably examples that employ the standardized approaches established for CEA-608, and -708 (caption service descriptors), EBU STL, and SMPTE and EBU Timed Text. AS-07's general requirement to retain caption and subtitle data from source materials mean that language identification information will also be retained.

6.2.12.1.10.2 *Timed Text Language Repertoire and Tagging*

AS-07 producers shall tag the primary Timed Text language in AS_07_GSP_TD_DMS (section 6.6.1), and are encouraged to tag the secondary Timed Text language (if any) as well. The range of languages may be constrained by a shim, where the shim's language specification shall employ the codes provided in RFC 5646 (2009; Tags for Identifying Languages).

6.2.12.1.11 Shim Parameter Table for Captions, Subtitles, and Timed Text

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
Caption	Carriage of CEA-608 or -708 captions (from source material or if newly produced)	caption_carriage	Strong	Mandated, Forbidden, Encouraged, Permitted
Caption signal scheme	Captions signal schemes	caption_scheme	Strong	CEA-608 in SMPTE ST 436:2006 CEA-708 in SMPTE ST 436:2006
EBU Subtitles	Carriage of EBU Tech 3264 STL (from source material or if newly produced)	ebu_stl_carriage	Strong	Mandated, Forbidden, Encouraged, Permitted
SMPTE or EBU Timed Text	Carriage of SMPTE or EBU Timed Text (when converted from CEA-608, CEA-708, or EBU STL, or if newly produced)	tt_carriage	Strong	Mandated, Forbidden, Encouraged, Permitted
Timed Text signal scheme	Timed text signal scheme	tt_scheme	Strong	SMPTE ST 2075:2013 EBU Tech 3350
Timed Text language tagging	Tagging of Timed Text languages that may be present, to be identified in AS_07_TD_DMS using codes from RFC 5646 (2009), e.g., en-US, fr-CA. Tagging mandated when languages are required.	tt_language_tagging	Moderate	Mandated, Forbidden, Encouraged, Permitted
Timed Text language repertoire	Timed Text languages required by a shim	tt_language_repertoire	Moderate	Identifiers selected from RFC 5646 Null

6.2.12.1.12 Decoder Requirements for Captions, Subtitles, and Timed Text

AS-07 decoders shall read all forms of captions, subtitles, and Timed Text specified in sections 6.2.12.1.4 through 6.2.12.1.8. Decoders shall provide for the display of all forms of these elements and for the provision of Timed Text to connected applications.

6.2.12.2 *VBI and Other Ancillary Data (ANC)*

6.2.12.2.1 ANC Packet Carriage of Ancillary Data

AS-07 encoders shall build files that carry Ancillary Data as specified below:
- In a SMPTE ST 334-1/-2:2007 compliant ANC packet within a SMPTE ST 436:2006-compliant VBI/ANC GC Element, using 8 bit encoding.
- [placeholder] As may be specified by the SMPTE ST 2057 process in the future.

The preceding provisions shall not apply when using ST 386:2004 "Mapping Type D-10 Essence Data to the MXF Generic Container." In that case, the ANC data shall be retained in the form in which it is delivered.

6.2.12.2.2   Shim Parameter Table for VBI and ANC

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
VBI data essence	A list of data essence types permitted in a given shim, including specific parameters such as VBI lines supported.	VBI_data_essence	Strong	[List from SMPTE ST 436] [Any, all]
ANC data essence	A list of supported data essence types permitted in a given shim, including specific parameters such as ANC packet types supported.	ANC_data_essence	Strong	[List from SMPTE ST 291] [Any, all]

6.2.12.2.3   Decoder requirements for VBI and ANC Data

AS-07 decoders shall read all forms of VBI and ANC specified in sections 6.2.12.2.1.

6.2.13 Active Format Description (AFD) and Pan-Scan Information

6.2.13.1   Active Format Description (AFD)

AS-07 files shall have an AFD value for the duration of the Picture Track. AS-07 encoders shall format and store AFD (and Bar Data, if present) values according to SMPTE ST 377-1:2011. Constant AFD values shall be stored in the MXF Picture Descriptor; changeable AFD values shall be stored in a SMPTE ST 436:2006-compliant VBI/ANC GC Data Element and shall be formatted according to SMPTE ST 2016-3.

All AFD values specified in SMPTE ST 2016-1:2009, Table 1 (Active Format Description codes), are permitted, however a shim may limit the permissible AFD values to a subset of the values specified in ST 2016-1:2009.

When reformatting video content, AS-07 encoders shall preserve AFD (and Bar Data, if present) values if they are properly formatted. If the source video includes an AFD value listed in SMPTE 2016-1:2009 and formatted per 2016-3:2007, encoders shall preserve and map this data to the appropriate places in the AS-07 file. If the source video does not include an AFD value, AS-07 encoders shall insert the value '0000' as well as enabling the user to change this and to specify a value of their choosing.

SMPTE ST 377-1:2011 further describes compliant encoder and decoder behavior with respect to SMPTE ST 2016-1:2009 (Format for Active Format Description and Bar Data). AS-07 implementers are directed to SMPTE ST 377-1:2011 paragraph G.2.5.

6.2.13.2   Pan-Scan Information

Pan-Scan Information is not required in AS-07 files, but it may be present. If included in AS-07 files, AS-07 encoders shall format Pan-Scan Information according to SMPTE ST 2016-2:2007 and SMPTE ST 2016-4:2007, and store it in a SMPTE ST 436:2006-compliant VBI/ANC GC Data Element.

All Pan-Scan values specified in SMPTE ST 2016-2:2007, Table 1 (Pan-Scan informational payload) are permitted, however a shim may limit the permissible Pan-Scan values to a subset of the values specified in SMPTE ST 2016-2:2007.

When reformatting video content, AS-07 encoders shall preserve Pan-Scan Information if it is properly formatted. If the source video includes Pan-Scan Information values that are listed in ST 2016-2:2007 and that are formatted according to 2016-4:2007, AS-07 encoders shall preserve and map this data to the appropriate places in the AS-07 file. AS-07 decoders shall identify and read Pan-Scan codes in the file and provide a method for reporting on their presence with the values indicated. Decoders are not required to interpret the codes and display picture data with Pan-Scan effects applied.

6.2.13.3   Shim Parameter Table for AFD and Pan-Scan

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
AFD codes	Selection of one or more of the 16 codes for AFD (SMPTE ST 2016-1:2009, Table 1)	AFD_codes	Gentle	Any
Pan-Scan data	Pan-Scan carriage (SMPTE ST 2016-2:2007)	PanScan_data	Moderate	Mandated Forbidden Encouraged Permitted

6.3 Operational Pattern Parameters and Constraints

6.3.1 AS-07 Operational Patterns for Item, Segmented, and Collection Files (informative)

AS-07 files employ three standardized MXF Operational Patterns: OP1a, OP1b, and OP3c. The impact of these three patterns for AS-07 files, however, is best understood in terms of three related conceptual structures not governed by standards: simple item files, segmented item files, and collection files. The OP standards and the AS-07 concepts are explained in the following paragraphs.

Simple Item Files
- OP1a. The bread-and-butter work to be supported by AS-07 is the reformatting of old videotapes, or other incoming baseband signal, analog or digital. The resulting files are generally be simple in form, with a single picture essence, a single sound essence in Generic Container(s), and a single Material Package.
- OP1b. Simple Item files may also contain out-of-band data, e.g., Timed Text, stored in Generic Stream Partitions. The resulting files contain picture and sound essences in Generic Containers, TT in a Generic Stream Partition, and a single Material Package.

Segmented Item Files
- OP1a with segmentation. For material in segments, e.g., for (i) content from a single videotape that consists of several distinct clips or segments, (ii) a continuous performance documented "across two tapes," or (iii) individual program episodes or movie reels that are cut together into a composite "reel" (file). The multiple segments are strung out as OP1a with (optional) AS_07_Segmentation_DMS (section 6.7.5 and appendix G) to identify segment-start timecode and duration.
- OP1b with segmentation. Like the preceding but with out-of-band data like timed text.

Collection Files
- OP3c. For bundled collections of items, e.g., a set of television advertisements or multiple episodes/reels for which the essences are not carried in a single file. Collection Files will not be included in the AS-07 Baseband Shim.

Comment: We recognize and respect the overlap in terms of function between the AS-07 bundle and other formatting specifications: the Archive eXchange Format (AXF), the Interoperable Master Format (IMF), the Linear Tape File System (LTFS), the BagIt specification, and AMWA MXF specification AS-02.

6.3.2 Baseline Operational Patterns

Encoders shall produce AS-07 files that comply with the MXF Operational Patterns required by a given AS-07 shim. The full set of AS-07 Operational Patterns shall be limited to the following: OP1a (SMPTE ST 378), OP1b (SMPTE ST 391), and OP3c (SMPTE ST 408), and these shall be implemented for AS-07 Item Files and AS-07 Collection Files, as specified in the sections that follow.

Encoders shall also produce AS-07 files that are labeled as OP1a, OP1b, or OP3c in the Operational Pattern property of all Partition packs and the Preface Set.

Decoders shall be capable of reading files with Operational Patterns as described in this and the following subsections.

6.3.3 Operational Patterns -- Item Files

Encoders shall produce AS-07 Item Files with internal essences that comply with MXF Operational Pattern OP1a (SMPTE ST 378) or OP1b (SMPTE ST 391), and are labeled as OP1a or OP1b in the Operational Pattern property of all Partition packs and the Preface Set.

AS-07 Item Files may be segmented as specified in section 6.7.5 (Program Segmentation).

AS-07 Item Files may or may not be required by a given shim.

6.3.4 Operational Patterns -- Collection Files

Encoders shall produce AS-07 Collection Files that reference sets external essences that consist of valid instances of AS-07 Item files. AS-07 Collection Files shall comply with MXF Operational Pattern OP3c (SMPTE ST 408), and are labeled as OP3c in the Operational Pattern property of all Partition packs and the Preface Set.

AS-07 Collection Files (External Essences) may or may not be required by a given shim.

6.3.5 Operational Pattern Labeling

Encoders shall label AS-07 files with the appropriate OP designation in the Operational Pattern property of all Partition packs and the Preface Set. Decoders shall be capable of reading files with the Operational Pattern labeling as described in this section.

6.3.6 Shim Parameter Table for Operational Patterns

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
Permitted Operational Patterns	MXF-specific Operational Pattern	operational_pattern_types	Strong	OP1a internal OP1b internal OP3c external

6.4 Timecode

6.4.1 Timecode Categories (informative)

AS-07 Files may contain many types of timecode, taking advantage of the multipart architecture offered by MXF. In addition to SMPTE's MXF standard, the specifications that follow owe much to the previous recommendations offered by EBU R122, *Material Exchange Format: Timecode Implementation*. These EBU recommendations have been extended and revised to support archive and preservation requirements.

The following sections employ two important terms: *Master Timecode* and *Historical Source Timecode*. AS-07 Master Timecode is continuous and is the primary, canonical representation of references into the essence for all timecode-dependent activities; for example, descriptive metadata and playback will refer to this timecode information. Master Timecode is sometimes referred to as Synthetic Timecode.

The term *Historical Source Timecode* has been taken from EBU R 122 and names various forms of legacy timecode, e.g., timecode(s) retained from a videotape being reformatted. AS-07 Historical Source Timecode may take various forms, including but not limited to, LTC, VITC and ATC, and it may be of various frame rates and frame counting modes. Historical Source Timecode may be discontinuous and is not used as the Master Timecode in AS-07 files.

6.4.2 Timecode Sources (informative)

AS-07 files will accommodate the range of timecode types outlined in the following list. Types *a* through *e* in the series are defined in EBU R122; types *f* and *g* have been added to support AS-07. Using AS-07 terminology, timecode types *a*, *b*, and *c* are examples of Historical Source Timecode, types *d* or *e* mark the start value for expressions of AS-07 Master Timecode.

a. Linear timecode (LTC) according to SMPTE 12M-1-2008. (Example of AS-07 Historical Source Timecode)
b. Vertical interval timecode (VITC) according to SMPTE 12M-1-2008. (Example of AS-07 Historical Source Timecode)
c. Ancillary Time Code (ATC, formerly known as DVITC) according to SMPTE 12M-2-2008. (Example of AS-07 Historical Source Timecode)
d. Preset timecode (Example of AS-07 Master Timecode)
e. Timecode from the application controlling the MXF encoder (e.g. real-time recording device or software encoder). Examples of interfaces for such timecode are the Sony 9 pin protocol, VDCP or other appropriate application programmable interfaces (API). (Example of AS-07 Master Timecode)
f. One or more of the timecode channels may be clock time (aka "TimeOfDay"); this will most likely include discontinuities (for example, if recording was intentionally paused); and it may include ST 309 Date and Timezone information. (Example of AS-07 Historical Source Timecode)
g. Other potential timecode types, including Edgecode, Camera Metadata, IRIG, ST309, even "Next Generation Timecode". Note that times in some cases may be obtained from the User Bits of the incoming timecode. (Example of AS-07 Historical Source Timecode)

6.4.3 Labeling Timecode in Header Metadata

6.4.3.1 Labeling Timecode in Header Metadata (informative)

Although optional in a strict sense, the use of descriptors and subdescriptors to characterize timecodes is encouraged for AS-07 users. One important application for AS-07 is as a target format for the reformatting of historical videotapes. Such videotapes often carry multiple timecodes of the types described in the preceding section. These timecodes often have long-term value: they may pertain to pre-existing log sheets or edit decision lists, represent time-of-day information needed for forensic analysis, or provide data that can be used by a researcher to reconstruct the history of a given stretch of video footage. Proper labeling of Historical Source Timecode serves all of these purposes.

In its handling of timecode, AS-07 uses elements from two SMPTE specifications: ST 405 specifies a method to construct timecode arrays in essence container System Items, while ST 385 provides a scheme for descriptors and subdescriptors. These descriptors and subdescriptors are associated with Timecode Tracks. In the case of Master and Historical Source Timecodes in essence container System Items, the tracks and descriptors are to be carried in the File Package (Top Level Source Package). When Timecode Tracks are carried in a Lower Level Source Package, the descriptors will be carried in that location as well.

6.4.3.2 Labeling Timecode in Header Metadata (requirements)

AS-07 encoders should create Timecode Tracks that have Track Numbers specified. The Track Number for Master Timecode shall be set to 1. Each of the Historical Source Timecode Tracks shall be assigned a number in a sequence of ascending integers beginning with 2.

Essence Descriptors of Source Packages should include a DateTimeDescriptor for each Timecode and should comply with the following requirements:
1. When present, a DateTimeDescriptor shall indicate the location in the Essence Container in which the timecode is embedded, or shall indicate the indicate Track Number in which the timecode is encoded, or both, as appropriate.
2. When present, a DateTimeDescriptor shall include a SMPTE UL indicating the time code type, as registered in RP 224 (revisions to RP224 forthcoming).
3. When present, a DateTimeDescriptor should include a subdescriptor that labels the original signal from which the Historical Timecode was derived.

6.4.3.2.1 Timecode Header Label Descriptor
The DateTimeDescriptor for AS-07 is derived from the one specified by ST 385 table 3. The list of properties of the DateTimeDescriptor, which is derived from ST 385 table 3 and updated to match ST 377-1:2011 is in appendix C.1.

Note that a single DateTimeDescriptor can simultaneously describe both a Timecode Track and an Essence Timecode. The LinkedTrackID propertyspecifies the Track that is described; the DateTimeEmbedded flag indicates if the timecode data is also embedded in the essence.

6.4.3.2.2 Timecode Header Label Subdescriptor

In addition, the SubDescriptors property shall strongly reference a TimecodeLabelSubDescriptor derived from the ST 377-1 annex B.3, and described in detail in appendix C.2.

6.4.4 Master Timecode

6.4.4.1 Master Timecode (informative)

AS-07 Master Timecode is required and will be uninterrupted (often called *continuous*) and ascending. Master Timecode is the primary, canonical representation of references into the essence for all timecode-dependent activities.

The best practice for preservation and long-term archival management is to set the frame rate and the frame count mode to match the actual frame repetition rate and count mode of the picture essence and this is required by this specification. For example, if the frame rate of a given source item is an integer (i.e., non-fractional) 30 fps, then the typical choice of non-drop Master Timecode would increment 30 times per second. In an example with a fractional frame rate, an essence with a sample rate of 30000/1001 (customarily stated as 29.97 fps) would typically employ a drop-frame Master Timecode that increments at 30000/1001 times per second. Many archives prefer to produce files for long-term archiving that carry non-drop Master Timecode and integer frame rates.

6.4.4.2 Master Timecode in Header Metadata File Package

Encoders shall place uninterrupted, ascending AS-07 Master Timecode in the Header Metadata as a Timecode Track and shall identify it by setting the track number property to 1. There shall be only one timecode track with a track number property value of 1 in a package. The Master Timecode frame rate and frame count mode shall be the same as the frame rate and count mode of the essence in the file.

When recording, the AS-07 Master Timecode time addresses for each essence container shall be represented in a Timecode Segment with Start Time and Length on a timecode track in the File Package (Top Level Source Package) that describes this essence container.

The start timecode of the Master Timecode may be set to a fixed number, or to match the Start time (i.e., the initial time address) of a historical source timecode. The preference may be specified in a shim.

Various frame rates and drop-frame and non-drop frame counting modes are permitted for the Master Timecode. This range of options may be constrained in a shim.

6.4.4.3 Master Timecode in Header Metadata Material Package

MXF encoders should generate a timecode track for each material package. For AS-07 files, the default start timecode time address of the material package timecode track should be equal to the timecode time address of the source package position that is referenced by the start of the first material package source clip.

Timecode frame rate and mode (drop-frame or non-drop frame) are required properties of a TimecodeSegment.

Various frame rates and drop-frame and non-drop frame counting modes are permitted for the Master Timecode. This range of options may be constrained in a shim.

6.4.4.4 Master Timecode in Essence Containers

Encoders shall place AS-07 Master Timecode in the Essence Container as a System Item in the container's Content Packages. It shall be encoded as the first element of the ST 405 TimecodeArray of the ST 394 System Element. Master Timecode in Essence Containers shall be stored with each frame and not as a start and duration, and shall be frame accurate.

Encoders should encode a DateTimeDescriptor (see above). Note that a single DateTimeDescriptor can simultaneously describe both a Timecode Track and an Essence Timecode.

6.4.5 Historical Source Timecode

6.4.5.1 Historical Source Timecode (informative)

AS-07 Historical Source Timecode is legacy timecode, e.g., from a videotape being reformatted, and it may take various forms, including but not limited to, LTC, VITC and ATC, and it may be of various frame rates and frame counting modes. Historical Source Timecode may be discontinuous and shall not be used as the Master Timecode.

The legacy timecodes in videotapes and other sources may themselves be layered in ways that an archive wishes to track, e.g., a videotape may carry LTC and may additionally carry an earlier generation of timecode recorded, say, as audio track 3. Implementers who wish to document such historical information will employ descriptors and subdescriptors as needed and/or provide documentation in the AS-07 Manifest (section 6.7.1).

6.4.5.2 Range of Types of Historical Source Timecode

When present in source material, AS-07 Baseband Shim encoders shall encode the following types of Historical Source Timecode:
- a. Linear timecode (LTC) according to SMPTE 12M-1-2008.
- b. Vertical interval timecode (VITC) according to SMPTE 12M-1-2008.
- c. Ancillary Time Code (ATC, formerly known as DVITC) according to SMPTE 12M-2-2008.
- d. Other potential timecode types, including Edgecode, Camera Metadata, IRIG, ST309, even "Next Generation Timecode". Note that times in some cases may be obtained from the User Bits of the incoming timecode.

6.4.5.3 Historical Source Timecode in Essence Container System Items

When supplied to the encoder, Historical Source Timecode shall be encoded in the second and subsequent elements of the ST405 TimecodeArray of the ST 394 System Element. (Section 6.4.4.2 reserves the first element for Master Timecode.) Historical Source Timecode in Essence Containers shall be stored with each frame and not as a start and duration. Encoders shall accommodate discontinuities in incoming Historical Source Timecode in Essence Containers and shall record matching discontinuities within the ST405 TimecodeArray.

Encoders should encode a DateTimeDescriptor as specified in 6.4.3 above (Labeling Timecode in Header Metadata).

6.4.5.4 Historical Source Timecode Tracks in Header Metadata

AS-07 encoders should generate a timecode track for each instance of Historical Source Timecode, numbered as indicated in section 6.4.5.3.

6.4.5.5 Historical Source Timecodes in Essence Container Data Items

Additional Historical Source Timecodes may also be represented as SMPTE ST 12-2 data in ANC packages in one or more Data Items in the Essence Container.

Encoders should encode a DateTimeDescriptor as specified in 6.4.3 above (Labeling Timecode in Header Metadata).

6.4.5.6 Historical Source Timecode in Lower Level Source Packages

6.4.5.6.1 Historical Source Timecode in Lower Level Source Packages (informative)
EBU R 122 (Material Exchange Format Timecode Implementation) foresaw the need to identify and characterize MXF files that contain multiple expressions of Timecode. In section 3 (Recommendations) of this EBU standard, recommendation 2.e specifies an approach that places Historical Source Timecode(s) in timecode tracks of the Lower Level Source Package (LLSP). This approach will also have value for AS-07 files. As specified below, AS-

07 shims may mandate, forbid, encourage, or permit this practice. In the initial AS-07 Baseband Shim (appendix J), the use of LLSP for Historical Source Timecode tracks is encouraged.

6.4.5.6.2 Historical Source Timecode in Lower Level Source Packages, Requirement Options for Shims (informative)

Each AS-07 shim will specify its requirements for the carriage of AS-07 Historical Source Timecode tracks in Lower Level Source Packages (LLSP) as follows:

- LLSP Historical Source Timecode tracks are mandated: The Timecodes encoded as the second and subsequent elements of the ST 405 Timecode Array (section 6.4.5.3) shall have a matching LLSP Timecode track.
- LLSP Historical Source Timecode tracks are forbidden: The Timecodes encoded as the second and subsequent elements of the ST 405 Timecode Array (section 6.4.5.3) shall never have a matching LLSP Timecode track.
- LLSP Historical Source Timecode tracks are encouraged: The Timecodes encoded as the second and subsequent elements of the ST 405 Timecode Array (section 6.4.5.3) should have a matching LLSP track, and there may be additional LLSP Timecode tracks for which there is no ST 405 Timecode Array element.
- LLSP Historical Source Timecode tracks are permitted: The Timecodes encoded as the second and subsequent elements of the ST 405 Timecode Array (section 6.4.5.3), and Timecodes for which there is no ST 405 Timecode Array element, may have matching LLSP tracks. Thus there is no required correspondence between the Timecodes encoded as the second and subsequent elements of the ST 405 Timecode Array (section 6.4.5.3) and LLSP Timecode tracks.

6.4.5.6.3 Historical Source Timecode in Lower Level Source Packages, Encoder Requirements

When Historical Source Timecode tracks are to be placed in Lower Level Source Packages, AS-07 encoders shall accommodate discontinuities in incoming Historical Source Timecode. Discontinuous timecode shall be represented as a Sequence of TimecodeComponents (ST 377-1 annex B.16). Continuous timecode shall be represented as a TimecodeComponent with Start Time and Length (ST 377-1 annex B.17). Segments with no timecode or undecodable timecode shall be represented as Filler (ST 377-1 annex B.10).

Encoders should encode a DateTimeDescriptor as specified in 6.4.3 above (Labeling Timecode in Header Metadata).

6.4.6 Shim Parameter Table for Timecode

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
Master Timecode mode	Master Timecode mode requirement	master_timecode_mode	Strong	Drop frame Non-drop-frame Mode not declared
Master Timecode frame rate	Master Timecode frame rate requirement	master_timecode_framerate	Gentle	Any integer or rational numerical value representing the number of frames per second. No requirement
Master Timecode start type	Type of clock start value for Master Timecode	master_timecode_starttype	Gentle	User specified fixed value Start value derived from historical source timecode Any value
User specified fixed value Master Timecode start time	Prescribed start time for fixed-value Master Timecode, e.g., 01:00:00:00	master_timecode_fixed_startvalue	Gentle	Any timecode value expressed as HH:MM:SS:FF No requirement
Historical Source Timecode in LLSP	Carriage of Historical Source Timecode track instances in the LLSP	historical_source_timecode_LLSP	Gentle	Mandated Forbidden Encouraged Permitted

6.4.7 Decoder Behavior with Regard to Timecode

6.4.7.1 Decoder Behavior with Regard to Master Timecode

Decoders shall use the AS-07 Master Timecode as the primary, canonical timecode instance for playback and other references.

In order to assist users in identifying problems in file encoding or decoding, AS-07 decoders may track Master Timecode in both the essence container (section 6.4.4.4) and in Master Timecode Tracks (sections 6.4.4.2 and 6.4.4.3), and provide an indication of any discrepancies.

6.4.7.2 Precedence of Timecode

Decoders should decode both the Master Timecode in the Header Metadata Material Package and the Master Timecode in the Essence Container, and when decoding a frame of essence, decoders should compare the two timecodes that are implied for that frame. In the event of a disagreement between the two implied timecodes, decoders should indicate an error condition and should indicate which timecode is chosen to take precedence.

6.4.7.3 Decoder Behavior with Regard to Historical Source Timecode

When decoding AS-07 files that carry Historical Source Timecode(s) in the SMPTE 12M-1-2008 format, carried in the ST405 TimecodeArray of the ST 394 System Element; Lower Level Source Packages; and/or Essence Container Data Items, decoders shall provide the ability to select and display these timecodes before and during playback, and shall output those instance(s) of timecode data, in the format as encoded, for applications external to the decoder. Note that SMPTE 12M timecodes (LTC, VITC, and ATC) are listed in section 6.4.5.2.

When decoding AS-07 files that carry other (non-SMPTE 12M-1) Historical Source Timecode(s), decoders may provide the ability to select and display these timecodes before and during playback, and shall output those instance(s) of timecode data, in the format as encoded, to applications external to the decoder.

6.5 Header Metadata Parameters and Constraints

6.5.1 Header Metadata

Header Metadata shall be compliant with SMPTE ST 377-1:2011 and with SMPTE ST 378:2004 OP1a; SMPTE ST 391:2004 OP1b; and SMPTE ST 408:2006 OP1c and OP3c.

6.5.2 Shim Parameter Table for Header Metadata

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
Program identification	Required identifiers	program_identification	Gentle	One of: UUID UMID UL Other
Master Timecode	Master Timecode track in the Material Package, synthetic and continuous, labeled as Track 1.	master_timecode_track	Strong	Mandated
Historical Source Timecode	One or more Historical Source Timecode tracks, with Descriptors and with Track Numbers 2 or greater.	historical_source_timecode_track	Strong	Mandated*
Intimate metadata	Metadata that is intimately associated with the essences and which must be carried with the file including information about the ingest of the source stream	intimate_metadata	Moderate	All of: Program Ident Track Ident Language Code Ingest Provenance

				Other per shim

* Mandated when Historical Source Timecode is carried in Essence Container System Items or Data Items.

6.5.3 Top-Level Source Packages

6.5.3.1 Top-Level Source Package Quantity (informative)

AS-07 files with internal essences will use operational patterns OP1a or OP1b. The MXF specification limits OP1a and OP1b files to a single Top-level Source Package. Multiple Top-level Source Packages will be required for AS-07 OP3c files, where external references will point to multiple essence-containing files.

6.5.3.2 Top-Level Source Packages

Encoders shall write AS-07 files with one or more Top-Level Source Packages. Shims may specify a required quantity or quantity range of Top-Level Source Packages. Decoders shall read all Top-Level Source Packages in an AS-07 file.

6.5.3.3 Shim parameter table for Top-Level Source Packages

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
Top-level source package	Quantity of top-level source packages	tlsp_quantity	Strong	Single Multiple

6.5.4 Lower-Level Source Packages

If present, Lower-Level Source Packages shall be compliant with SMPTE ST 377-1:2011.

6.5.4.1 Lower-Level Source Packages, Relevant New Standard (informative)

Several topics, including the properties of the Lower Level Source Packages, are addressed in SMPTE 2001-2, pertaining to the mapping of registered data in XML form. Publication of this standard is anticipated in 2014. The additional guidance about Lower Level Source Package properties may include features that will be implemented in future editions of AS-07.

6.5.5 MXF Tracks

Packages in AS-07 files shall contain exactly the number of MXF Tracks required to describe the Video, Audio, Content Integrity, Timecode, Descriptive Metadata, and other Ancillary Tracks contained in the file. Tracks in the Material Package shall be compliant with SMPTE ST 377-1:2011. In addition, Timecode tracks shall be compliant with the rules outlined in section 6.4.

6.5.6 Descriptors

The Descriptors in the File Package (Top Level Source Package) of AS-07 files shall be compliant SMPTE ST 377-1:2011. Descriptors shall include all properties specified by SMPTE ST 377-1:2011 and specific parametric metadata as required by Video, Audio, and Closed Captions Tracks. In addition, descriptors and subdescriptors for Timecode shall be compliant with the rules outlined in section 6.4.

6.5.7 Package Labeling

PackageIDs in AS-07 files shall be in compliance with SMPTE ST 330:2004.

6.6 Descriptive Metadata Parameters and Constraints

6.6.1 AS-07 Descriptive Metadata (informative)

This AS-07 specification defines four Descriptive Metadata Schemes (DMS) that may be included in an AS-07 MXF file. One of the schemes pertains to the whole file (and is required); two define sets of metadata elements for additional (a) text-based or (b) binary data that may be embedded in the file; and the fourth provides information about the segmentation of essences. The DM Schemes for embedded text-based or binary data are implementations of a "superclass" DMS, which is also specified in this document. Thus appendixes D through G

provide specifications for five DM Schemes: the four that may be included in AS-07 files and the superclass DMS.

Organizations may also include other Descriptive Metadata Schemes, e.g., DMS-1, in AS-07 files.

The expectation is that organizations creating the files will provide the data for the instances of descriptive metadata to AS-07 encoders, either for one file at a time or in batches. Although not part of this specification, organization-provided data will be structured in the form of CSV tables, XML documents, etc. Encoders will be expected to receive this data and embed it according to the requirements below.

6.6.1.1 AS-07 Core Descriptive Metadata Scheme (informative)

AS-07 Core Descriptive Metadata Scheme (AS_07_Core_DMS) is required for all AS-07 files. In a mix of optional and mandatory elements, AS_07_Core_DMS provides one or more identifiers for the file and its content, a high level description of the file's content (e.g., title or working title), identifies who is responsible for the file (the "keeper" in terms of long-term management), provides basic video characteristic information, identifies if captions are present, defines audio track allocations, and offers high level information about how the file was made (e.g., "reformatted from videotape"). This scheme is not repeatable within the file.

AS_07_Core_DMS is relatively simple by design, offering less information than found in, say, an AS-11 Core-DMS track. The optional Supplementary Metadata entities in an AS-07 file—which are user developed and vary from organization to organization—provide creating organizations with an opportunity to offer more detailed metadata, e.g., complete cataloging information, detailed information about the reformatting or production process, other administrative and technical metadata, etc. Although AS-07 has no required schemas or other structures for Supplementary Metadata, specifications for its carriage as text-based streams in Generic Stream Partitions (SMPTE ST 410-2008) are provided in section 6.2.4.

Meanwhile, specific parametric information required by Video, Audio and Closed Caption tracks is stored in Picture, Sound and Generic Descriptors as described in SMPTE ST 377-1:2001; see section 6.4.7.

6.6.1.1.1 AS-07 Core DMS Device Objects (informative)

AS_07_Core_DMS_Device Objects defines the unordered set of references for use in AS_07_Core_DMS that describe the device(s) used to capture or create the content. This optional and repeatable object set defines the device type (such as "camera"), manufacturer, model, serial number and usage description.

6.6.1.2 AS-07 DMS Identifier Objects (informative)

AS_07_Core_DMS_Identifier Objects defines the unordered set of references that describe file- and part-identifiers in an AS-07 file. This set of references may be used in AS_07_Core_DMS and also in other AS-07 DMSes. Many organizations employ multiple identifiers for items (or parts of items) in their collections, some of which are local (e.g., shelf number for a physical item), and AS_07_Core_DMS_Identifier Objects are intended to permit embedding these multiple identifiers in AS-07 DMSes, and to distinguish them in terms of type and by optional comments. The list of elements includes identifier value, role (Main, Additional or GSP), type (such as UUID, UMID, UL, Other), and a free text comment field. At least one AS_07_DMS_Identifier set is required in AS_07_Core_DMS with the IdentifierRole = Main. Beyond the main identifier, additional AS_07_Core_DMS_Identifier sets are optional; there can be as many IdentifierRole = Additional identifiers as an organization requires.

6.6.1.3 AS-07 Generic Stream Partition Superclass Descriptive Metadata Scheme (informative)

The AS-07 Generic Stream Partition Descriptive Metadata Scheme (AS_07_GSP_DMS) defines the required superclass metadata scheme for data stored in Generic Stream Partitions in AS-07 files (see section 6.2.4). AS_07_GSP_DMS will provide a high level description of the GSP data payload including identifiers, data description, a free text comment field and, where applicable, mime type.

The AS_07_GSP_DMS, like the DMS specified in SMPTE ST 2057, requires the use of a MIME type for text-based data to characterize the text-based entity carried in the Generic Stream Partition. Mime types are optional for binary data. In the library and archive world, MIME types have been registered for some widely used cataloging record types. For example, IETF's RFC 6207 documents two library community examples: MODS (Metadata Object Description Schema) is application/mods+xml, while the MARC21 XML Schema is application/marcxml+xml. Other valuable metadata types, however, do not have registered MIME types. Examples include PBCore (the U.S. Public Broadcasting Metadata Dictionary, which has an XML schema) and the process-logging metadata produced by the Front Porch SAMMA device. Typically, complex non-registered entities like these would be assigned the generic MIME application/xml. Meanwhile, IETF's RFC 3023 suggests that XML data that is "readable by casual users" be assigned the generic MIME text/xml.

6.6.1.3.1 AS-07 Generic Stream Partition Binary Data Descriptive Metadata Framework (informative)

AS-07 Generic Stream Partition Descriptive Metadata Framework (AS_07_GSP_BD_DMS) is required for each binary data stream in AS-07 Generic Stream Partitions (SMPTE ST 410-2008). In this edition of the AS-07 specification, this scheme is identical to the superclass described in section 6.6.1.3 above, but it may be extended in the future.

6.6.1.3.2 AS-07 Generic Stream Partition Text-based Data Descriptive Metadata Framework (informative)

AS-07 Generic Stream Partition Text-based Data Descriptive Metadata Framework (AS_07_GSP_TD_DMS) is required for each text-based data streams in AS-07 Generic Stream Partitions (SMPTE ST 410-2008 and see section 6.2.4) including XML-structured Timed Text (SMPTE or EBU), Supplementary Metadata and the AS-07 Manifest (section 6.6.1). AS_07_GSP_TD_DMS augments the data in AS_07_GSP_DMS to be compliant with the Descriptive Metadata Scheme and Sets for Text-Based Metadata described in SMPTE RP 2057-2011 (Text-Based Metadata Carriage in MXF).

6.6.1.4 AS-07 Segmentation Descriptive Metadata Scheme (informative)

AS-07 Segmentation Descriptive Metadata Scheme (AS_07_Segmentation_DMS) is required for all AS-07 files that implement essence Segmentation (see section 6.7.5). AS_07_Segmentation_DMS will provide a description of both the individual segmented parts as well as the aggregate group of parts. Since AS-07 files with internal essences are limited to Operational Patterns OP1a and OP1b, AS_07_Segmentation_DMS will not repeat in a file.

6.6.1.4.1 AS-07 Segmentation Descriptive Metadata Scheme – Parts Object (informative)

AS-07 Segmentation Descriptive Metadata Scheme – Parts Object (AS_07_Segmentation_DMS_PartsObjects) defines the unordered set of references which describe the parts within a program. This optional and repeatable set includes the part number and total number of parts, i.e. "1 of 3", "2 of 3", "3 of 3."

6.6.2 AS-07 Descriptive Metadata Schemes Encoder Requirements

AS-07 encoders shall create instances of Descriptive Metadata Schemes in compliance with SMPTE ST 377:2011 and EG 42:2004 as well as SMPTE RP 2057:2011 for text-based metadata only.

Each metadata scheme used in the file shall be identified by the use of a DM Scheme label contained in the MXF Preface Set by the DMSchemes property.

The detailed metadata dictionaries and scheme labels for the AS-07 schemes are defined and labeled in the appendixes as listed below:

Data dictionary	Scheme label	Comment	Appendix
AS-07 Core Descriptive Metadata Scheme	AS_07_Core_DMS		D.1
AS-07 Core DMS Device Objects	n/a	Used by AS_07_Core_DMS	D.2
AS-07 DMS Identifier Objects	n/a	Used by AS_07_Core_DMS and other DM schemes	E
AS-07 Generic Stream Partition DMS Superclass	AS_07_GSP_DMS	Used by AS_07_GSP_BD_DMS and	F.1

		AS_07_GSP_TD_DMS	
AS-07 Generic Stream Partition Binary Text Descriptive Metadata Framework	AS_07_GSP_BD_DMS		F.2
AS-07 Generic Stream Partition Text-based Text Descriptive Metadata Framework	AS_07_GSP_TD_DMS		F.3
AS-07 Segmentation Descriptive Metadata Scheme	AS_07_Segmentation_DMS		G.1
AS-07 Segmentation DMS - Parts Objects	n/a	Used by AS_07_Segmentation_DMS	G.2

AS-07 files may contain other Descriptive Metadata Schemes unless forbidden by a specific shim.

An AS-07 Metadata Scheme Definition shall fully specify the following: 1) the DM Scheme Label that identifies the scheme, 2) the schemes specialized DM Framework, 3) the individual metadata items contained by the scheme's specialized DM Framework.

All keys used to identify AS-07 DM Scheme labels, their associated specialized DM Framework, and individual metadata items, shall be SMPTE ST 298:2008 Universal Labels and shall be published in the SMPTE metadata registry (http://www.smpte-ra.org).

6.6.2.1 AS-07 Descriptive Metadata Track Encoder Requirements

AS-07 encoders shall construct Descriptive Metadata Tracks in accordance with the recommendations of SMPTE ST 377:2011 and SMPTE EG 42:2004 as well as SMPTE RP 2057:2011 for text-based metadata only.

An AS-07 file shall contain one AS-07 Core Descriptive Metadata track. An AS-07 file shall contain zero or more AS-07 GSP Binary Text Descriptive Metadata Tracks, AS-07 GSP Text-based Text Descriptive Metadata Tracks, and/or AS-07 Segmentation Descriptive Metadata Tracks. AS-07 files may contain other Descriptive Metadata Tracks unless forbidden by a specific shim.

AS-07 encoders shall produce files in which each DMS has an associated specialized DM Framework contained by a dedicated Descriptive Metadata Track of the MXF Material Package that indicates which specific AS-07 shim (constraint set) applies to the file.

6.6.2.2 AS-07 Descriptive Metadata Track Decoder Requirements

AS-07 decoders shall be capable of identifying and reading all DM tracks specified in section 6.5.3, and providing a display or other readable output for AS_07_Core_DMS, AS_07_GSP_DMS, and AS_07_GSP_TD_DMS. AS-07 decoders shall be capable of providing usable output for AS_07_Segmentation_DMS in order to manage the playback of segmented content.

6.6.3 Shim Parameter Table for Descriptive Metadata Schemes

Dimension	Description	Shim parameters	AS-07 Constraint	AS-07 Values
AS_07_GSP_BD_DMS binary data	Requirement to carry AS_07_GSP_BD_DMS for binary data in Generic Stream Partitions	AS_07_GSP_BD_DMS	Strong	Permitted*
AS_07_GSP_TD_DMS text-based data	Requirement to carry AS_07_GSP_TD_DMS for text-based data in Generic Stream Partitions	AS_07_GSP_TD_DMS	Strong	Permitted**
AS_07_Segmentation_DMS segmentation data	Requirement to carry AS_07_GSP_Segmentation_DMS for segmented essences	AS_07_Segmentation_DMS	Strong	Permitted***
Additional Descriptive	Carriage of additional descriptive	additional_DMS	Gentle	Mandated, Forbidden,

Schemes	metadata schemes, e.g., DMS-1			Encouraged, Permitted

   * Mandated when binary data is carried in a Generic Stream Partition, otherwise permitted.
  ** Mandated when text-based data is carried in a Generic Stream Partition, otherwise permitted.
*** Mandated when segmented essences are carried in an AS-07 file, otherwise permitted.

6.6.4 Redundant Metadata

Custom metadata included in an AS-07 file by a shim should not duplicate metadata elements that are already carried in MXF Structural Metadata or are already part of the AS-07 Core Metadata Scheme. In the event of disagreement between redundant and/or duplicate metadata items present in an AS-07 MXF file, decoders should accord the highest priority to MXF Structural Metadata and AS-07 Core Descriptive Metadata Scheme, and lowest priority to the redundant shim-specified metadata.

6.6.5 KLV Fill

To provide for the addition of metadata to existing AS-07 MXF files, implementations should include a KLV Fill of at least 8 kilobytes in length following the header partition.

6.6.6 Static Descriptive Metadata Requirements

AS-07 files shall conform to the Descriptive Metadata Track structure described by SMPTE EG 42:2004. AS-07 Descriptive Metadata Tracks shall use the following subset of the MXF structure described in SMPTE EG 42:2004:

- A Static Track contained by the single Material Package in the AS-07 MXF file.
- A Sequence object contained by the Static Track.
- A single DM Segment object contained by the Sequence.
- A DM Framework instance contained by the DM Segment. The DM Framework instance type must map to one of the schemes defined in Preface:DMSchemes.

6.7 Other Parameters and Constraints

6.7.1 Manifest

6.7.1.1 Manifest (informative)

The AS-07 Manifest supports preservation and good housekeeping by offering an inventory of the AS-07 file's parts and expresses the relationships between them. Through a mix of required and optional elements, it provides a high level inventory of the parts including their identifiers, data description, MIME type, size and location. This information can help the user to better understand the composition of the file and it will also provide machine-interpretable information for content processing if, for example, an AS-07-aware application used values in the DataDescription element to quickly locate the correct QC file in a workflow or to delete embedded graphics (binary data) prior to distribution.

The Manifest is a form of text-based data to be carried in a Generic Stream Partition in an AS-07 file.

6.7.1.2 Manifest Structure

The top-level element in the manifest shall be designated Manifest. See 6.7.1.5 for more information and appendix H for the formal element definition in the XML schema declaration.

6.7.1.2.1 File identifier

6.7.1.2.1.1 File identifier element
For overall management of the asset, the required file identifier (FileID) element shall uniquely identify the AS-07 file. Each unique AS-07 file shall have a universally distinct and persistent file identifier.

This element shall contain the same value as the AS_07_Core_DMS_Identifier value where AS_07_DMS_IdentifierRole = Main in the AS_07_Core_DMS (see section 6.6 and appendix D). See section 6.7.1.4 for Manifest Encoder Requirements.

6.7.1.2.1.2 File identifier type attribute

The required file identifier type (FileIDType) attribute shall represent the type of unique identifier present in the FileID element.

This element shall contain the controlled vocabulary value for the AS_07_DMS_IdentifierType element where the AS_07_DMS_IdentifierRole = Main in the AS_07_Core_DMS. The controlled vocabulary for AS_07_DMS_IdentifierType is listed in AS_07_DMS_Identifier Objects (see section 6.6 and appendix E). See section 6.7.1.4 for Manifest Encoder Requirements.

6.7.1.2.2 Responsible Organization Name

The required responsible organization name (ResponsibleOrgName) element shall be a free-form, human-readable annotation describing the main name for the entity responsible for the creation, maintenance, preservation of this digital item.

This element contains the same value as the AS_07_Core_DMS_ResponsibleOrganizationName from the AS_07_Core_DMS (see section 6.6 and appendix D). See section 6.7.1.4 for Manifest Encoder Requirements.

Note: The responsible organization name property is intended only for display as guidance to a user.

6.7.1.2.3 Creation date element

The required creation date (CreationDate) element shall be set to the time and date at which the file was created.

The creation date shall be encoded as xs:dateTime type.

6.7.1.2.4 Annotation text element (optional)

The annotation text (AnnotationText) element may be present and shall be a list of zero or more free-form, human-readable annotations describing the file. This element may be used to give additional information about the file.

Note: The annotation text element is intended only for display as guidance to a user.

6.7.1.2.5 Part list element

The part list (PartList) element shall contain the list of Part elements that describe each of the parts contained in the AS-07 MXF file including essences and Generic Stream Partitions (see section 6.2.4). The structure of the Part element is described in section 6.7.1.3. The order of Part elements in the list shall not be significant.

6.7.1.3 Part element

A part (Part) element shall represent any part or file that exists in the AS-07 file such as an essence track or Generic Stream Partition contents (see 6.2), etc. Each part shall be described by a part element. See the XML schema declaration in section 6.7.1.5 and appendix H for a normative definition.

The manifest shall not include a part element entry for the manifest itself.

6.7.1.3.1 Part identifier

6.7.1.3.1.1 Part identifier element (informative)

Internally generated unique identifiers for part objects, like SIDs, are not persistent because they are intended to be assigned at will by the encoder and may change. Universally unique identifiers, on the other hand, will remain constant over time. Parts may have more than one unique identifier but one must be universally unique.

6.7.1.3.1.2 Part identifier element

The required part identifier (PartID) element shall represent the universally unique and persistent identifier associated with the described part object.

When the PartID element describes an object in a Generic Stream Partition (see section 6.2.4), the PartID element shall contain the same value as AS_07_GSP_DMS_Identifier from AS_07_GSP_DMS (see appendix F.1).

If the part contains no universally unique identifier, then the creator of the Manifest file shall generate one. See section 6.7.1.4 for Manifest Encoder Requirements.

6.7.1.3.1.3 Part identifier type attribute

The required part identifier type (PartIDType) attribute shall represent the type of unique identifier present in the PartID element.

This element shall contain the same values as the AS_07_DMS_IdentifierType. The controlled vocabulary for AS_07_DMS_IdentifierType is listed in AS_07_DMS_Identifier Objects (see section 6.6 and appendix E). See section 6.7.1.4 for Manifest Encoder Requirements.

6.7.1.3.2 Data description element

The required data description (DataDescription) element shall be used to describe the role of the part within the AS-07 file. The value of the element shall be used both for display as guidance for the user and as machine-interpretable information for content processing.

When the data description (DataDescription) element describes an object in a Generic Stream Partition (see section 6.2.4), the data description element shall contain the same value as AS_07_GSP_DMS_DataDescription. See section 6.7.1.4 Manifest Encoder Requirements.

6.7.1.3.3 MIME media type (optional)

The MIME media type (MimeType) element may be used to describe the data type of the part object. When used, a value shall be selected from values listed at the following website:
http://www.iana.org/assignments/media-types

When the MIME media type (MimeType) describes an object in a Generic Stream Partition (see section 6.2.4), the MIME media type element shall contain the same value as AS_07_GSP_DMS_MIMEMediaType if it is present.

6.7.1.3.4 Size element

The required size (Size) element contains the size of the part in bytes. This size shall be expressed as an integer number of bytes, encoded as type xs:positiveInteger.

6.7.1.3.5 Location element (optional)

The location (Location) element contains the relative URI of the part, relative to the root of the file.

6.7.1.3.6 Part annotation text element (optional)

Part annotation text (PartAnnotationText) elements may be present and shall be a list of zero or more free-form, human-readable annotations describing the file. This element may be used to give additional information about the part.

Note: Annotation text elements are intended only for display as guidance to a user.

6.7.1.4 Manifest Encoder Requirements

6.7.1.4.1 General Manifest Requirements

AS-07 encoders may create an AS-07 manifest and embed it in the file as specified in the following subsections. The inclusion of a manifest may be mandated, forbidden, encouraged, or permitted by a shim.

6.7.1.4.2 Detailed Manifest Requirements

The following requirements apply when an AS-07 encoder embeds a manifest in an AS-07 file.

Encoders shall identify and extract the value from the AS_07_Core_DMS_Identifier value where AS_07_DMS_IdentifierRole = Main in the AS_07_Core_DMS (see section 6.6) and insert the value into the FileID element in the Manifest.

Encoders shall identify and extract the controlled vocabulary value for the AS_07_DMS_IdentifierType element where the AS_07_DMS_IdentifierRole = Main in the AS_07_Core_DMS and insert the value into the FileIDType element in the Manifest.

Encoders shall identify and extract the value from the AS_07_Core_DMS_ResponsibleOrganizationName from the AS_07_Core_DMS (see section 6.6) and insert the value into the ResponsibleOrgName element in the Manifest.

Encoders shall identify and extract the universally unique identifier for each part object and insert the value in the PartID element in the Manifest. Encoders shall generate a universally unique identifier if one is not already assigned to each part object. For the purposes of the Manifest, a UUID encoded as a URN according to IETF RFC 4122 shall be sufficient although application domains may require more stringent identifier implementations.

When the data description (DataDescription) element describes an object in a Generic Stream Partition (see section 6.5), encoders shall identify and extract the value from the AS_07_GSP_DMS_DataDescription from the Generic Stream Partition Data Descriptive Metadata Scheme (see section 6.6) and insert the value into the DataDescription element in the Manifest.

Encoders shall assign the correct DataDescription element value if a new part object is added to the file. When an application modifies parts or transcodes files, encoders shall persist those DataDescription element values in the new Manifest.

Encoders shall identify and extract the value from the AS_07_GSP_DMS_MIMEMediaType if it is present and insert the value into the MimeType element in the Manifest.

6.7.1.5 XML Schema, Naming, and Carriage of Manifest

When a manifest is required by a shim, AS-07 encoders shall encode the AS-07 Manifest as an XML document (W3C XML 1.0), conforming to the XML schema defined in appendix H. The manifest file shall be named *manifest.xml*. Encoders shall treat the manifest file as a form of text-based data and embed it in a Generic Stream Partition in the AS-07 file as specified in section 6.2.4.

6.7.1.6 Shim parameter table for the manifest

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
Manifest	Indicates the requirement for the AS-07 manifest.	manifest	Strong	Mandated, Forbidden, Encouraged, Permitted

6.7.2 Content Integrity

6.7.2.1 Content Integrity Objective and Relevant Standards (informative)

Content in AS-07 files will often be destined for long term archiving-and-preservation management. This objective is supported by a number of actions, including the creation of fixity or hash values and the monitoring of those values for change over time. In other MXF Application Specifications, this objective is called *media integrity* (sometimes abbreviated as *MI*).

For digital library specialists, content or media integrity usually turns on whole-file fixity values, critical for a well-run asset management system. But whole-file fixity data cannot be embedded in the file itself: that action would change the file, making the hash value "next time" different, thus invalidating it for comparison and monitoring. Whole-file checksums are a critical part of storage and repository systems but have no place in a file-wrapper specification. For file wrappers, a good fit is provided by specifying a carriage location for hash values on segments of the file, e.g., on a frame or some other small unit of video.

AS-07 calls for the embedding of fixity data on the *V* or *value* data in the KLV triplets that represent frame-wrapped essences. Similar approaches are used in other standards and specifications and, writing informally, this is often referred to as *frame-level* or *edit-unit-level fixity*; the latter term is defined in SMPTE ST 377-1:2011. It is worth noting that frame-level hash values (often referred to as *checksums* or *Cyclic Redundancy*

Checks, *CRCs*) are sometimes employed for use cases such as monitoring production. For example, some specialists use ffmpeg's *framecrc* and *framemd5* to produce checksums on a more granular, per-frame level, making it more feasible to assess the extent or location of digital change in the event of a checksum mismatch.

AS-07 files will generally be frame-wrapped, with the exception of files that carry long-GOP D- 10 essences. For D-10, content integrity systems native to long-GOP are to be retained in AS-07 files.

Frame-wrapped picture may be progressive-scanned or interlaced. Picture data for progressive-scanned content will be represented as the V in a KLV triplet, and the calculation of fixity is straightforward. Picture data for interlaced video will very often be carried with the data from both fields represented as a single V in a KLV triplet. This is the case for uncompressed video mapped according to SMPTE ST 384 and ST 377-1 (annex G.2.25), and also for JPEG 2000 compressed video *case I2* (frame wrapping, interlaced two fields per KLV triplet) mapped according to SMPTE ST 422:2014.

The exception to the general rule outlined in the preceding paragraph is the JPEG 2000 interlaced picture wrapping identified as *case I1* in SMPTE ST 422:2014, where each field is wrapped as a separate KLV triplet. In this case, AS-07 requires that the concatenated V values for pairs of KLV triplets be hashed as one. AS-07 uses this approach so that the integrity data for interlaced video is always at the frame (edit unit) level. The same hash value would be calculated as from *case I2*, and this outcome supports integrity monitoring if an essence is re-wrapped from *I1* to *I2* or vice versa.

The AS-07 approach borrows from two important precedents: (1) SMPTE ST 429-6:2006 (D- Cinema Packaging -- MXF Track File Essence Encryption) and (2) the BBC Archive Preservation File Format described in section 5 in the BBC White Paper 233: http://downloads.bbc.co.uk/rd/pubs/whp/whp-pdf-files/WHP233.pdf.

From SMPTE ST 429-6:2006, AS-07 re-uses the equivalent of a DMS (Descriptive Metadata Scheme) system for fixity data. In the digital cinema context represented by this standard, fixity data is conjoined with data pertaining to the encryption of the triplet.

Although the use of encryption will be very rare in AS-07 files, in order to allow for this rare use and also to remain consistent with ST 429-6:2006, AS-07 files use that standard's terminology: *Cryptographic Context Set* (like a DM Scheme), *Cryptographic Framework* (like a DM Framework), and *Cryptographic Framework DM Tracks*. The Cryptographic Context Set implemented in AS-07 includes three adaptations from the ST 429-6:2006 implementation: (1) the addition of the optional MICCarriage item, (2) specifying the permitted Null value as the default value for the CipherAlgorithm item and (3) specifying 0 (zero) as the default value for the CryptographicKeyID item.

When content integrity data is created for an AS-07 file, however, the specification does not require the Encrypted Triplet Variable Length Pack specified by ST 429-6:2006 to carry the hash values. Instead AS-07 employs the System Item in the Generic Container, like the BBC and as specified below.

In some instances, incoming content will include Encrypted Triplet Variable Length Pack data, either because it pre-exists as it may for digital cinema content or because a specialized application creates and presents it to the AS-07 production system. This will typically be a circumstance in which content wrapped in non-AS-07 MXF is intended for re-wrapping as AS-07. As noted in section 6.7.2.7, in this case, AS-07 production systems are to retain the Encrypted Triplet Variable Length Pack data in the re-wrapped file, and decoders are to output the Encrypted Triplet Variable Length Pack data (if present) to applications external to the decoder.

It is also the case that ST 429-6:2006 specifies the SHA-1 algorithm for integrity. For the AS-07 preservation use case, this specification calls for the more easily created Castagnoli CRC-32C. The Encrypted Triplet Variable Length Pack from ST 429-6:2006 also carries an element called Sequence Number, defined as "Sequence number of this Triplet within the Track File." In AS-07, the required carriage of the Master Timecode in a System Item (see section 6.4.4.4) provides a one-up set of numbers that can be consulted to the same effect. To allow decoders to differentiate between AS-07 use of System Items and ST429-6:2006 Encrypted Triplets, AS-07

defines an optional item MICCarriage in the Cryptographic Context Set in which a SystemItem value indicates the AS- 07 usage and whose absence indicates use of Encrypted Triplets.

The BBC Archive Preservation File Format provides AS-07 with the structure that carries the fixity data itself, as specified in BBC White Paper 233, which refers to the approach as a frame- level checksum. There is one small variation: BBC calls for the use of the PNG CRC-32 Cyclic Redundancy Code algorithm; instead, we specify Castagnoli CRC-32C.

It is beyond the scope of a wrapper specification to specify when in an organization's workflow the initial MIC hash value should be calculated. It is worth noting, however, that many experts counsel that hash creation should occur at the moment of initial encoding, a possibility enhanced by the selection of the Castagnoli CRC-32C hash, which is easy and fast to calculate. Generating the initial hash at the time of encoding means that a sophisticated file-creation system can use this data to verify that the file has been correctly written to media the first time file-writing occurs, thereby supporting quality control at an early stage in the life cycle.

6.7.2.2 CRC-32C Values per KLV Essence Triplets

When required by a shim, AS-07 encoders shall calculate a Castagnoli CRC-32C Cyclic Redundancy Code (IETF RFC 3385) value for every V or value data unit in the KLV triplets that represent frame-wrapped essences, with the exception of interlaced JPEG 2000 that is wrapped according the case I1 specified in SMPTE ST 422:2014, the case in which each field is wrapped as a separate KLV triplet. In the latter case, when integrity data is required by a shim, AS07 encoders shall calculate the Castagnoli CRC-32C for the concatenated values of the two Vs in the pair of KLVs.

For non-frame-wrapped D-10 essences, AS-07 encoders shall retain the integrity elements that are native to that essence.

6.7.2.3 Content Integrity Values Carried in Arrays in Essence Container System Items (informative)

The structure of data arrays of the type described here, and in the section devoted to Timecode (6.4), are governed by the batch syntax for KLV values specified in ST 2003:2012. For AS-07, the TimecodeArray is a single property whose value is an array, with the first element MasterTC, and with second and subsequent elements representing other Historical Source Timecodes. The integrity data is represented in a HashArray with a single property whose value is an array, with the first element EssenceTrack Hash, and with second and subsequent Hashes for other EssenceTracks. Generally speaking the first EssenceTrack is picture and the second and subsequent elements are sound, as in the BBC illustrative example below. However, the actual identifiers for these essence tracks are contained in the structural metadata for the FilePackage, and also in the Descriptors contained in or strongly referenced by the FilePackage.

In the illustrative example that follows, the system item bytes for Timecode are a value equal to 09:58:10:12, and the hash values for video and four audio elements are bytes shown in hexadecimal notation with the start of each array item highlighted in bold text:

ITEM	ILLUSTRATIVE VALUE	COMMENT
Key	06.0e.2b.34.02.53.01.01.0d.01.03.01.14.02.01.00	
Len	83.00.00.3c	
Timecode array	01.02	
Local len	00.18	
Array len	00.00.00.02	
Array element len	00.00.00.08	

MasterTC	12.10.58.09.00.00.00.00	Value is actual bytes that represent a Timecode (in this case 09:58:10:12).
VITC element	12.10.58.09.00.00.00.00	Value is actual bytes that represent a Timecode.
LTC element	12.10.58.09.00.00.00.00	Value is actual bytes that represent a Timecode.
Hash array	ff.ff	
Local len	00.1c	
Array len	00.00.00.05	
Array element len	00.00.00.04	
EssenceTrack Hash	8b.cf.fa.3c	First hash is typically picture
EssenceTrack Hash	89.45.12.55	Second hash typically audio 1
EssenceTrack Hash	6f.89.01.06	Third hash typically audio 2
EssenceTrack Hash	32.cc.10.9a	Fourth hash typically audio 3
EssenceTrack Hash	32.cc.10.9a	Fifth hash typically audio 4

6.7.2.4 Content Integrity Array in Essence Container System Items

The CRC-32C values shall be stored in essence System Items as arrays that comply with SMPTE ST 2003:2012.

6.7.2.5 Encryption data (informative)

This version of the AS-07 specification does not offer specifications pertaining to encryption, reserving this topic for a future version. The approach to be adopted is anticipated to follow the guidance provided by SMPTE ST 429-6:2006 and will take into account additional or refined guidance that may result from the development of the Interoperable Master Format (IMF).

6.7.2.6 Cryptographic Context Set, Cryptographic Framework, and Cryptographic Framework DM Tracks.

When CRC-32C hash values are created for frame-wrapped essences, AS-07 encoders shall also create and populate Cryptographic Context Set, Cryptographic Framework, and Cryptographic Framework DM Tracks as specified in SMPTE ST 429-6:2006, with the optional item MICContainer in the Cryptographic Context Set in which a SystemItem value indicates the AS- 07 usage and whose absence indicates use of Encrypted Triplets. Detailed information and requirements on this interrelated set of metadata elements is provided in appendix I.

6.7.2.7 Retention of Encrypted Triplet Variable Length Pack Data

When the input to an AS-07 production system includes integrity and/or encryption data as specified in SMPTE ST 429-6:2006, from an MXF source file that includes an Encrypted Triplet Variable Length Pack or from a specialized system that provides equivalent data in that format, AS-07 encoders shall retain this data in the AS-07 file.

6.7.2.8 Decoder Requirements

AS-07 decoders shall provide the ability to output the CRC-32C data to applications external to the decoder.

Decoders shall provide the ability to select and display the metadata in the Cryptographic Context Set, Cryptographic Framework, and Cryptographic Framework DM Tracks before and during playback, but shall not depend on the presence of this data for the handoff of the CRC data.

This capability shall extend to CRC-32 data in non-Castagnoli formats, thus permitting AS-07 decoders to support "legacy" BBC archive files, which do not have Cryptographic Context Set, Cryptographic Framework, and Cryptographic Framework DM Tracks.

AS-07 decoders shall provide the ability to output the Encrypted Triplet Variable Length Pack data to applications external to the decoder, thus permitting AS-07 decoders to support files that employ the integrity and encryption structure specified in SMPTE ST 429-6:2006.

6.7.2.9 Shim parameter table for content integrity

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
Content integrity	Content integrity data required	content_integrity	Strong	Mandated, Forbidden, Encouraged, Permitted
MIC algorithm	Type of integrity algorithm supported by decoders	mic_algorithm_decoder	Strong	CRC-32C CRC-32 MD5 SHA-1 SHA-256 SHA-512
MIC carriage	MIC carriage location in file	mic_carriage	Strong	SystemItem Encrypted Triplet Variable Length Pack

6.7.3 File Names

6.7.3.1 File names

The general provisions of the AS-07 specification do not constrain the choice of filenames. Individual shims may constrain file names.

6.7.3.2 Shim parameter table for file names

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
File names	File name restrictions	filenames	Gentle	No constraint [Filename pattern as described in shim specification]

6.7.4 Directory Structure

The general provisions of the AS-07 specification do not constrain the choice of directory names or structures for storage of AS-07 files.

6.7.5 Program Segmentation

6.7.5.1 Program Segmentation (informative)

Program Segmentation refers to the presence of regions in the program's Essence data that represent parts of a larger whole (e.g., episodes in a series) or points where the program content may be broken (interrupted) in playback. Segmentation may be useful to archives, e.g., if a content asset is a complete movie, a DMS Segmentation track would indicate where the reels start and stop; if the content is episodes of television series, a DMS Segmentation track would indicate where the episodes start and stop. Another example is the film strip genre, where the timing and linkage to the sound track could be described as DMS Segmentation. This type of segmentation is used in AS-11 broadcast files to indicate when non-program content like advertising may be inserted at broadcast time.

6.7.5.2 Program Segmentation Requirements

6.7.5.2.1 Segmentation Track

6.7.5.2.1.1 Segmentation Track General Requirement
Program segmentation is optional in AS-07 files unless required or forbidden by a shim.

6.7.5.2.1.2 Segmentation Track Detailed Requirements
If AS_07_Segmentation_DMS is used in an AS-07 file, encoders shall represent program segmentation by creating an MXF Timeline track in the file's Material Package, referred to as the Segmentation Track. Encoders shall construct the Segmentation Track's descriptive metadata in accordance with the recommendations of SMPTE EG 42:2004. Lower Level Source Package objects in AS-07 should not have a Segmentation Track.

An AS-07 file shall contain zero or one Segmentation Track. The Segmentation Track shall be identified by the presence of DM_AS_07_Segmentation_Framework objects in DM Segment objects on a Timeline track.

The Segmentation Track shall contain a Sequence object that is composed of DM Segment objects and Filler, if required.. The DM Segment objects shall contain a DM_AS_07_Segmentation_Framework. The MXF files's Preface:DMSchemes property shall contain a DM_AS_07_Segmentation_Scheme label that indicates the presence of segmentation descriptive metadata in the file.

The MXF Timeline Track:TrackName property shall be assigned the value "AS_07_Segmentation".

Filler objects in the segmentation track shall represent, and align with, regions of non-program content in the Source Essence (e.g. black, ident, clock, etc.). DM Segment objects (that contain DM_AS_07_Segmentation_Framework objects) shall represent, and align with, program content regions.

6.7.5.2.1.3 Segmentation Track SOM and EOM (informative)
Note that the start and end timecodes for program regions, commonly referred to as start of material (SOM) and end of material (EOM), may be determined based on the location of DM Segment objects on the Segmentation Track relative to the adjacent Timecode Track in the MXF Material Package that contains the Segmentation Track. The relevant metadata elements within the DM_AS_07_Segmentation set are AS_07_part_SOM and AS_07_part_duration, from which the SOM and EOM can be calculated.

6.7.5.2.2 Single/Soft/Hard-Parted Programs (informative)
A Single-Part Program is one that has optional non-program run-in followed by uninterrupted program content. This is represented using a single DM Segment on the segmentation track.

A Soft-Parted Program is one that has optional non-program run-in followed by uninterrupted program content that includes optional break points where a broadcaster may insert non-program content. This is represented using DM Segment objects that are not separated by Filler objects on the segmentation track. DM Segment objects that are adjacent to each other on a segmentation track shall always be considered soft. Users of Soft-Parted AS-07 files may nominate alternative break points or ignore break points.

A Hard-Parted Program is one that has optional non-program run-in followed by program content that is interrupted by non-program content. This is represented using multiple DM Segment objects that are separated by Filler objects on the segmentation track.

6.7.5.3 DM_AS_07_Segmentation_Framework (informative)

The DM_AS_07_Segmentation_Framework extends the generic MXF DM Framework class. It contains the segment's part number and the total number of parts in the program. These metadata items represent part numbers of the form "1 of 3", "2 of 3", "3 of 3". Refer to appendix G for the complete definitions of DM_AS_07_Segmentation_Framework and DM_AS_07_Segmentation_Scheme.
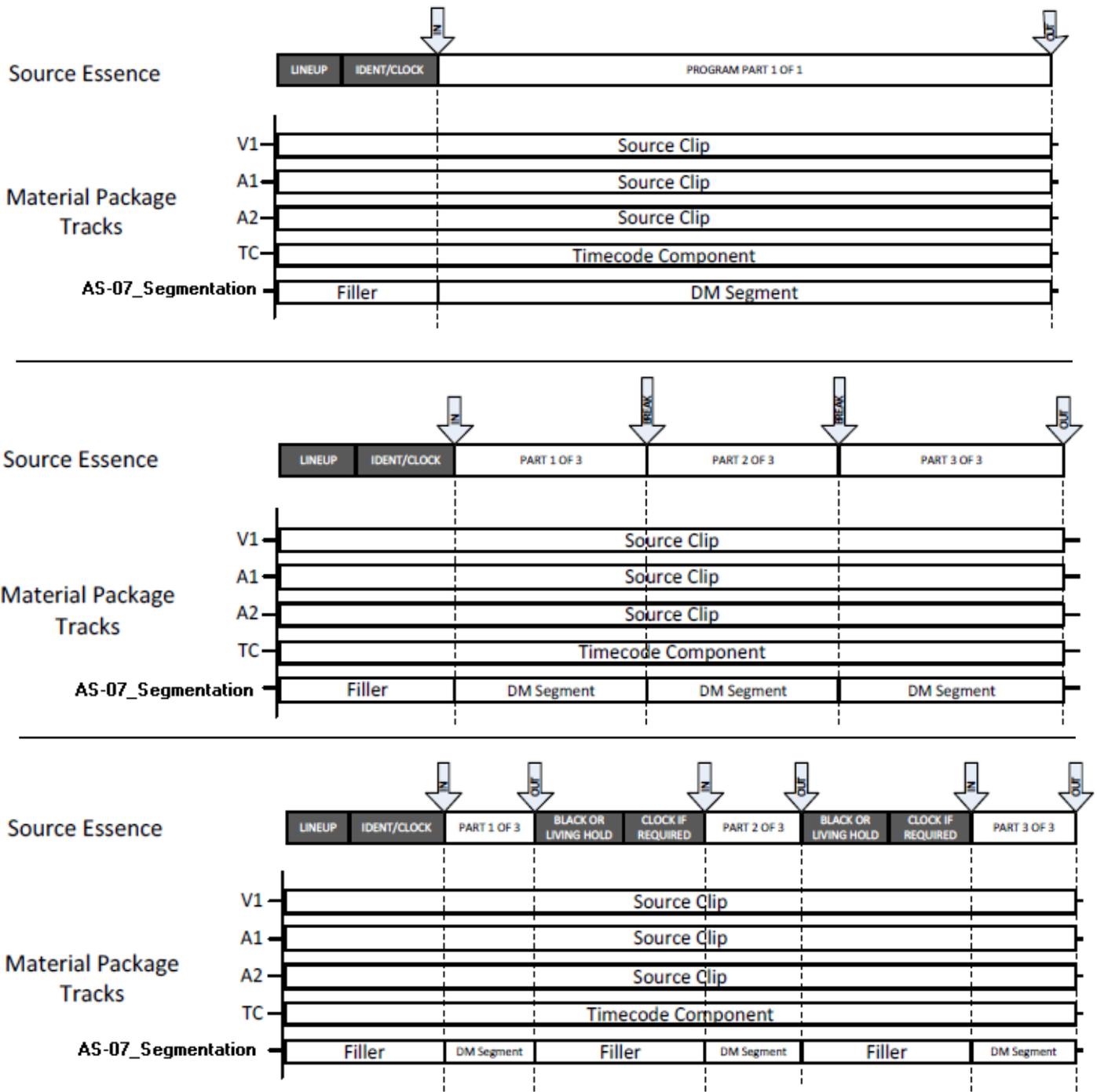
Illustrative examples of program segmentation. Top: single-part program with run-in followed by a single program segment. Middle: uninterrupted soft-parted program with identified break points where a user may interrupt playback to insert non-program content. The user may nominate alternative break points in the soft-parted case. Bottom: hard-parted program with run-in and regions of black and clock where a broadcaster must insert non-program content between segments.

6.7.5.4 Shim parameter table for program segmentation

Dimension	Description	Shim parameter	AS-07 Constraint	AS-07 Values
Program segmentation requirement	Segmentation track requirement	program_segmentation	Gentle	Mandated, Forbidden, Encouraged, Permitted
Program segmentation type	Shim limit as to the type of "parted-ness"	program_segmentation_type	Gentle	All types Soft-parted Hard-parted

7 Test Material (forthcoming)

Test material not available at this writing.

8 Appendix A. Recap: AS-07 Shim Parameters and Constraints (informative)

AS-07 shims will specify a value, as described, for each of the shim parameters listed in the main body of the specification (preceding this appendix). Shims specify additional constraints that make sense within the context of the general AS-07 requirements, i.e., constraints that tighten the conformance language that appears in the general specification (e.g. change *should* to *shall*).

For the sake of easy reference, all of the AS-07 shim parameters have been copied from section 6 above and compiled in this informative appendix.

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Cells to carry shim constraint	Cells to carry shim values
Essence Partitions (6.2.3.1)						
Essence Partition Strategy	Defines whether the essence is a single partition or divided into multiple partitions.	essence_partition _strategy	Strong	Single Multiple		
Index Tables (6.2.5.1)						
.	Defines the position of the index tables in the MXF file (frame wrapped essences); value terminology from SMPTE ST 377-1:2011 amd 2:2012.	index_strategy_fr ame	Moderate	Single index location Single essence location Forward index direction		
Picture Essence – JPEG 2000 Compressed (6.2.10.2.3)						
Picture family for JPEG 2000	Picture signal schemes (compression or sampling or other)	picture_family	Gentle	Conform to ISO/IEC 15444-1:2004/Amd 3:2010; JPEG 2000 Core Coding Broadcast Profiles: Profile levels 6 and 7 (lossless) and levels 1 through 5 (lossy). Conform to ISO/IEC 15444-1:2004/Amd 1:2006; JPEG 2000 Core Coding Profiles for digital cinema applications: Profiles for 4K and 2K (lossy)		

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Cells to carry shim constraint	Cells to carry shim values
Picture raster format	Picture raster and aspect ratio.	picture_format	Moderate	In the following list, if interlaced video, then 59.94 Hz or 50 Hz field frequency. If progressive video, then 59.94 Hz, 50 Hz, 29.97 Hz, 25 Hz, or 23.98 frame frequency. 480p 4:3 486i 4:3 486i/p 16:9 576i/p 4:3, 576i/p 16:9 720p 16:9 1080i/p		
Picture bitrate	Maximum bits per second in real time	picture_bitrate	Gentle	SD 360 Mbps HD 1.5 Gbps		
Permitted pixel layout	*PixelLayout* and/or *J2CLayout* types that may be present in the file	permitted_pixel_layout	Moderate	Any		
Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor		
Permitted containers	Essence container types that may be present in the file.	permitted_essence_container	Moderate	Any of MXFGCJP2K_P1 MXFGCJP2K_I1 MXFGCJP2K_I2		
Picture Essence – Uncompressed (6.2.10.3.3)						
Picture family for uncompressed	Picture signal schemes (compression or sampling or other)	picture_family	Gentle	Uncompressed carried in a SMPTE ST 384-compliant GC Element, using bitstream codings as specified in SMPTE ST 377-1:2009 (or later), annex G.2.25.		
Picture raster format	Picture raster and aspect ratio.	picture_format	Moderate	In the following list, if interlaced video, then 59.94 Hz or 50 Hz field frequency. If progressive video, then 59.94 Hz, 50 Hz, 29.97 Hz, 25 Hz, or 23.98 frame frequency. 480p 4:3 486i 4:3 486i/p 16:9 576i/p 4:3, 576i/p 16:9 720p 16:9 1080i/p		

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Cells to carry shim constraint	Cells to carry shim values
Picture bitrate	Maximum bits per second in real time	picture_bitrate	Gentle	SD 360 Mbps HD 1.5 Gbps		
Permitted pixel layout	*PixelLayout* types that may be present in the file	permitted_pixel_layout	Moderate	Any permitted by SMPTE ST 384:2005.		
Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor		
Permitted containers	*EssenceContainerLabel* types that may be present in the file.	permitted_essence_container	Moderate	Any frame-wrapped container permitted by SMPTE ST 384:2005.		
Picture Essence – Retain Source Encoding as Acquired (6.2.10.4.4)						
Picture family for retain born digital as acquired	Picture signal schemes (compression or sampling or other)	picture_family	Gentle	MPEG (ST 381-1 and 381-2) DV-DIF (ST 383) SDTI-CP (ST 385) D-10 (ST 386) D-11 (ST 387) JPEG 2000 (ST 422) VC-3 (ST 2019) VC-1 (ST 2037) AVC (ST 381-3) Forbidden		
Picture format	Picture raster and aspect ratio	picture_format	Moderate	480p 4:3 486i 4:3 486i/p 16:9 576i/p 4:3, 576i/p 16:9 720p 16:9 1080i/p Forbidden		
Picture bitrate	Bits per second in real time	picture_bitrate	Gentle	Up to 1.5 Gbps Forbidden		
Permitted pixel layout	*PixelLayout* types that may be present in the file	pixel_layout	Moderate	Any permitted by the following MXF mapping standards: SMPTE ST 381-1:2005 SMPTE ST 381-2:2011 SMPTE ST 383:2008 SMPTE ST 385:2004 SMPTE ST 386:2004 SMPTE ST 387:2004 SMPTE ST 2019-1:2009 SMPTE ST 2037:2009 SMPTE ST 381-3 (forthcoming)		

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Cells to carry shim constraint	Cells to carry shim values
				Forbidden		
Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor Forbidden		
Permitted containers	Essence container types that may be present in the file.	permitted_essence_container	Moderate	Any frame-wrapped container permitted by the following MXF mapping standards: SMPTE ST 381-1:2005 SMPTE ST 381-2:2011 SMPTE ST 383:2008 SMPTE ST 385:2004 SMPTE ST 386:2004 SMPTE ST 387:2004 SMPTE ST 2019-1:2009 SMPTE ST 2037: 2009 SMPTE ST 381-3 (forthcoming) Forbidden		

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Cells to carry shim constraint	Cells to carry shim values
Audio Essences (6.2.11.6)						
Sound family	Sound signal schemes (compression or sampling or other)	sound_family	Moderate	PCM 192 kHz 24 bit PCM 96 kHz 24 bit PCM 88.2 kHz 24 bit PCM 48 kHz 24 bit PCM 48 kHz 16 bit PCM 44.1 kHz 16 bit PCM 32 kHz 12 bit Additional pull-down and pull-up PCM sampling frequencies for fractional frame rates: 192192, 191808, 96096, 95904, 88112, 88288, 48048, 47952, 44144, 44056, 32032, and 31968 Hz. AC-3 Other MPEG schemes, e.g., layer 2 or layer 3 (MP3), or AAC (ST 338)		
Sound language tagging	Tagging of soundtrack languages that may be present, to be identified in AS_07_Core_DMS using codes from RFC 5646 (2009), e.g., en-US, fr-CA. Tagging mandated when languages are required.	sound_language_tagging	Moderate	Mandated, Forbidden, Encouraged, Permitted		
Sound language repertoire	Soundtrack languages required by a shim	sound_language_repertoire	Moderate	Identifiers selected from RFC 5646 Null		
Captions, Subtitles, and Timed Text (6.2.12.1.11)						
Caption	Carriage of CEA-608 or -708 captions (from source material or if newly produced)	caption_carriage	Strong	Mandated, Forbidden, Encouraged, Permitted		
Caption signal scheme	Captions signal schemes	caption_scheme	Strong	CEA-608 in SMPTE ST 436:2006 CEA-708 in SMPTE ST 436:2006		

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Cells to carry shim constraint	Cells to carry shim values
EBU Subtitles	Carriage of EBU Tech 3264 STL (from source material or if newly produced)	ebu_stl_carriage	Strong	Mandated, Forbidden, Encouraged, Permitted		
SMPTE or EBU Timed Text	Carriage of SMPTE or EBU Timed Text (when converted from CEA-608, CEA-708, or EBU STL, or if newly produced)	tt_carriage	Strong	Mandated, Forbidden, Encouraged, Permitted		
Timed Text signal scheme	Timed text signal scheme	tt_scheme	Strong	SMPTE ST 2075:2013 EBU Tech 3350		
Timed Text language tagging	Tagging of soundtrack languages that may be present, to be identified in AS_07_Core_DMS using codes from RFC 5646 (2009), e.g., en-US, fr-CA. Tagging mandated when languages are required.	tt_language_taggi ng	Moderate	Mandated, Forbidden, Encouraged, Permitted		
Timed Text language repertoire	Soundtrack languages required by a shim	tt_language_reper toire	Moderate	Identifiers selected from RFC 5646 Null		
VBI and ANC (6.2.12.2.2)						
VBI data essence	A list of supported data essence types permitted in a given shim, including specific parameters such as VBI lines supported.	VBI_data_essence	Strong	[List from SMPTE ST 436] [Any, all]		
ANC data essence	A list of supported data essence types permitted in a given shim, including specific parameters such as ANC packet types supported.	ANC_data_essenc e	Strong	[List from SMPTE ST 291] [Any, all]		
AFD and Pan-Scan (6.2.13.3)						
AFD codes	Selection of one or more of the 16 codes for AFD (SMPTE ST 2016-1:2009, Table 1)	AFD_codes	Gentle	Any		
Pan-Scan data	Pan-Scan carriage (SMPTE ST 2016-2:2007)	PanScan_data	Moderate	Mandated, Forbidden, Encouraged, Permitted		
Operational Patterns (6.3.6)						
Permitted Operational Patterns	MXF-specific Operational Pattern	operational_patter n_types	Strong	OP1a internal OP1b internal OP3c external		

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Cells to carry shim constraint	Cells to carry shim values
Timecode (6.4.6)						
Master Timecode mode	Master Timecode mode requirement	master_timecode_ mode	Strong	Drop frame Non-drop-frame Mode not declared		
Master Timecode frame rate	Master Timecode frame rate requirement	master_timecode_ framerate	Gentle	Integer or rational numerical value representing the number of frames per second. No requirement		
Master Timecode start type	Type of clock start for Master Timecode	master_timecode_ starttype	Gentle	Fixed value Start value derived from Historical Source Timecode Any value		
Fixed value Master Timecode start time	Prescribed start time for fixed-value Master Timecode	master_timecode_ fixed_startvalue	Gentle	Any timecode value expressed as HH:MM:SS:FF No requirement		
Historical Source Timecode in LLSP, requirement type	Historical Source Timecode track instances in the LLSP	historical_source_ timecode_LLSP	Gentle	Mandated, Forbidden, Encouraged, Permitted		
Header metadata (6.5.2)						
Program identification	Required identifiers	program_identific ation	Gentle	One of: UUID UMID UL Other		
Master Timecode	Master Timecode track in the Material Package, synthetic and continuous, labeled as Track 1.	master_timecode_ track	Strong	Mandated		
Historical Source Timecode	One or more Historical Source Timecode tracks, with Descriptors and with Track Numbers 2 or greater.	historical_source_ timecode_track	Strong	Mandated*		
Intimate metadata	Metadata that is intimately associated with the essences and which must be carried with the file including information about the ingest of the source stream.	intimate_metadat a	Moderate	All of: Program Ident Track Ident Language Code Ingest Provenance Other per shim		
* Mandated when Historical Source Timecode is carried in Essence Container System Items or Data Items.						
Top-Level Source Packages (6.5.3.3)						
Top-level source package	Quantity of top-level source packages	tlsp_quantity	Strong	Single Multiple		

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Cells to carry shim constraint	Cells to carry shim values
Descriptive Metadata Schemes (6.6.3)						
AS_07_GSP_BD_DMS binary data	Requirement to carry AS_07_GSP_BD_DMS for binary data in Generic Stream Partitions	AS_07_GSP_BD_DMS	Strong	Permitted*		
AS_07_GSP_TD_DMS text-based data	Requirement to carry AS_07_GSP_TD_DMS for text-based data in Generic Stream Partitions	AS_07_GSP_TD_DMS	Strong	Permitted**		
AS_07_Segmentation_DMS segmentation data	Requirement to carry AS_07_Segmentation_DMS for segmented essences	AS_07_Segmentation_DMS	Strong	Permitted***		
Additional Descriptive Schemes	Carriage of Additional Descriptive Schemes	additional_DMS	Gentle	Mandated, Forbidden, Encouraged, Permitted		
* Mandated when binary data is carried in a Generic Stream Partition, otherwise permitted. ** Mandated when text-based data is carried in a Generic Stream Partition, otherwise permitted. *** Mandated when segmented essences are carried in an AS-07 file, otherwise permitted.						
Manifest (6.7.1.6)						
Manifest	Manifest required	manifest	Strong	Mandated, Forbidden, Encouraged, Permitted		
Content Integrity (6.7.2.9)						
Content integrity	Content integrity data required	content_integrity	Strong	Mandated, Forbidden, Encouraged, Permitted		
MIC algorithm	Type of integrity algorithm supported by decoders	mic_algorithm_decoder	Strong	CRC-32C CRC-32 MD5 SHA-1 SHA-256 SHA-512		
MIC carriage	MIC carriage location in file	mic_carriage	Strong	SystemItem Encrypted Triplet Variable Length Pack		
File names (6.7.3.2)						
File names	File name restrictions	filenames	Gentle	No constraint [Filename pattern as described in shim specification]		
Program Segmentation (6.7.5.4)						
Program segmentation requirement	Segmentation track requirement	program_segmentation	Gentle	Mandated, Forbidden, Encouraged, Permitted		
Program segmentation type	Shim limit as to the type of "parted-ness"	program_segmentation_type	Gentle	All types Soft-parted Hard-parted		

9 Appendix B. AS-07 Audio Layout Configurations, Identifiers, and Expected Values

B.1 Introduction (informative)

AS-07 audio layout configurations are specified in section 6.2.11.7. This requires the carriage of certain values under the AS_07_Core_DMS_AudioTrackLayout element and permits additional comments to be carried under the AS_07_Core_DMS_AudioTrackLayoutComment element. The following tables provide information about those values.

This appendix contains two main parts:
- **B.2. Audio layout configuration table.** General overview table with ID values (forthcoming at this writing)
- **B.3 Expected layout detail tables.** These are the tables referenced in the first column of overview table B.1.

This appendix covers all specified layouts for this edition of AS-07; additional layouts are anticipated for future editions. Although comments are permitted in the DMS metadata for any layout, there are expected track assignments for 7 layouts, and these will warrant comments when there is deviation from the expected values as listed in appendix section B.3.

B.2 Audio layout configuration table

Detail table refer- ence	ID	Text-based ID	Descriptive name for audio layout	*Comment*
AUDIO LAYOUT IDENTIFICATIONS DEFINED IN INITIAL PUBLICATION OF AS-07				
Layouts to be identified by AS-07 encoders				*Support Baseband Video Shim*
	tbd	AudioLayoutSilence	No content on audio channels (AS-11 "valid silence")	*Likely to be encountered in analog tape source media*
	tbd	AudioLayoutUnknown	Unknown, undefined	*Likely to be encountered in analog tape source media*
1	tbd	AudioLayout1TrackUndef	One track detected, content undefined	*Likely to be encountered in analog tape source media*
2	tbd	AudioLayout2TrackUndef	Two tracks detected, content undefined	*Likely to be encountered in analog tape source media*
3	tbd	AudioLayout3TrackUndef	Three tracks detected, content undefined	*Likely to be encountered in analog tape source media*
4	tbd	AudioLayout4TrackUndef	Four tracks detected, content undefined	*Likely to be encountered in analog tape source media*
Layouts to be identified by encoding organizations, and provided as input to the encoder				*Support Baseband Video Shim*
5	tbd	AudioLayout1TrackAudio	One track (one audio)	*Likely to be encountered in analog tape source media*
6	tbd	AudioLayout2TracksAudio	Two tracks (two audio)	*Likely to be encountered in analog tape source media*
7	tbd	AudioLayout1TrackAudio1TrackTime code	Two tracks (one audio, one timecode)	*Likely to be encountered in analog tape source media*
8	tbd	AudioLayout3TracksAudio	Three tracks (three audio)	*Likely to be encountered in analog tape source media*

9	tbd	AudioLayout2TrackAudio1TrackTimecode	Three tracks (two audio, one timecode)	*Likely to be encountered in analog tape source media*
10	tbd	AudioLayout4TrackAudio	Four tracks (four audio)	*Likely to be encountered in analog tape source media*
11	tbd	AudioLayout3TrackAudio1TrackTimecode	Four tracks (three audio, one timecode)	*Likely to be encountered in analog tape source media*
	tbd	AudioLayoutEBU48_2a	EBU R 48: 2a (For 4 ch. only)	*Reference EBU standard, pattern from AS-11*
	tbd	AudioLayoutEBU123_4b	EBU R 123: 4b (For 4 ch. only)	*Reference EBU standard, pattern from AS-12*
	tbd	AudioLayoutEBU123_4c	EBU R 123: 4c (For 4 ch. only)	*Reference EBU standard, pattern from AS-13*
	tbd	AudioLayoutEBU123_16c	EBU R 123: 16c (For 16 ch. only)	*Reference EBU standard, pattern from AS-14*
	tbd	AudioLayoutEBU123_16d	EBU R 123: 16d (For 16 ch. only)	*Reference EBU standard, pattern from AS-15*
	tbd	AudioLayoutEBU123_16f	EBU R 123: 16f (For 16 ch. only)	*Reference EBU standard, pattern from AS-16*
	tbd	AudioLayoutST377_4MCA	SMPTE ST 377-4 MultiChannelAudio (MCA)	*AS-07 encoders must also embed the descriptors and subdescriptors specified in SMPTE ST 377-1 and ST 377-4.*
AUDIO LAYOUT IDENTIFICATIONS TO BE DEFINED IN FUTURE AS-07 UPDATES				
	tbd	tbd	Configuration as specified by various broadcasters	
	tbd	tbd	Configurations for digital cinema as specified in SMPTE ST 429-12 and elsewhere.	
	tbd	tbd	Additional configurations to be determined.	

B.3 Expected audio layout detail tables
These are the tables referenced in the first column of the overview table above.

TABLE 1   **One track detected, content undefined**

Track	Expected	Other, should be commented in DMS
1	Undefined	n/a

TABLE 2   **Two tracks detected, content undefined**

Track	Expected	Other, should be commented in DMS
1	Undefined	n/a
2	Undefined	n/a

TABLE 3   **Three tracks detected, content undefined**

Track	Expected	Other, should be commented in DMS
1	Undefined	n/a
2	Undefined	n/a
3	Undefined	n/a

TABLE 4   **Four tracks detected, content undefined**

Track	Expected	Other, should be commented in DMS
1	Undefined	n/a
2	Undefined	n/a
3	Undefined	n/a
4	Undefined	n/a

TABLE 5 **One track audio**

Track	Expected	Other, should be commented in DMS
1	Mono audio	n/a

TABLE 6 **Two tracks audio**

Track	Expected	Other, should be commented in DMS
1	Left channel	Dual mono, or other
2	Right channel	Dual mono, or other

TABLE 7 **Two tracks, one track audio, one track timecode**

Track	Expected	Other, should be commented in DMS
1	Mono audio	Other
2	Timecode as audio	Other

TABLE 8 **Three tracks audio**

Track	Expected	Other, should be commented in DMS
1	Left channel	Other
2	Right channel	Other
3	Center channel	Other, e.g., DVS, SAP

TABLE 9 **Three tracks, two tracks audio, one track timecode**

Track	Expected	Other, should be commented in DMS
1	Left channel	Other
2	Right channel	Other, e.g., DVS, SAP
3	Timecode as audio	Other

TABLE 10 **Four tracks audio**

Track	Expected	Other, should be commented in DMS
1	Left front channel	Other
2	Right front channel	Other
3	Left rear channel	Other, e.g., DVS, SAP
4	Right rear channel	Other, e.g., DVS, SAP

TABLE 11 **Four tracks, three tracks audio, one track timecode**

Track	Expected	Other, should be commented in DMS
1	Left channel	Other
2	Right channel	Other
3	Center channel	Other, e.g., DVS, SAP
4	Timecode as audio	Other, e.g., DVS, SAP

10 Appendix C. Timecode Header Label Descriptor and Subdescriptor

C.1 Timecode Header Label Descriptor

The DateTimeDescriptor for AS-07, described in 6.4.3, is derived from the one specified by SMPTE ST 385 table 3.

Item Name	Type	Len	Local Tag	Item UL	Req ?	Meaning	Default	*Informative Comment*
Generic Descriptor	Group UL	16		As defined in ST 377-1 (see Table 19) and ST385 table 4	Req	Defines the DateTimeDescriptor		*Standard MXF element and values*
All items in ST 377-1, A.1 except the Key or Group UL and the Length, if present	See A.1		See A.1	See ST 377-1, A.1	See A.1	See A.1		*Standard MXF element and values*
Locators	Array of StrongRef (Locators)	8+ 16n	2F.01	06.0E.2B.34 01.01.01.02 06.01.01.04 06.03.00.00	Opt	Array of strong references to Locator Sets If present, Essence may be located external to the file. If there is more than one Locator Set an MXF decoder shall use them in the order specified. [RP 210 Specifies a vector of references to essence locators]		*Standard MXF element and values*
SubDescriptors	Array of StrongRef (SubDescriptors)	8+ 16n	dyn	06.0E.2B.34 01.01.01.09 06.01.01.04 06.10.00.00	Opt	Array of strong references to SubDescriptor Sets (see 10.5.4) [RP 210 Specifies a vector of an ordered set of references to SubDescriptor sets]		*Standard MXF element and values*
Linked Track ID	UInt32 (Track ID)	4	30.06	06.0E.2B.34 01.01.01.05 06.01.01.03 05.00.00.00	Opt	Link to (i.e. value of) the Track ID of the Track in this Package to which the Descriptor applies. [RP 210 Link to (i.e. value of) the Track ID of the Track in this Package to which the Essence Descriptor applies.]		*Standard MXF element and values*
Sample Rate	Rational	8	30.01	06.0E.2B.34 01.01.01.01 04.06.01.01 00.00.00.00	Req	The rate of non-divisible, contiguously accessible units of the byte stream of an Essence Element (not the Essence (Pixel) sampling clock rate) [RP 210 Specifies the number of addressable elements of essence data per second]		*This element gives the duration of each timecode sample.*

Container Duration	Length	8	30.02	06.0E.2B.34 01.01.01.01 04.06.01.02 00.00.00.00	Opt	Duration of Essence Container (measured in Edit Units) A file writer should write the best value it can write. If it cannot be completed, the Item should be omitted. [RP 210 Specifies the number of addressable elements of essence data]		*Standard MXF element and values*
Essence Container	UL	16	30.04	06.0E.2B.34 01.01.01.02 06.01.01.04 01.02.00.00	Req	The UL identifying the Essence Container described by this Descriptor. Listed in SMPTE 400M (RP 224) [RP 210 Specifies a reference to the format of Container of Essence Data]		*Standard MXF element and values*
Codec	UL	16	30.05	06.0E.2B.34 01.01.01.02 06.01.01.04 01.03.00.00	Opt	UL to identify a codec compatible with this Essence Container. Listed in SMPTE 400M (RP 224) [RP 210 Specifies a reference to the codec used to create Essence Data]		*Standard MXF element and values*
Date/Time Rate	Rational	8	35.01	06.0E.2B.34 01.01.01.05 04.04.01.02 01.00.00.00.	Opt	Defines the Date/Time rate where this differs from the essence container rate	Sample Rate	*Rational expression of frames per second (fps)*
Date/Time Drop Frame	Boolean	1	35.02	06.0E.2B.34 01.01.01.05 04.04.01.02 02..00.00.00	Opt	TRUE if drop-frame is active	FALSE	*Flag to indicate whether the timecode is drop frame or not*
Date/Time Embedded	Boolean	1	35.03	06.0E.2B.34 01.01.01.05 04.04.01.02 03.00.00.00	Opt	Is it embedded in other data?	TRUE	*Flag to indicate whether the timecode also appears in the Essence of the file*
Date/Time Kind	UL	16	35.04	06.0E.2B.34 01.01.01.05 04.04.01.02 04.00.00.00	Req	Date/Time format kind. Values are listed in SMPTE RP224		*ULs required to identify AS-07 Master and Historical Source Timecode types will be added to RP 224*

Note that a single DateTimeDescriptor can simultaneously describe both a Timecode Track and an Essence Timecode. The LinkedTrackID propertyspecifies the Track that is described; the DateTimeEmbedded flag indicates if the timecode data is also embedded in the essence.

C.2 Timecode Header Label Subdescriptor

The SubDescriptors property shall strongly reference a TimecodeLabelSubDescriptor, which is derived from SMPTE ST 377-1, annex B.3.

Item Name	Type	Len	Local Tag	Item UL	Req ?	Meaning	Default	*Informative comment*
TimecodeLabel SubDescriptor	Group UL	16		TBD	Req	Defines the TimecodeLabel subclass of the SubDescriptor Class		*ULs required to identify AS-07 Master and Historical Source Timecode types will be added to RP 224*
All items in ST 377-1, B.3 except the Key or Group UL and the Length, if present	See B.3		See B.3	See ST 377-1, B.3	See B.3	See B.3		*Standard MXF element and values*
DateTime Symbol	UTF16String	var	Dyn	TBD	Req	Symbol that specifies the timecode, values listed in RP224		*Coded description of the timecode type that can be understood by humans*
DateTime ChannelID	UInt32	4	Dyn	TBD	Opt	The numerical channel identifier within the essence, if applicable	0	*The number of the audio channel that the timecode is stored on*
DateTime Description	UTF16String	var	Dyn	TBD	Opt	Additional optional text description of the timecode origin or role or details		*Text description of the type and location of timecode. This may provide information such as VITC on Line 21.*

11 Appendix D. Data Dictionary for AS-07 Core Descriptive Metadata Scheme and DMS Device Objects

D.1 Data Dictionary for AS-07 Core Descriptive Metadata Scheme

The scheme labeled *AS_07_Core_DMS* pertains to the whole file and defines the required metadata that is included in all AS-07 files (see 6.6).

Item Name	Type	Len	Local Tag	Item UL	Req?	Occurs	Meaning
General Information							
AS_07_Core_DMS	DM_Scheme			tbd			Required Core Metadata for AS-07 Archiving and Preservation Format
AS_07_Core_DMS_Framework	DM_Framework			tbd			AS-07 Descriptive Metadata
AS_07_Core_DMS_ShimName	UTF16String	Var		tbd	Req	1	Controlled vocabulary string value indicating the AS-07 Shim Name, e.g., Derived from video serial interface
File Identifiers							
AS_07_Core_DMS_Identifier	Batch of StrongRef (AS_07_DMS_Identifier objects)	8+ 16n		tbd	Req	1and n	Unordered batch of strong references to all AS_07_DMS_Identifier sets. At least one AS_07_DMS_Identifier Objects set is required with the IdentifierRole = Main. Other AS_07_DMS_IdentifierObjects sets are optional.
Responsible Organization Information							
AS_07_Core_DMS_ResponsibleOrganizationName	UTF16String	Var		tbd	Req	1	The main name for the entity responsible for the creation, maintenance, preservation of this digital item.
AS_07_Core_DMS_ResponsibleOrganizationCode	UTF16String	Var		tbd	Opt	0	A familiar abbreviation of entity name.
AS_07_Core_DMS_NatureOfOrganization	UTF16String	Var		tbd	Opt	0	The nature of an organization (e.g., limited company, government department, etc.)
Title Information							
AS_07_Core_DMS_WorkingTitle	UTF16String	Var		tbd	Opt	0 or 1	Free text: Best known or working title of the production or production component
AS_07_Core_DMS_SecondaryTitle	UTF16String	Var		tbd	Opt	0 or 1	Free text Secondary title of the production or production component
Basic Source Information							
AS_07_Core_DMS_PictureFormat	UTF16String			tbd	Req	1	The signal standard (frame resolution and aspect ratio) of the encoded file.
AS_07_Core_DMS_IntendedAFD	UTF16String			tbd	Req	1	String value indicating the intended display format for the program, per SMPTE 2016-1 table 1 a3 a2 a1 a0 with optional informative appended

							text e.g. 1001 Pillarbox, 0100 Letterbox, 1000 FullHD
AS_07_Core_DMS_Captions	UTF16String			tbd	Req	1	Y/N value to indicate if captions are present in the encoded file
Basic Audio Information							
AS_07_Core_DMS_AudioTrackPrimaryLanguage	UTF16String	Var	Dyn	tbd	Opt	0 or 1	The primary language in audio track by codes as defined by RFC5646. Use only when language is known.
AS_07_Core_DMS_AudioTrackSecondaryLanguage	UTF16String	Var	Dyn	tbd	Opt	0 or 1	The secondary language in audio track by codes as defined by RFC5646. If multiple secondary languages are present, the RFC tags in white space separated list. Use only when secondary languages are present and language is known
AS_07_Core_DMS_AudioTrackLayout	AUID			tbd	Req	1	Appropriate values in AS-07 Appendix E.
AS_07_Core_DMS_AudioTrackLayoutComment	UTF16String			tbd	Opt	0 or 1	Free text comment to augment AS_07_Core_DMS_AudioTrackLayout. This is for track tagging information and is not to be used for descriptive essays. Robust descriptive data can be held in Supplemental Metadata in GSPs.
Basic Capture History							
AS_07_Core_DMS_Device	Batch of StrongRef (AS_07_Core_DMS_Device objects)	8+ 16n		tbd	Opt	0 and n	Unordered batch of strong references to all AS_07_Core_DMS_Device objects used in this file

D.2 Data Dictionary for AS-07-Core DMS Device Objects

AS_07_Core_DMS_Device Objects defines the unordered set of references that describe the device used to capture or create the content. These references are employed in AS_07_Core_DMS specified in appendix D.1.

Item Name	Type	Len	Local Tag	Item UL	Req?	Occurs	Meaning
AS_07_Core_DMS_DeviceType	UTF16String	Var		tbd	Opt	0 or 1	The kind of device used to capture or create the content (as either a commonly known name or as a locally defined name; e.g., Radio-camera)
AS_07_Core_DMS_DeviceManufacturer	UTF16String	Var		tbd	Opt	0 or 1	The manufacturer or maker of the device
AS_07_Core_DMS_DeviceModel	ISO7String	32 chars max		tbd	Opt	0 or 1	Identifies the device model used in capturing or

							generating the essence.
AS_07_Core_DM S_DeviceSerialNu mber	ISO7String	32 chars max		tbd	Opt	0 or 1	Alphanumeric serial number identifying the individual device
AS_07_Core_DM S_DeviceUsageD escription	UTF16String	Var		tbd	Opt	0 or 1	Free text description of the function or use of the device in the production of a specific content item

12 Appendix E. Data Dictionary for AS-07 DMS Identifier Objects

AS_07_DMS_Identifier Objects defines the unordered set of references that describe the file and part identifiers in an AS-07 file. At least one AS_07_DMS_Identifier set is required in AS_07_Core_DMS with the IdentifierRole = Main. Other AS_07_DMS_Identifier sets are optional. AS_07_DMS_Identifier sets may also occur in other AS-07 DMSes.

Item Name	Type	Len	Local Tag	Item UL	Req?	Occurs	Meaning
AS_07_DMS_IdentifierValue	UTF16String			tbd	Req	1	Identifier Value
AS_07_DMS_IdentifierRole	ISO7String			tbd	Req	1	Controlled vocabulary string value identifying the role of identifier: **Main** (universally unique primary identifier for the entire AS-07 file) **Additional** (additional, possibly local, identifier for the entire AS-07 file. Additional identifiers are not required to be universally unique) **GSP** (universally unique identifier for GSP payload)
AS_07_DMS_IdentifierType	ISO7String			tbd	Opt	0 or 1	Controlled vocabulary string value identifying the type of identifier: **UUID** - UUID encoded as a URN according to IETF RFC 4122; **UMID** - Unique Material Identifier (UMID) defined by SMPTE ST 330M , represented as an URN per ST2029:2007; **UL** – Universal Label as defined by SMPTE ST 298:2009 , represented as an URN per ST2029:2007; **Other** –A value not included in the controlled list, including archive specific values.
AS_07_DMS_IdentifierComment	UTF16String			tbd	Opt	0 or 1	Free text comment pertaining to the additional identifier

13 Appendix F. Data Dictionaries for AS-07 Generic Stream Partition DMS, Binary Data DMS, and Text-based Data DMS

F.1 Data Dictionary for AS-07-Generic Stream Partition DMS

The scheme labeled *AS_07_GSP_DMS* defines the superclass metadata scheme for data stored in Generic Stream Partitions in AS-07 files (see 6.6). This scheme is further defined (as subclasses) for binary-data items and text-based-data items in appendixes F.2 and F.3 below.

Item Name	Type	Len	Local Tag	Item UL	Req ?	Occurs	Meaning
AS_07_GSP_DMS	DM_Scheme	16					AS-07 GSP Scheme
AS_07_GSP_DMS_Framework	DM_Framework	16					Abstract GSP Framework
AS_07_GSP_DMS_Identifier	Batch of StrongRef (AS_07_DMS_Identifier objects)	8+ 16n		tbd	Req	1 and n	Unordered batch of strong references to all AS_07_DMS_Identifier Object sets.
AS_07_GSP_DMS_MIMEMediaType	ISO7String	Var	Dyn	tbd	Req	0 or 1 (Req for text-based data; optional for binary data)	A text string that defines the data type of the text. A value shall be selected from the values listed at the following web site. http://www.iana.org/assignments/media-types/text/
AS_07_GSP_DMS_DataDescription	ISO7String	Var	Dyn	tbd	Req	1	A controlled vocabulary string identifying the role of the data within the AS-07 file: • Caption • Timed Text • Graphic • Related document • Supplementary Metadata • Associated Material • Trailer • QC • Other
AS_07_GSP_DMS_Note	UTF16String		Var	tbd	Opt	0	A free text note pertaining to the GSP data payload.

F.2 Data Dictionary for AS-07 GSP Binary Data DMS

The framework labeled *AS_07_GSP_BD_DMS* defines the metadata for binary data stored in Generic Stream Partitions in AS-07 files (see 6.6).

Item Name	Type	Len	Local Tag	Item UL	Req?	Occurs	Meaning
AS_07_GSP_BD_DMS_Framework	DM_Framework	16					Binary Data GSP Framework
All items in Appendix C.1	*See Appendix C.1*		*See Appendix C.1*	*See Appendix C.1*	*See Appendix C.1*		*See Appendix C.1*
No added elements in this edition of AS-07; reserved for future use.							

F.3 Data Dictionary for AS-07 GSP Text-based Data DMS

The framework labeled *AS_07_GSP_TD_DMS* defines the metadata for text-based data stored in Generic Stream Partitions in AS-07 files (see 6.6).

Item Name	Type	Len	Local Tag	Item UL	Req?	Occurs	Meaning
AS_07_GSP_TD_DMS_Framework	DM_Framework	16					Text Data GSP Framework
All items in Appendix C.1	*See Appendix C.1*		*See Appendix C.1*	*See Appendix C.1*	*See Appendix C.1*		*See Appendix C.1*
AS_07_GSP_TD_DMS_PrimaryRFC5646LanguageCode	ISO7String	Var	Dyn	tbd	Req	1	Identifies the primary language in Timed Text by codes defined by RFC5646.
AS_07_GSP_TD_DMS_SecondaryRFC5646LanguageCode	ISO7String	Var	Dyn	tbd	Opt	0 or 1	Identifies the secondary language in Timed Text by codes defined by RFC5646. If multiple secondary languages are present, the RFC tags in white space separated list. Use only when secondary languages are present and language is known.

14 Appendix G. Data Dictionaries for Segmentation DMS and Parts Objects

G.1 Data Dictionary for Segmentation DMS

The scheme labeled *AS_07_Segmentation_DMS* defines the metadata scheme for AS-07 files that segment essence data (see 6.6).

Item Name	Type	Len	Local Tag	Item UL	Req?	Occurs	Description
AS_07_Segmentation_DMS	DM_Scheme			tbd			AS_07_Segmentation_DMS
AS_07_Segmentation_DMS_Framework	DM_Framework						AS_07_Segmentation_DescriptiveMetadata

G.2 Data Dictionary for AS-07 Segmentation DMS Part Objects

AS_07_Segmentation_DMS_Part Objects defines the unordered set of references that describe the parts within a program, and these elements are used by AS_07_Segmentation_DMS (G.1 above).

Item Name	Type	Len	Local Tag	Item UL	Req?	Occurs	Description
AS_07_Segmentation_DMS_PartNumber	UInt16			tbd	Opt	0 or 1	Identifier for the part number. Combined with AS_07_Segmentation_DMS_PartTotal, these metadata items represent part numbers of the form "1 of 3", "2 of 3", "3 of 3" with AS_07_Segmentation_DMS_PartNumber being the first integer.
AS_07_Segmentation_DMS_PartTotal	UInt16			tbd	Opt	0 or 1	Identifier for the total number of parts in the program. Combined with AS_07_Segmentation_DMS_PartNumber, these metadata items represent part numbers of the form "1 of 3", "2 of 3", "3 of 3" with AS_07_Segmentation_DMS_PartTotal being the second integer.

15 Appendix H. AS-07 Manifest XML Schema

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!-- edited with XMLSpy v2013 rel. 2 sp2 (http://www.altova.com) by The Library of Congress (LIBRARY OF CONGRESS) -->
<!-- AS-07-Manifest -->
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:mft="http://www.amwa.tv/as-07/1.0/manifest"
targetNamespace="http://www.amwa.tv/as-07/1.0/manifest" elementFormDefault="qualified"
attributeFormDefault="unqualified">
   <!-- ManifestType -->
   <xs:complexType name="ManifestType">
      <xs:sequence>
         <xs:element name="FileID" type="mft:UUID"/>
         <xs:element name="FileIDType" type="mft:IdType"/>
         <xs:element name="ResponsibleOrgName" type="xs:string"/>
         <xs:element name="CreationDate" type="xs:dateTime"/>
         <xs:element name="AnnotationText" type="xs:string" minOccurs="0" maxOccurs="unbounded"/>
         <xs:element name="PartList">
            <xs:complexType>
               <xs:sequence>
                  <xs:element name="Part" type="mft:PartType" maxOccurs="unbounded"/>
               </xs:sequence>
            </xs:complexType>
         </xs:element>
         <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##other" processContents="lax"/>
   </xs:complexType>
   <!-- PartType -->
   <xs:complexType name="PartType">
      <xs:sequence>
         <xs:element name="PartID" type="mft:IdType"/>
         <xs:element name="DataDescription" type="mft:DataDescription"/>
         <xs:element name="MimeType" type="xs:string" minOccurs="0" maxOccurs="1"/>
         <xs:element name="Size" type="xs:nonNegativeInteger"/>
         <xs:element name="Location" type="xs:anyURI" minOccurs="0" maxOccurs="1"/>
         <xs:element name="PartAnnotationText" type="xs:string" minOccurs="0" maxOccurs="unbounded"/>
         <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##other" processContents="lax"/>
   </xs:complexType>
   <!-- IdType -->
   <xs:simpleType name="IdType">
      <xs:union memberTypes="mft:UUID mft:UMID mft:UL mft:otherID"/>
   </xs:simpleType>
   <!-- UUID -->
   <xs:simpleType name="UUID">
      <xs:restriction base="xs:string">
         <xs:pattern value="urn:uuid:[0-9a-fA-F]{8}-[0-9a-fA-F]{4}-[0-9a-fA-F]{4}-[0-9a-fA-F]{4}-[0-9a-fA-F]{12}"/>
      </xs:restriction>
   </xs:simpleType>
   <!-- UMID -->
   <xs:simpleType name="UMID">
      <xs:restriction base="xs:string">
         <xs:pattern value="urn:smpte:umid:([0-9a-fA-F]{8}\.){7}[0-9a-fA-F]{8}"/>
      </xs:restriction>
   </xs:simpleType>
   <!-- UL -->
   <xs:simpleType name="UL">
      <xs:restriction base="xs:string">
         <xs:pattern value="urn:smpte:ul:([0-9a-fA-F]{8}\.){3}[0-9a-fA-F]{8}"/>
```

```xml
        </xs:restriction>
    </xs:simpleType>
    <!-- Other -->
    <xs:simpleType name="otherID">
        <xs:restriction base="xs:string">
            <xs:pattern value=""/>
        </xs:restriction>
    </xs:simpleType>
    <!-- DataDescription -->
    <xs:simpleType name="DataDescription">
        <xs:restriction base="xs:string">
            <xs:enumeration value="caption"/>
            <xs:enumeration value="graphic"/>
            <xs:enumeration value="related document"/>
            <xs:enumeration value="associated material"/>
            <xs:enumeration value="supplementary metadata"/>
            <xs:enumeration value="trailer"/>
            <xs:enumeration value="qc"/>
            <xs:enumeration value="other"/>
        </xs:restriction>
    </xs:simpleType>
    <xs:element name="Manifest" type="mft:ManifestType"/>
</xs:schema>
```

16 Appendix I. Cryptographic Structures

This appendix details the AS-07 implementation of content integrity elements tailored to maximize interoperability with the approach used in the digital cinema specification SMPTE ST 429-6:2006, and as specified in this document in section 6.7.2.6.

I.1 AS-07-Cryptographic Framework

Item Name	Type	Len	Rec	Meaning	Compare to SMPTE ST 429-6:2006 (Informative)
CryptographicFrameworkKey	Set Key	16	Req	Defines the Cryptographic Framework Set	*No change*
Length	BER Length	var	Req	Set length	*No change*
InstanceID	UUID	16	Req	Unique identifier for the framework.	*No change*
GenerationUID	UUID	16	Opt	Optional Generation Identifier	*No change*
ContextSR	Strong Ref	16	Req	Strong reference to the associate Cryptographic Context Set	*No change*

I.2 AS-07-Cryptographic Context Set

Item Name	Type	Len	Rec	Meaning	Compare to SMPTE ST 429-6:2006 (Informative)
CryptographicContextKey	Set Key	16	Req	Defines the Cryptographic Context Set	*No change*
Length	BER Length	var	Req	Set length	*No change*
InstanceID	UUID	16	Req	Unique identifier for the context used by Cryptographic Framework to refer to the Context.	*No change*
GenerationUID	UUID	16	Opt	Optional Generation Identifier	*No change*
Context ID	UUID	16	Req	Unique identifier used by Encrypted Triplets to refer to the Context.	*No change*
SourceEssenceContainerLabel	UL	16	Req	Essence Container Label for the source essence, prior to encryption	*No change*
CipherAlgorithm	UL or zero	16	Req	Algorithm used for Triplet encryption, if any.	*Use SMPTE ST 429-6:2006 option for Null value as default.*
MICAlgorithm	UL or zero	16	Req	Algorithm used for Triplet integrity, if any.	*Replace SHA-1 with CRC-32C.*
CryptographicKeyID	UUID	16	Req	Unique identifier for the cryptographic key.	*Use a Zero value*

MICCarriage	UL	16	Opt	Informs decoder where to find MIC value	*Added item for AS-07.* *Value = SystemItem indicates AS-07 usage; absent Value indicates use of Encrypted Triplets*

17 Appendix J. AS-07 Baseband Shim: Single Items from Baseband Video

AS-07 Baseband Shim files are intended to carry single items derived from baseband video, understood to encompass both analog baseband and uncompressed digital video (as incoming source streams). AS-07 Baseband Shim files are intended to contain a single rendition of a single source item. This represents the priority use case for the Federal Agencies FADGI Working Group: the reformatting of older analog and digital videotapes and, at a few agencies, the encoding and packaging of "live" content streams. (For example, the Library of Congress will be receiving, processing, and archiving high definition digital streams from congressional venues.) In these instances, a baseband or uncompressed digital video signal is input to an MXF-file production system.

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Baseband shim constraint	Baseband shim values
Essence Partitions (6.2.3.1)						
Essence Partition Strategy	Defines whether the essence is a single partition or divided into multiple partitions.	essence_partition_strategy	Strong	Single Multiple	Strong	Multiple
Index Tables (6.2.5.1)						
.	Defines the position of the index tables in the MXF file (frame wrapped essences); value terminology from SMPTE ST 377-1:2011 amd 2:2012.	index_strategy_frame	Moderate	Single index location Single essence location Forward index direction	Moderate	Forward index direction
Picture Essence – JPEG 2000 Compressed (6.2.10.2.3)						
Picture family for JPEG 2000	Picture signal schemes (compression or sampling or other)	picture_family	Gentle	Conform to ISO/IEC 15444-1:2004/Amd 3:2010; JPEG 2000 Core Coding Broadcast Profiles: Profile levels 6 and 7 (lossless) and levels 1 through 5 (lossy). Conform to ISO/IEC 15444-1:2004/Amd 1:2006; JPEG 2000 Core Coding Profiles for digital cinema applications: Profiles for 4K and 2K (lossy)	Gentle	Conform to ISO/IEC 15444-1:2004/Amd 3:2010; JPEG 2000 Core Coding Broadcast Profiles: Profile levels 6 and 7 (lossless) and levels 1 through 5 (lossy).

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Baseband shim constraint	Baseband shim values
Picture raster format	Picture raster and aspect ratio.	picture_format	Moderate	In the following list, if interlaced video, then 59.94 Hz or 50 Hz field frequency. If progressive video, then 59.94 Hz, 50 Hz, 29.97 Hz, 25 Hz, or 23.98 frame frequency. 480p 4:3 486i 4:3 486i/p 16:9 576i/p 4:3, 576i/p 16:9 720p 16:9 1080i/p	Moderate	In the following list, if interlaced video, then 59.94 Hz or 50 Hz field frequency. If progressive video, then 59.94 Hz, 50 Hz, 29.97 Hz, 25 Hz, or 23.98 frame frequency. 480p 4:3 486i 4:3 486i/p 16:9 576i/p 4:3, 576i/p 16:9 720p 16:9 1080i/p
Picture bitrate	Maximum bits per second in real time	picture_bitrate	Gentle	SD 360 Mbps HD 1.5 Gbps	Gentle	SD 360 Mbps HD 1.5 Gbps
Permitted pixel layout	*PixelLayout* and/or *J2CLayout* types that may be present in the file	permitted_pixel_layout	Moderate	Any	Strong	Any of YUV8 YUV10 YUV16 RGB8 RGB10 RGB16 XYZ12 XYZ16
Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor	Strong	Any of CDCIDescriptor RGBADescriptor
Permitted containers	Essence container types that may be present in the file.	permitted_essence_container	Moderate	Any of MXFGCJP2K_P1 MXFGCJP2K_I1 MXFGCJP2K_I2	Strong	Any of MXFGCJP2K_P1 MXFGCJP2K_I2
Picture Essence – Uncompressed (6.2.10.3.3)						
Picture family for uncompressed	Picture signal schemes (compression or sampling or other)	picture_family	Gentle	Uncompressed carried in a SMPTE ST 384-compliant GC Element, using bitstream codings as specified in SMPTE ST 377-1:2009 (or later), annex G.2.25.	Gentle	Uncompressed carried in a SMPTE ST 384-compliant GC Element, using bitstream codings as specified in SMPTE ST 377-1:2009 (or later), annex G.2.25.

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Baseband shim constraint	Baseband shim values
Picture raster format	Picture raster and aspect ratio.	picture_format	Moderate	In the following list, if interlaced video, then 59.94 Hz or 50 Hz field frequency. If progressive video, then 59.94 Hz, 50 Hz, 29.97 Hz, 25 Hz, or 23.98 frame frequency. 480p 4:3 486i 4:3 486i/p 16:9 576i/p 4:3, 576i/p 16:9 720p 16:9 1080i/p	Moderate	In the following list, if interlaced video, then 59.94 Hz or 50 Hz field frequency. If progressive video, then 59.94 Hz, 50 Hz, 29.97 Hz, 25 Hz, or 23.98 frame frequency. 480p 4:3 486i 4:3 486i/p 16:9 576i/p 4:3, 576i/p 16:9 720p 16:9 1080i/p
Picture bitrate	Maximum bits per second in real time	picture_bitrate	Gentle	SD 360 Mbps HD 1.5 Gbps	Gentle	SD 360 Mbps HD 1.5 Gbps
Permitted pixel layout	*PixelLayout* types that may be present in the file	pixel_layout	Moderate	Any permitted by SMPTE ST 384:2005.	Moderate	Any permitted by SMPTE ST 384:2005.
Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor	Moderate	Any of CDCIDescriptor RGBADescriptor
Permitted containers	*EssenceContainerLabe l* types that may be present in the file.	permitted_essence_container	Moderate	Any frame-wrapped container permitted by SMPTE ST 384:2005.	Moderate	Any frame-wrapped container permitted by SMPTE ST 384:2005.
Picture Essence – Retain Source Encoding as Acquired (6.2.10.4.4)						
Picture family for retain born digital as acquired	Picture signal schemes (compression or sampling or other)	picture_family	Gentle	MPEG (ST 381-1 and 381-2) DV-DIF (ST 383) SDTI-CP (ST 385) D-10 (ST 386) D-11 (ST 387) JPEG 2000 (ST 422) VC-3 (ST 2019) VC-1 (ST 2037) AVC (ST 381-3) Forbidden	Strong	Forbidden
Picture format	Picture raster and aspect ratio	picture_format	Moderate	480p 4:3 486i 4:3 486i/p 16:9 576i/p 4:3, 576i/p 16:9 720p 16:9 1080i/p Forbidden	Strong	Forbidden

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Baseband shim constraint	Baseband shim values
Picture bitrate	Bits per second in real time	picture_bitrate	Gentle	Up to 1.5 Gbps Forbidden	Strong	Forbidden
Permitted pixel layout	*PixelLayout* types that may be present in the file	pixel_layout	Moderate	Any permitted by the following MXF mapping standards: SMPTE ST 381-1:2005 SMPTE ST 381-2:2011 SMPTE ST 383:2008 SMPTE ST 385:2004 SMPTE ST 386:2004 SMPTE ST 387:2004 SMPTE ST 422:2014 SMPTE ST 2019-1:2009 SMPTE ST 2037:2009 SMPTE ST 381-3 (forthcoming) Forbidden	Strong	Forbidden
Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor Forbidden	Strong	Forbidden
Permitted containers	Essence container types that may be present in the file.	permitted_essence_container	Moderate	Any frame-wrapped container permitted by the following MXF mapping standards: SMPTE ST 381-1:2005 SMPTE ST 381-2:2011 SMPTE ST 383:2008 SMPTE ST 385:2004 SMPTE ST 386:2004 SMPTE ST 387:2004 SMPTE ST 422:2014 SMPTE ST 2019-1:2009 SMPTE ST 2037:2009 SMPTE ST 381-3 (forthcoming) Forbidden	Strong	Forbidden

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Baseband shim constraint	Baseband shim values
Audio Essences (6.2.11.6)						
Sound family	Sound signal schemes (compression or sampling or other)	sound_family	Moderate	PCM 192 kHz 24 bit PCM 96 kHz 24 bit PCM 88.2 kHz 24 bit PCM 48 kHz 24 bit PCM 48 kHz 16 bit PCM 44.1 kHz 16 bit PCM 32 kHz 12 bit Additional pull-down and pull-up PCM sampling frequencies for fractional frame rates: 192192, 191808, 96096, 95904, 88112, 88288, 48048, 47952, 44144, 44056, 32032, and 31968 Hz. AC-3 Other MPEG schemes, e.g., layer 2 or layer 3 (MP3), or AAC (ST 338)	Moderate	PCM 96 kHz 24 bit PCM 48 kHz 24 bit PCM 48 kHz 16 bit
Sound language tagging	Tagging of soundtrack languages that may be present, to be identified in AS_07_Core_DMS using codes from RFC 5646 (2009), e.g., en-US, fr-CA. Tagging mandated when languages are required.	sound_language _tagging	Moderate	Mandated, Forbidden, Encouraged, Permitted	Moderate	Encouraged
Sound language repertoire	Soundtrack languages required by a shim	sound_language _repertoire	Moderate	Identifiers selected from RFC 5646 Null	Moderate	Identifiers selected from RFC 5646 Null
Captions, Subtitles, and Timed Text (6.2.12.1.11)						
Caption	Carriage of CEA-608 or -708 captions (from source material or if newly produced)	caption_carriage	Strong	Mandated, Forbidden, Encouraged, Permitted	Strong	Mandated
Caption signal scheme	Captions signal schemes	caption_scheme	Strong	CEA-608 in SMPTE ST 436:2006 CEA-708 in SMPTE ST 436:2006	Strong	CEA-608 in SMPTE ST 436:2006 CEA-708 in SMPTE ST 436:2006
EBU Subtitles	Carriage of EBU Tech 3264 STL (from source material or if newly produced)	ebu_stl_carriage	Strong	Mandated, Forbidden, Encouraged, Permitted	Strong	Mandated

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Baseband shim constraint	Baseband shim values
SMPTE or EBU Timed Text	Carriage of SMPTE or EBU Timed Text (when converted from CEA-608, CEA-708, or EBU STL, or if newly produced)	tt_carriage	Strong	Mandated, Forbidden, Encouraged, Permitted	Strong	Mandated
Timed Text signal scheme	Timed text signal scheme	tt_scheme	Strong	SMPTE ST 2075:2013 EBU Tech 3350	Strong	SMPTE ST 2075:2013 EBU Tech 3350
Timed Text language tagging	Tagging of soundtrack languages that may be present, to be identified in AS_07_Core_DMS using codes from RFC 5646 (2009), e.g., en-US, fr-CA. Tagging mandated when languages are required.	tt_language_tagging	Moderate	Mandated, Forbidden, Encouraged, Permitted	Moderate	Encouraged
Timed Text language repertoire	Soundtrack languages required by a shim	tt_language_repertoire	Moderate	Identifiers selected from RFC 5646 Null	Moderate	Identifiers selected from RFC 5646 Null
VBI and ANC (6.2.12.2.2)						
VBI data essence	A list of supported data essence types permitted in a given shim, including specific parameters such as VBI lines supported.	VBI_data_essence	Strong	[List from SMPTE ST 436] [Any, all]	Strong	[List from SMPTE ST 436] [Any, all]
ANC data essence	A list of supported data essence types permitted in a given shim, including specific parameters such as ANC packet types supported.	ANC_data_essence	Strong	[List from SMPTE ST 291] [Any, all]	Strong	[List from SMPTE ST 436] [Any, all]
AFD and Pan-Scan (6.2.13.3)						
AFD codes	Selection of one or more of the 16 codes for AFD (SMPTE ST 2016-1:2009, Table 1)	AFD_codes	Gentle	Any	Gentle	Any
Pan-Scan data	Pan-Scan carriage (SMPTE ST 2016-2:2007)	PanScan_data	Moderate	Mandated, Forbidden, Encouraged, Permitted	Moderate	Permitted
Operational Patterns (6.3.6)						
Permitted Operational Patterns	MXF-specific Operational Pattern	operational_pattern_types	Strong	OP1a internal OP1b internal OP3c external	Strong	OP1a internal OP1b internal

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Baseband shim constraint	Baseband shim values
Timecode (6.4.6)						
Master Timecode mode	Master Timecode mode requirement	master_timecode_mode	Strong	Drop frame Non-drop-frame Mode not declared	Strong	Drop frame Non-drop-frame Mode not declared
Master Timecode frame rate	Master Timecode frame rate requirement	master_timecode_framerate	Gentle	Integer or rational numerical value representing the number of frames per second. No requirement	Gentle	Integer or rational numerical value representing the number of frames per second.
Master Timecode start type	Type of clock start for Master Timecode	master_timecode_starttype	Gentle	Fixed value Start value derived from Historical Source Timecode Any value	Gentle	Any value
Fixed value Master Timecode start time	Prescribed start time for fixed-value Master Timecode	master_timecode_fixed_startvalue	Gentle	Any timecode value expressed as HH:MM:SS:FF No requirement	Gentle	No requirement
Historical Source Timecode in LLSP, requirement type	Historical Source Timecode track instances in the LLSP	historical_source_timecode_LLSP	Gentle	Mandated, Forbidden, Encouraged, Permitted	Gentle	Encouraged
Header metadata (6.5.2)						
Program identification	Required identifiers	program_identification	Gentle	One of: UUID UMID UL Other	Gentle	One of: UUID UMID UL Other
Timecode	Program timecode supplied	program_timecode	Strong	Mandatory	Strong	Mandatory
Master Timecode	Master Timecode track in the Material Package, synthetic and continuous, labeled as Track 1.	master_timecode_track	Strong	Mandated	Strong	Mandated
Historical Source Timecode	One or more Historical Source Timecode tracks, labeled as a sequence of numbers beginning with 2.	historical_source_timecode_track	Strong	Mandated*	Strong	Mandated*

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Baseband shim constraint	Baseband shim values
Intimate metadata	Metadata that is intimately associated with the essences and which must be carried with the file including information about the ingest of the source stream	intimate_metadata	Moderate	All of: Program Ident Track Ident Language Code Ingest Provenance Other per shim	Moderate	All of: Program Ident Track Ident Language Code Ingest Provenance Other per shim
* Mandated when Historical Source Timecode is carried in Essence Container System Items or Data Items.						
Top-Level Source Packages (6.5.3.3)						
Top-level source package	Quantity of top-level source packages	tlsp_quantity	Strong	Single Multiple	Strong	Single
Descriptive Metadata Schemes (6.6.3)						
AS_07_GSP_BD_DMS binary data	Requirement to carry AS_07_GSP_BD_DMS for binary data in Generic Stream Partitions	AS_07_GSP_BD_DMS	Strong	Permitted*	Strong	Permitted*
AS_07_GSP_TD_DMS text-based data	Requirement to carry AS_07_GSP_TD_DMS for text-based data in Generic Stream Partitions	AS_07_GSP_TD_DMS	Strong	Permitted**	Strong	Permitted**
AS_07_Segmentation_DMS segmentation data	Requirement to carry AS_07_Segmentation_DMS for segmented essences	AS_07_Segmentation_DMS	Strong	Permitted***	Strong	Permitted***
Additional Descriptive Schemes	Carriage of Additional Descriptive Schemes	additional_DMS	Gentle	Mandated, Forbidden, Encouraged, Permitted	Gentle	Permitted
* Mandated when binary data is carried in a Generic Stream Partition, otherwise permitted. ** Mandated when text-based data is carried in a Generic Stream Partition, otherwise permitted. *** Mandated when segmented essences are carried in an AS-07 file, otherwise permitted.						
Manifest (6.7.1.6)						
Manifest	Manifest required	manifest	Strong	Mandated, Forbidden, Encouraged, Permitted	Strong	Mandated
Content Integrity (6.7.2.9)						
Content integrity	Content integrity data required	content_integrity	Strong	Mandated, Forbidden, Encouraged, Permitted	Strong	Mandated

Dimension	Description: what may be constrained	Shim parameter	AS-07 constraint	AS-07 values	Baseband shim constraint	Baseband shim values
MIC algorithm	Type of integrity algorithm supported by decoders	mic_algorithm_decoder	Strong	CRC-32C CRC-32 MD5 SHA-1 SHA-256 SHA-512	Strong	CRC-32C
MIC carriage	MIC carriage location in file	mic_carriage	Strong	SystemItem Encrypted Triplet Variable Length Pack	Strong	System Item
File names (6.7.3.2)						
File names	File name restrictions	filenames	Gentle	No constraint [Filename pattern as described in shim specification]	Gentle	No constraint
Program Segmentation (6.7.5.4)						
Program segmentation requirement	Segmentation track requirement	program_segmentation	Gentle	Mandated, Forbidden, Encouraged, Permitted	Gentle	Permitted
Program segmentation type	Shim limit as to the type of "parted-ness"	program_segmentation_type	Gentle	All types Soft-parted Hard-parted	Gentle	All types