SMPTE REGISTERED DISCLOSURE DOCUMENT

MXF Archive and Preservation Format Registered Disclosure Document

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All other inquiries in respect of this document, including inquiries as to intellectual property requirements that may be attached to use of the disclosed technology, should be addressed to the proponent identified below.

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Federal Agencies Digital Guidelines Initiative

MXF Archive and Preservation Format Registered Disclosure Document

By the Federal Agencies Digital Guidelines Initiative (FADGI) Audio-Visual Working Group
http://www.digitizationguidelines.gov/audio-visual/

Document Status

This document is a Registered Disclosure Document developed by the Federal Agencies Digital Guidelines Initiative (FADGI), and the project leaders request discussion and suggestions for improvements. Send comments to Kate Murray at the Library of Congress (kmur@loc.gov).

Abstract

RDD 48 specifies a vendor-neutral subset of the MXF file format for the long-term archiving and preservation of moving image and other audiovisual content, including all forms of Ancillary Data, together with Associated Materials. Among other features, RDD 48 defines a means for the carriage and labeling of multiple timecodes and audio tracks; the handling of captions, subtitles, and Timed Text; a minimal core metadata set; program segmentation metadata; and embedded content integrity data.

The overall Registered Disclosure Document has been written broadly, to cover a wide range of audiovisual content. One derivative or secondary related version (referred to by the former Advanced Media Workflow Association or AMWA term *shim*) is included via a set of constraints specified in annex J. This derivative version is named the *RDD 48 Baseband Shim: Single Items from Baseband Video*, and it 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. Additional derivative or secondary related versions 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 RDD 48 development project is led by the Library of Congress and other members of the Federal Agencies Digital Guidelines Initiative (FADGI). At various times, the project team included representatives of the Library, the US National Archives, EVS, Cube-Tec, AVP, the CBC, George Blood Audio/Video, and Metaglue Corporation. The core user group for RDD 48 will be archives that maintain audiovisual content for the long term.

Document History

This document began as the *Application Specification for Archiving and Preservation (ASAP)* by FADGI. The AS-07 designation was assigned in 2012 when the specification came under AMWA auspices. Although AMWA had not yet established its Work in Progress (WIP) category, versions of AS-07 have been shared in a WIP manner with the archiving community five times and once as a Proposed Specification with peer review. The 2017 version was published under FADGI sponsorship, again with community peer review and is the last iteration to carry the AS-07 designation. Starting in 2018, the name is changed to RDD 48 and the document is published by SMPTE:

- September 8, 2017 (FADGI): AS-07: MXF Archive and Preservation Format Application Specification
  - http://www.digitizationguidelines.gov/guidelines/AS-07_20170908.pdf
- June 2016 (AMWA): AS-07 MXF Archive and Preservation Format Proposed Specification
  - http://www.amwa.tv/downloads/specifications/AS-07_Proposed_Application_Specification.pdf
- September 2015 (AMWA): AS-07 MXF Archive and Preservation Format (draft 9/2015)
  - https://www.amwa.tv/downloads/as-07/AS-07_reviewDraft_20150904.pdf
- September 2014 (AMWA): AS-07 MXF Archive and Preservation Format (draft 9/2014)
  - https://www.amwa.tv/downloads/as-07/AS-07_reviewDraft_20140923.pdf
- October 2012 (FADGI): MXF Application Specification for Archiving and Preservation, version 1k
  - http://www.digitizationguidelines.gov/audio-visual/documents/FADGI_MXF_ASAP_1k_2012_10_05.pdf
- August 2011 (FADGI): MXF Application Specification for Archiving and Preservation, version 1h
  - http://www.digitizationguidelines.gov/guidelines/FADGI_MXF_ASAP_Arch_Pres_1h_20110815.pdf
- October 2010 (FADGI): MXF Application Specification for Archiving and Preservation, version 1d
  - http://www.digitizationguidelines.gov/guidelines/FADGI_MXF_ASAP_Arch_Pres_1d_cf_20101020.pdf

Legacy Elements in RDD 48

The document now known as RDD 48 was developed and launched as the AS-07 Application Specification project under the AMWA process rules in effect at that time (2012-2015). The majority of the drafting work on the specification as presented in this document was completed in 2016 under a new set of AMWA process rules. This history accounts for the fact that this document retains the AS-07 identifier in some areas and includes information about the derivative version called the *Baseband Shim*. Some of the SMPTE ULs and other tagging elements especially the DMS Item Names established during 2014 and 2015 use "AS07" and “AS-07” in tag strings as they were created when the AS-07 designation was in in use. In addition, the Manifest XML scheme includes references to AS-07 in the target namespace. These elements and naming conventions will continue but are understood to represent RDD 48.

Table of Contents

1 Scope

This document describes a vendor-neutral subset of the MXF file format to use for the long-term archiving and preservation of moving image and other audiovisual content, including all forms of Ancillary Data, together with Associated Materials. Among other features, RDD 48 defines a means for the carriage and labeling of multiple timecodes; the handling of captions, subtitles, and Timed Text; a minimal core metadata set; program segmentation metadata; and embedded content integrity data.

RDD 48 files may contain a single item, or an entire series of items.

RDD 48 files are not intended for direct online access; however they may include renditions intended for viewing without further processing.

RDD 48 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, RDD 48 files must stand alone, so they would retain their value even if they were the only extant copy of an item.

Derivative versions of RDD 48 will be developed over time. Prior to 2016, AMWA referred to these as *shims*, and that term is used in this document, reflecting the fact that it was initially drafted in 2014-15. In this version, the *Baseband Shim* specified in annex J is an important element. This derivative version 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

3.1 External documents that contain RDD 48 requirements

The following external documents contain provisions which, through reference in this text, constitute provisions of this RDD. At the time of publication, the editions indicated were valid. All standards and other external documents are subject to revision, and parties to agreements based on this RDD are encouraged to investigate the possibility of applying the most recent edition of the standards and other external documents indicated below.

EBU R 48	Allocation of audio tracks on digital television recorders
EBU R 123	Audio Track Allocation for File Exchange
EBU 3264	Subtitling data exchange format
SMPTE EG 42:2004	Material Exchange Format (MXF) — MXF Descriptive Metadata
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 ST 12-1:2014	Time and Control Code
SMPTE ST 12-2:2008	Transmission of Time Code in the Ancillary Data Space
SMPTE ST 12-3:2016	Time Code for High Frame Rate Signals and Formatting in the Ancillary Data Space
SMPTE ST 274:2008	For Television - 1920 x 1080 Image Sample Structure, Digital Representation and Digital Timing Reference Sequences for Multiple Picture Rates
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 335:2012	Metadata Element Dictionary Structure
SMPTE ST 336:2007	Data Encoding Protocol Using Key-Length-Value
SMPTE ST 337:2008	Format for Non-PCM Audio and Data in an AES3 Serial Digital Audio Interface
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 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 381-2:2018	Material Exchange Format (MXF) — Mapping MPEG Streams into the MXF Constrained Generic Container
SMPTE ST 381-3:2013	Material Exchange Format— Mapping AVC 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 385:2012	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 394:2006	Material Exchange Format (MXF) — System Scheme 1 for the MXF Generic Container
SMPTE ST 400:2012	SMPTE Labels Structure
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 2000 Codestreams into the MXF Generic Container

SMPTE ST 429-5:2009 D-Cinema Packaging — Timed Text Track File
SMPTE ST 429-6:2006 D-Cinema Packaging – MXF Track File Essence Encryption
SMPTE ST 436-1:2013 MXF Mappings for VI 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 2029:2009 Uniform Resource Names for SMPTE Resources
SMPTE ST 2035:2009 Audio Channel Assignments for Digital Television Recorders (DTRs)
SMPTE ST 2075:2013 Mapping EBU TECH 3264 (STL) into the MXF Generic Stream Container
ANSI/CTA-608-E R-2014 Line 21 Data Services (formerly ANSI/CEA-608-E R-2014)
ANSI/CTA-708-E (Aug 2013) Digital Television (DTV) Closed Captioning (formerly ANSI/CEA-708-E)
ISO/IEC 15444-1:2004 JPEG 2000 Core Coding
ISO/IEC 15444-1:2004/Amd 1:2006 JPEG 2000 Core Coding Profiles for digital cinema applications: Profiles for 4K and 2K
ISO/IEC 15444-1:2004/Amd 3:2010 JPEG 2000 Core Coding Broadcast Profiles
ISO/IEC 15444-1:2004/Amd 8:2015 JPEG 2000 Core Coding Profiles for an interoperable master format IMF
IETF RFC 5646 (2009) Tags for Identifying Languages
IETF RFC 6838 (2013) Media Type Specifications and Registration Procedures

3.2 External documents that support RDD 48 informative sections

The following external documents are cited in informative sections of RDD 48 because they contain helpful background and context for this RDD. At the time of publication, the editions indicated were valid.

AMWA AS-02 MXF Versioning
AMWA AS-03 MXF Program Delivery
AMWA AS-11 MXF Contribution Format

EBU R 122 Material Exchange Format Timecode Implementation

SMPTE ST 2001-2:2014 XML Representation of SMPTE Registered Data (Reg-XML) — AAF and MXF Data info only

ISO/IEC 13818-2:2013 Information technology -- Generic coding of moving pictures and associated audio information -- Part 2: Video
ITU-T H.264 Advanced Video Coding (a.k.a. ISO 14496-10 MPEG-4 part 10)

4 Acronyms and Terms

Acronym or Term	Description
AES3	Professional digital audio transport standard (Audio Engineering Society 3).
AFD	Active Format Description. See SMPTE ST 2016-1:2009.
ANC	Ancillary Data, essence data other than Video or Audio that is often embedded in a bitstream that carries Video and Audio and that will often also be contained in the RDD 48 file. *See also HANC and VANC*.
Ancillary Data	*See ANC*.
Associated Materials	Binary non-essence 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).
Ancillary Resource (Timed Text)	An integral unit of data in a Timed Text resource such as a font, sub-picture image or an XML document (SMPTE ST 429-5:2009)
Audio	Essence data of any type contained in the RDD 48 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. In some cases, sound tracks on certain videotape formats 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).*
Audio Track	A type of Essence Track that references Sound Essence. Synonymous with Sound Track.
AVC-Intra	A video compression standard that is compliant with H.264 but uses intraframe only coding. Described by ITU-T Rec H.264.
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 will have to 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 (RDD 48)	RDD 48 Collection Files contain essences that are organized as Operational Pattern OP3c. RDD 48 Collection Files have multiple Material Packages and permit external references, the targets of which are RDD 48 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 (RDD 48) 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 RDD 48 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 RDD 48 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 Framework	A Descriptive Metadata Class that is a Subclass of Descriptive Framework. See SMPTE ST 377-1:2011.
DM Scheme	A mechanism for defining collections of Descriptive Metadata. Also known as *DMS*.
DM Scheme Label	An identifier for a DM Scheme. It is stored in an MXF file's Preface::DMSchemes property to signify the use of that DM Scheme in the file. 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	A mechanism for defining collections of Descriptive Metadata. See known as *DM Scheme.*
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 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* carries different meanings.
Essence Partition	An MXF file Partition that is dedicated to storing Essence data.
Essence Element	An Essence stream within an Essence Container.
Essence Track	A type of Track that references Essence.
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.
Graphic/image	An example of a graphic/image is scanned image of the video container box cover in formats such as TIFF or JPEG. Within RDD 48, it is a controlled vocabulary term to identify the data description role of non-essence binary data in a Generic Stream Partition.
Hard-Parted Program	A type of Segmentation. Breaks between segments are a necessary part of such a program. *See also Segmentation, Single-Part Program, and Soft-Parted Program.*
HANC	Horizontal Ancillary Data; ancillary data stored in non-picture portions of horizontal scan lines.
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 (RDD 48)	RDD 48 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. RDD 48 Historical Source Timecode is often discontinuous and not suitable for use as the RDD 48 Master Timecode.
Horizontal Ancillary Data	*See HANC*
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 (RDD 48)	RDD 48 Item Files contain internal essences organized as Operational Patterns 1a or 1b, featuring a single Material Package. Essences can be represented as segments using AS_07_Segmentation_DMS. See also *Collection Files (RDD 48)* and *Segmentation.*
KLV Alignment Grid	A notional byte spacing that is generally used to align KLV items within a Partition. See SMPTE ST 377-1:2011.
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 (RDD 48)	RDD 48 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 13818-2 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 Essence	A type of Essence containing predominantly picture data.
Picture Essence Descriptor	MXF technical metadata that describes the Picture Essence. See Section F.4 of SMPTE ST 377-1:2011.
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 RDD 48, Process Metadata will often be a form of Supplementary Metadata, carried in a Generic Stream Partition.
Quality control/review data	An example of quality control/review data is process-logging metadata produced by the Front Porch SAMMA device. Within RDD 48, it is a controlled vocabulary term to identify the data description role of non-essence data in a Generic Stream Partition.
Random Index Pack	A table that contains the byte offsets of all Partitions. See SMPTE ST 377-1:2011.
Related Document	Examples of related documents are scanned text of the video's script or shot list. Within RDD 48, it is a controlled vocabulary term to identify the data description role of non-essence data 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. SAP can 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 can be interrupted to insert non-program content at broadcast time. In RDD 48, 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 constraint 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 RDD 48 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 12 Timecode	Traditional timecode as specified by SMPTE ST 12-1:2014.
Soft-Parted Program	A type of Segmentation. Segment breaks are not a necessary part of such a program. *See also Hard-Parted Program, Segmentation and Single-Part Program.*
Sound Essence	A type of Essence containing sound data.
Sound Essence Descriptor	MXF technical metadata that describes the Sound Essence. See Section F.5 of SMPTE ST 377-1:2011.
Sound Track	A type of Essence Track that references Sound Essence. Synonymous with Audio Track.
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 RDD 48. This term is used broadly in EBU R 122 to cover a range of timecode entities that include the ones named by the preferred RDD 48 terms *Master Timecode* and *Historical Source Timecode*.
Static Track (DM)	A Track carrying unchanging Descriptive Metadata. See Annex B.27 of SMPTE ST 377-1:2011.
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 RDD 48, for example, annex C.3 builds on the superclass to define a subdescriptor for the timecode header label. *See also Descriptors.*
Supplementary Metadata	Metadata that supplements the metadata for which the RDD 48 specification derives its requirements from MXF standards (e.g., metadata in headers, DM Schemes, etc.). Supplementary Metadata if often represented by organization-specific descriptive ("cataloging") or administrative metadata, or by specialized forms of Process Metadata. In RDD 48 files, Supplementary Metadata is carried in Generic Stream Partitions.
Synthetic Timecode	See *Master Timecode (RDD 48).*
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., part of the Web dissemination rulemaking promulgated by the Federal Communication Commission (FCC).
Timecode	An annotation of elapsed time along a Track. See SMPTE ST 377-1:2011.
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.
Top Level File Package	A Source Package that is internal to the file and which is directly referenced by a Material Package of the file. See 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.
Trailer/preview	A trailer/preview is an advertisement or a commercial for a program that will be exhibited in the future at a cinema. Within RDD 48, it is a controlled vocabulary term to identify the data description role of non-essence data in a Generic Stream Partition.
Universal Label	Unique identifiers for metadata items, specified in SMPTE ST 298:2008.
VANC	Vertical Ancillary Data, non-video information (such as audio, other forms of essence, and metadata) embedded within non-picture portions of vertical scan lines of the serial digital interface. *See also ANC and HANC.*
VBI	Vertical Blanking Interval, the time between the end of the final line of a frame or field and the beginning of the first line of the next frame in a raster graphics display.
Vertical Ancillary Data	*See VANC.*
Vertical Blanking Interval	*See VBI*.

5 Overview (informative)

5.1 Summary of File Format Requirements

5.1.1 General

RDD 48 files 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 Pattern Parameters and Constraints), 6.7.5 (Program Segmentation), and elsewhere.

RDD 48 files sometimes include one or several renditions of the items. Different renditions can arise from different original sources of the item; different renditions can also be created from multiple encodings of the original source using different image compression or encoding schemes. RDD 48 files are not intended for direct online access, however they can include renditions intended for viewing without further processing.

5.1.2 Metadata

RDD 48 files contain metadata in several locations, including the following: the MXF header; DM tracks; and as closed captioning, other forms of Timed Text, and/or other ancillary data; and as text-based data (called RDD 48 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 will be adopted or developed by archiving organizations and are not part of the RDD 48 specification.

For many archiving organizations, the metadata embedded in RDD 48 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 RDD 48 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 very often provide additional or updated metadata elements to be inserted or appended in RDD 48 files in the archival storage system.

At the same time, the RDD 48 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, RDD 48 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 RDD 48 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 will repay any effort.

5.2 RDD 48 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 RDD 48 files and thus represent the maximum needed capability of cache and playout servers and transcoder operations.

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

5.3 Use-cases for Shims

The purpose of a shim name or identifier is to describe the content in a particular variant of RDD 48 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 express stronger constraints than the general specification by strengthening the conformance language, e.g. strengthening “should” to “shall.” Shims also constrain parameter values to a set of permissible values that is a sub-set of those defined in the general specification. In some cases, shims directly constrain the general provisions; in others, they 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 can 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 are thus unconstrained, meaning that RDD 48 encoders can 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 be 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 to 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 RDD 48 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).

6.1.3 Shim parameter constraint strengths and conformance testing (informative)

The strength categories (gentle, moderate, strong) listed in 6.1.2 will be applied in different ways. Their main purpose is as stated in 6.1.2. For conformance testing, however, there will often be more stringent uses. The RDD 48 Baseband Shim, defined in annex J, provides a convenient example. (Other RDD 48 shims are anticipated in the near future.) As the Baseband Shim was defined, the RDD 48 team enumerated the shim's testable requirements as a guide for conformance testing. In this analysis (not part of this narrative version of the specification), every parameter is treated as mandatory in order to permit the easy development of automated tools to validate the conformance of RDD 48 Baseband Shim files.

6.2 Essence Track Parameters and Constraints

6.2.1 General (informative)

RDD 48 files will 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. Some organizations will 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

6.2.2.1.1 Interleaving (informative)

Many RDD 48 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. Section 6.2.2.2 provides more information on frame- and clip-wrapping. Regarding DV DIF, this essence is usually represented in a different way: “compound items.” Section 6.2.10.4 (Retain Source Encoding as Acquired) provides more information on wrapping born digital content like DV by importing but not transcoding.

6.2.2.1.2 Interleaving requirements

Essence in each Generic Container in RDD 48 Files may be interleaved or non-interleaved frame-by-frame. Conformant encoders shall produce files that interleave or non-interleave Essence in accordance with the specifications for each shim.

6.2.2.2 Frame-, and Clip-wrapping

6.2.2.2.1 Frame-, and Clip-wrapping (informative)

RDD 48 echoes widespread current practices by requiring frame-wrapping, as is normally employed for interleaved essences. Exceptions be called out in a shim.

The RDD 48 Baseband Shim, as its name implies, is intended to serve instances where the essence input to the encoder will be in a digital baseband format, or will have just been transcoded into baseband. Thus the Baseband Shim is limited to frame-wrapping.

Clip-wrapping in RDD 48 files is generally associated with digital picture essences for which the coding is to be retained-as-acquired; section 6.2.10.4 provides more information. RDD 48 files, however, ask that even those essences be frame-wrapped, as stated within section 6.2.10.4.2: "In order to accommodate RDD 48 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." For example, MPEG-2 Elementary Streams often arrive clip-wrapped in .mpg files. There is little difficulty in dividing such streams into access units amenable to frame-wrapping without loss of information, and there is great practical benefit in frame-wrapping and interleaving with VI, ANC, sound and other data.

There is an exception to this rule, however, that recognizes the difficulties associated with retain-as-acquired essences that are acquired already clip-wrapped and which it is impractical or counterproductive to frame-wrap. For example, MPEG-2 Transport Streams include complex internal relationships and sub-streams and it would be difficult or impossible to avoid data loss when dividing such streams into frame oriented access units. In addition, some archives that are adopting RDD 48 possess certain classes of video content for which legal restraints prevent changing essences in any way.

The specifics for carrying out the exception outlined in the preceding paragraph will be drafted as a part of the forthcoming RDD 48 shim for retain-as-acquired essences. Once written, that shim will specify a structure for an MXF file with frame-wrapped VI, ANC, sound, and data, with a clip-wrapped picture element in the same file.

Meanwhile, Teletext will be carried as Ancillary Data, as specified in section 6.2.12.5.

6.2.2.2.2 Frame-, and Clip-wrapping requirements

Conformant encoders shall produce files that framewrap Essences in each Generic Container, unless an alternate wrapping is explicitly required by a shim.

RDD 48 shims may offer specifications for the wrapping of specialized elements, e.g., NICAM audio. Such wrapping may be either frame- or clip-wrapped, and the shim definition shall include the KLV metadata keys that are part of the essence container syntax.

6.2.3 Essence Partitions

6.2.3.1 Essence Partitions (informative)

The handling of Essence in terms of Partitions and Generic Containers conforms to SMPTE ST 377-1:2011, including section 6.2.1. Note that the use of the term *segmented* in ST 377-1:2011 and in the RDD 48 requirement that follows pertains to the segmentation of a single Essence. The structuring of an RDD 48 file in which a single program is divided into *segments*, each of which is an Essence of its own, is covered in section 6.7.5, which owes a great debt to AS-11.

6.2.3.2 Essence Partition Requirements

RDD 48 Essence Containers may be contained in a single Partition or may be segmented and distributed over two or more Partitions. If Essence Containers are partitioned, conformant encoders shall produce files that 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, conformant 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. Conformant encoders shall produces files in which new Partitions have been inserted 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.

Conformant decoders shall be capable of reading files with Partitions as described in this section.

The Header Partition shall be marked closed and complete.

6.2.3.3 Shim Parameter Table for Essence Partitions

Dimension	Description	Shim parameter	RDD 48 Constraint	RDD 48 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 and Embedding Data (informative)

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

Data streams in RDD 48 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 Top Level Source Package, and will influence the determination of the file's Operational Pattern. Other text-based and binary data in RDD 48 files will generally not be considered to be essences and will not influence the determination of an RDD 48 file's Operational Pattern.

Category	Entity type	How described in file metadata?	Main informative and normative sections
RDD 48 Essence Binary Data Objects			
	EBU STL	Caption data Descriptors, no DMS Standard: SMPTE ST 2075:2013	6.2.12.7
	Other Essence Data	*Deferred*	
RDD 48 Non-Essence Binary Data Objects			
	Binary Associated Materials	AS_07_BD_GSP_DMS	6.2.4.1.2
RDD 48 Essence Textual Data			
	SMPTE and EBU Timed Text	Caption data	6.2.12.6

		Descriptors, no DMS	6.2.12.7
RDD 48 Non-Essence Textual Data			
	Supplementary Metadata and Manifest	AS_07_TD_GSP_DMS	6.2.4.1.4

The informative sections that follow provide information about entities that could be carried in RDD 48 Generic Stream Partitions.

6.2.4.1.1 RDD 48 Essence Binary Data Objects (informative)

6.2.4.1.1.1 EBU STL (informative)

EBU STL is the European Broadcast Union (EBU) binary subtitling format standardized in EBU Tech 3264 (1991), and it is related to the timeline and as such is considered essence data. 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 RDD 48 in 6.2.12.

Unlike non-essence embedded binary data, a DMS is not needed for EBU STL, since it is described by appropriate Descriptors as detailed in 6.2.12.7.

6.2.4.1.1.2 Other Essence Data (informative)

Other forms of binary essence data include examples such as device control data ("dim the theater house lights now"), smell-o-vision, feelies, etc. Directions on these data types are deferred until a later time.

6.2.4.1.2 RDD 48 Non-Essence Binary Data Objects (informative)

6.2.4.1.2.1 Binary Associated Materials (informative)

Associated Materials are non-essence 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 could be unevenly distributed along the timeline. Associated Materials contribute to the completeness, comprehensibility, or usability of the information object represented by the RDD 48 file. Associated Materials will often take the form of data files such as TIFF, JPEG, MP4, PDF, and the like.

Unlike binary essence data, such as EBU STL, Associated Materials do not have Descriptors and are instead associated with instances of AS_07_TD_GSP_DMS.

6.2.4.1.3 RDD 48 Essence Textual Data (informative)

6.2.4.1.3.1 SMPTE and EBU Timed Text Track Files and Timed Text Ancillary Resources (informative)

The carriage of SMPTE ST 2052-1:2010 Timed Text, EBU Timed Text including DCP Timed Text Ancillary Resources such as pre-rendered open captions or font data (as described in ST 429-5: 2009) is important to organizations that use RDD 48 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. Unlike other types of embedded textual data in GSPs, a DMS is not needed for Timed Text, since Timed Text and Ancillary Resources are described by appropriate Descriptors as detailed in 6.2.12.6 and 6.2.12.7.

6.2.4.1.4 RDD 48 Non-Essence Textual Data (informative)

6.2.4.1.4.1 Supplementary Metadata and Manifest (informative)

Supplementary Metadata augments the metadata called for as necessary by the MXF standards as specified in RDD 48 (e.g., metadata in headers, Descriptive Metadata Schemes, etc.). Supplementary Metadata can consist of organization-specific descriptive ("cataloging") or administrative metadata, or specialized forms of Process Metadata. It is often structured as XML.

One form of supplementary metadata common in the cultural heritage community is frame-by-frame "logging" metadata from the digital conversion process. This encoded metadata tracks anomalies in the video stream and is typically of interest in the post-process environment on a special case basis when forensic investigation is needed. Although this metadata contains embedded timecode, it is not considered essence data.

The RDD 48 Manifest, specified in section 6.7.1, provides summary information about the RDD 48 file and its provenance, an inventory of the RDD 48 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 6.7.1. Annex H provides the formal element definition in the XML schema declaration.

6.2.4.1.5 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 RDD 48 files, organizations are encouraged to provide descriptions of the entities that are so carried.

As noted, the inclusion of non-essence binary and text-based data call for the use of the RDD 48 Generic Stream Partition Descriptive Metadata Scheme specified in section 6.6 and annex F.1 and, as appropriate, the RDD 48 GSP Binary Data Descriptive Metadata Scheme specified in section 6.6.1.3.1 and annex F.2 and the RDD 48 GSP Text-Based Data Descriptive Metadata Scheme specified in section 6.6.1.3.2 and annex F.3.

6.2.4.2 Generic Stream Partition Encoder Requirements

Conformant encoders shall be capable of producing RDD 48 files that contain Generic Stream Partitions (SMPTE ST 410:2008) within MXF Body Partitions and included in the Random Index Pack. Conformant encoders shall be able to receive a Generic Stream Payload and write it to a valid Generic Stream Partition. Conformant 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.

Conformant encoders shall produce files that assign each Generic Stream Partition a StreamID (SID) that is unique within the file.

Conformant encoders shall produce files that treat data streams in RDD 48 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 Top Level Source Package, and use them to determine the file's Operational Pattern (OP1b when Timed Text is present).

As described in SMPTE 429-5:2009, the Timed Text resource may refer to Ancillary Resources such as fonts and sub-pictures. All Ancillary Resources referenced by the Timed Text Resource shall be contained within the Timed Text Track File in separate Generic Stream Partitions.

Generic Stream Partitions that consist of Timed Text, EBU STL or DCP Timed Text Ancillary Resources do not require a DMS but rather are described by appropriate Descriptors as detailed in 6.2.12.

For each instance of a Generic Stream Partition containing non-essence binary or textual data as described in 6.2.4.1.2 and 6.2.4.1.4, conformant encoders shall produce files that include an instance of AS_07_BD_GSP_DMS or AS_07_TD_GSP_DMS as appropriate. Section 6.6.1.3 and appendixes D, E and F provide more information.

When required by a shim, conformant encoders shall produce files that wrap the Manifest according to SMPTE RP 2057:2012 and carry it as a form of non-essence textual data in a Generic Stream Partition as specified in section 6.2.4.1.4. The Manifest shall conform to the formal element definition in the XML schema declaration as specified in annex H. The Manifest shall require an instance of AS_07_TD_GSP_DMS as described in 6.6.1.3.

6.2.4.3 Generic Stream Partition Decoder Requirements

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

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

Conformant decoders shall be capable of identifying and reading all Generic Stream Partition Descriptive Metadata tracks as specified in section 6.6.

6.2.5 Index Tables

6.2.5.1 Index Tables (informative)

Index Tables provide byte offset information within an Essence Container for a given time offset from the start of that Essence Container. If the Essence Container has interleaved data within it, then extra mechanisms are provided for finding the offsets to the individual Essence Elements once the correct time offset is located. Although the terms CBR (Constant Bit Rate) and VBR (Variable Bit Rate) are familiar and widely used to categorize

essence, SMPTE ST 377-1:2011, the main MXF standard, uses the terms CBE (Constant Bytes per Element) and VBE (Variable Bytes per Element) to define different kinds of Index Tables. VBE index tables can be used for CBR essence, and (with the use of KLV fill) CBE index tables can be used for VBR essence.

CBR and VBR essences are often mixed in an MXF file, making Index Table design challenging. One example is interleaving 48kHz audio with 30000/1001 video. The frequent use of VBR essences or a mix of CBR and VBR essences underlies the general advice offered by broadcast professionals: use VBE tables unless you are certain that your file can be supported by the simpler CBE index tables.

The greater simplicity of CBE index tables results from the fact that they provide EditUnitByteCount data and omit the Index Entry Array, as specified in ST 377-1:2011 section 11.1.9 (Constant Edit Unit Size). Meanwhile, a specialized "sparse" or "partial" design for VBE index tables is specified in ST 377-1:2011 section 11.3 (Partial / Sparse Index Tables for VBE Essence). These are permitted in RDD 48 files; however RDD 48 contains no other conformance points for partial or sparse index tables.

6.2.5.2 Index Tables

Conformant encoders shall write full MXF Index Tables, compliant with SMPTE ST 377-1:2011, including Amd 2:2012. The full Index Tables in RDD 48 files 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.

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

6.2.5.3 Shim Parameter Table for Index Tables

Dimension	Description: what may be constrained	Shim parameter	RDD 48 constraint	RDD 48 values
Single index location	If all Index Table Segments that compose one Complete Index Table are in one Partition, value shall be TRUE. Else (multiple Partitions), value shall be False.	single_index_location	Moderate	True False
Single essence location	If all Essence Containers are in one Partition, the value shall be TRUE. Else, (Essence Container Segments in multiple Partitions), value shall be FALSE.	single_essence_location	Moderate	True False
Forward index direction	If all Index Table Segments that compose one Complete Index Table precede Essence Container Segments that they index, value shall be TRUE. Else (Index Table Segments follow Essence Container Segments), value shall be FALSE.	forward_index_direction	Moderate	True False

Dimension	Description: what may be constrained	Shim parameter	RDD 48 constraint	RDD 48 values
CBE Index Tables	Use of Index Tables for CBE essences that omit the Index Entry Array (SMPTE ST 377-1:2011, section 11.1.9).	cbe_index_table	Moderate	Mandated, Forbidden, Encouraged, Permitted
VBE Index Tables	Use of Index Tables for VBE essences that employ partial or sparse tables (SMPTE ST 377-1:2011, section 11.3).	vbe_index_tables	Moderate	Mandated, Forbidden, Encouraged, Permitted

6.2.6 Generic Container

Conformant encoders shall produce files that map essences to the frame-based wrapping mode defined in ST 379-2:2010, except for the wrapping exceptions identified in section 6.2.2.2 above.

RDD 48 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).

6.2.6.1 Generic container mapping for JPEG 2000 codestreams (informative)

As specified in 6.2.10.2, JPEG 2000 broadcast-profile and IMF-profile codestreams (ISO/IEC 15444-1:2004/Amd 3:2010 and ISO/IEC 15444-1:2004/Amd 8:2015) are to be carried in a SMPTE ST 422:2014-compliant GC Element.

6.2.7 System Item

Conformant encoders shall produce files that create System Items in Essence Containers following the requirements of SMPTE ST 379-1:2010 or ST 379-2:2010. Conformant decoders shall be capable of decoding the Master Timecode as carried in System Items of RDD 48 files.

6.2.8 Random Index Pack

Conformant encoders shall produce closed and complete files that carry a Random Index Pack per SMPTE ST 377-1:2011. Conformant decoders may use a Random Index Pack if one is present. When reading an RDD 48 file, decoders may use other means, such as building data structures equivalent to a Random Index Pack, instead.

6.2.9 KAG Size

Conformant 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. RDD 48 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.

Conformant decoders shall not rely upon any specific KAG Size.

6.2.10 Picture Essence Encoding

6.2.10.1 Picture Essences

6.2.10.1.1 Broad Range of Picture Essences Possible (informative)

Moving image picture content that is wrapped by RDD 48 will include a wide range of types: uncompressed, lossless compressed, or lossy compressed. Rasters could range to sizes as great as 8Kx8K, and picture could 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 RDD 48 could 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 RDD 48.

The initial edition of RDD 48 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 annex 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. RDD 48 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 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 RDD 48, 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.

6.2.10.1.2 MXF Picture Essence Descriptors and Subdescriptors in RDD 48 (informative)

The use of appropriate picture essence types is important when preparing video content for archiving and preservation, as is the proper characterization of these essences in metadata Descriptors and Subdescriptors, which RDD 48 uses to express its constraints on picture essences. Using terminology commonly found in SMPTE standards, two important sets of picture essence characteristics are:

1. *Essence type, pixel layout and bit depth*. Is the essence in this file CDCI (Color Difference Component Image) or RGBA (Red Green Blue Alpha), and what is the pixel layout and bit depth?

2. *Picture format.* For the essence in this file, what is the raster, aspect ratio, and frame rate?

Regarding metadata, SMPTE ST 377-1:2011 (and earlier versions) provides MXF files with two different options for Picture Essence Descriptors: CDCI and RGBA. There is a potential for confusion since the sets of Properties for each Descriptor are slightly different. For example, the CDCI Descriptor has a Component Bit Depth Property while the RGBA Descriptor has a PixelLayout Property. When JPEG 2000 picture essences are present, both the CDCI and RGBA Descriptors can be augmented by the J2CLayout Subdescriptor, standardized in ST 377-1 and in ST 422:2014. When both Descriptor and Subdescriptor are used, RDD 48 uses the Descriptor to describe the essence in its uncompressed state, while the Subdescriptor describes the essence as compressed. (Readers will wish to remain aware that SMPTE ST 377-1 and some other SMPTE standards use the ambiguous shorthand YUV for certain color-difference-component picture essences. In most cases, the reference is to the YCbCr or Y'CbCr color model.)

In order to (a) minimize confusion and (b) support the future development of a machine-readable expression of the RDD 48 specification, RDD 48 shim parameter tables define the metadata expressions for Pixel Layout, Component Bit Depth, Picture Format, and J2CLayout in a repetitive fashion. In effect, the parameters play out this way:

- CDCI essence
    - CDCI Descriptor is used, and its properties and values provide raster, aspect ratio, and frame rate data (values for uncompressed, when the J2CLayout Subdescriptor is used)
    - Component Bit Depth property provides bits-per-sample data
    - J2CLayout Subdescriptor provides JPEG 2000 pixel layout, when relevant (values for compressed essence)
- RGBA essence
    - RGBA Descriptor is used, and its properties and values provide raster, aspect ratio, and frame rate data (values for uncompressed, when the J2CLayout Subdescriptor is used)
    - PixelLayout property (which includes expression of bit depth) is used, ignored when not relevant (as for JPEG 2000 essences)
    - J2CLayout Subdescriptor provides JPEG 2000 pixel layout (which includes expression of bit depth), when relevant (values for compressed essence)

For picture essence metadata, the RDD 48 specification takes advantage of the path-finding Interoperable Master Format (IMF) standards, especially SMPTE ST 2067-20:2013 (Interoperable Master Format — Application #2), with its focus on "video" content. Meanwhile, in this version of RDD 48, the most complete statement of the essence metadata sets will be found in annex J, in the table that lists the RDD 48 general constraints and the additional constraints on the Baseband Shim. (Additional shims will be developed in the future and they could have different constraints.)

6.2.10.1.3 Picture Essences general requirement

Conformant encoders shall produce files that encode Picture Essences as follows: JPEG 2000 as specified in section 6.2.10.2; uncompressed picture as specified in section 6.2.10.3; selected encodings to be retained from source materials as specified in section 6.2.10.4.

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 lead to the use of RGB- or XYZ-based components. There is an emerging practice to treat some analog source materials in a High Dynamic Range manner and for this reason the RDD 48 Baseband Shim (annex J) includes 16-bit sampling under the *permitted_pixel_layout* parameter.

The carriage for JPEG 2000 essences specified in section 6.2.10.2.2 references SMPTE ST 422:2014, which maps six possible cases, three of which are permitted in RDD 48 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 KLV Element and one frame per Content Package will then ["shall" in ST 422:2014] comprise one or more pairs of KLV triplets each of which will then ["shall" in ST 422:2014] contain one JPEG 2000 codestream. Case I1 was developed to serve needs within the digital cinema community and its use is not anticipated for video recordings. Thus it is not an option for the Baseband Shim.
>
> *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 will then ["shall" in ST 422:2014] comprise one or more KLV triplets each of which will then ["shall" in ST 422:2014] contain two JPEG 2000 codestreams. The general use of this case is anticipated for video recordings.

6.2.10.2.2 JPEG 2000 Essences and SMPTE ST 422

Conformant encoders shall produce files that place JPEG 2000 picture essences in a SMPTE ST 422-compliant GC Element. 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.

Conformant encoders shall produce files that carry YUV, RGB, or XYZ *J2CLayouts* permitted by the following three profile amendments to ISO/IEC 15444-1:2004 (JPEG 2000 core coding): Amd 1:2006, JPEG 2000 Core Coding Profiles for digital cinema applications: Profiles for 4K and 2K; Amd 3:2010, JPEG 2000 Core Coding Broadcast Profiles: Profile levels 6 and 7 (lossless) and levels 1 through 5 (lossy); and Amd 8:2015, Profiles for an interoperable master format IMF, but this may be constrained by a shim.

The *Essence Descriptors* provided by conformant encoders in RDD 48 files 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 422:2014 in table 6) but this may be constrained by a shim. Conformant encoders shall produce files that provide the JPEG 2000 picture Subdescriptor that includes the *J2CLayout*

property, the format of which shall conform to ST 422:2014. The CDCI and RGBA Descriptors shall describe the essence in its uncompressed form and the J2CLayout property shall describe the essence as compressed.

For CDCIDescriptors, any bit-depth constraint for a shim shall be expressed in terms of the Component Depth property. Shims may also place other constraints on CDCI essences expressed in terms of CDCI Descriptors.

For the RGBADescriptor, the *PixelLayout* property should be made equal to any permitted in SMPTE 377-1:2011. Regarding shim constraints for RDD 48 files that carry RGBA essences, constraints shall be expressed in terms of the *J2CLayout* property and/or in terms of RGBA Descriptors.

The *Essence Container Label* shall be provided as indicated in the first paragraph in this subsection. The essence descriptors and essence container label shall conform to SMPTE ST 422:2014.

6.2.10.2.3 JPEG 2000 decoder requirement

Conformant 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	RDD 48 Constraint	RDD 48 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) Conform to ISO/IEC 15444-1:2004/Amd 8:2015; Profiles for an interoperable master format IMF
Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor
Picture format (CDCI)	If Descriptor is CDCI, picture raster, aspect ratio, and frame rate	picture_format_CDCI	Moderate	If CDCI Descriptor, any picture format permitted by ST 352:2013. Other specialized rasters may be added in future editions of RDD 48.
Permitted component depth (CDCI)	if Descriptor is CDCI, *Component Depth* types that may be present in the file	permitted_component_depth_CDCI	Moderate	If CDCI Descriptor: Any permitted by SMPTE ST 377-1:2011, sections F.4.2 and G.2.26.
Permitted J2CLayout (CDCI)	if Descriptor is CDCI, *PixelLayout* types that may be present in the file, with J2CLayout subdescriptor	permitted_J2C_layout_CDCI	Moderate	If CDCI Descriptor, any permitted by SMPTE ST 422:2014 Shall not be present.
Picture format (RGBA)	if Descriptor is RGBA, picture raster, aspect ratio, and frame rate	picture_format_RGBA	Moderate	If RGBA Descriptor, any picture format permitted by ST 352:2013. Other specialized rasters may be added in future editions of RDD 48.
Permitted pixel layout (RGBA)	if Descriptor is RGBA, *PixelLayout* types that may be present in the file	permitted_pixel_layout_RGBA	Moderate	If RGBA Descriptor, any permitted by SMPTE 377-1:2011.
Permitted J2C layout (RGBA)	if Descriptor is RGBA, *J2CLayout* types that may be present in the file, with J2CLayout subdescriptor	permitted_J2C_layout_RGBA	Moderate	If RGBA Descriptor, any permitted by SMPTE ST 422:2014 Shall not be present.
Picture bitrate	Maximum bits per second in real time	picture_bitrate	Gentle	SD 360 Mbps* HD 1.5 Gbps* Will expand in future

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 RDD 48 as it is extended in future editions:

Dimension	RDD 48 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 call for the use of RGB- or XYZ-based components.

In order to accommodate RDD 48 timecode (section 6.4), VBI and ancillary data (6.2.13), and content integrity (6.7.2) elements, essence containers will use frame-wrapping rather than clip-wrapping.

6.2.10.3.2 Uncompressed picture essences

Conformant encoders shall produce files that carry YUV, RGB, or XYZ essences but this may be constrained by a shim. The permitted ITU-R formats may be any established by the International Telecommunication Union Radiocommunication sector or, if fully specified in a shim, an equivalent formulation. Conformant encoders shall produce files that carry frame-wrap uncompressed essences in a SMPTE ST 384:2005-compliant GC Element.

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.

For CDCI Descriptors, any bit-depth constraint for a shim shall be expressed in terms of the *Component Depth* property. Shims may also place other constraints on CDCI essences expressed in terms of the CDCIDescriptor.

For the RGBADescriptor, the *PixelLayout* may be any permitted by SMPTE ST 377-1:2011 and ST 384:2005, but this may be constrained by a shim. Shims may place other constraints on RGBA essences expressed in terms of the RGBADescriptor.

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

Conformant 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	RDD 48 Constraint	RDD 48 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 377-1:2011, annex G.2.25.

Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor
Picture format (CDCI)	If Descriptor is CDCI, picture raster, aspect ratio, and frame rate	picture_format_CDCI	Moderate	If CDCI Descriptor, any picture format permitted by ST 352:2013. Other specialized rasters may be added in future editions of RDD 48.
Permitted component depth (CDCI)	if Descriptor is CDCI, *Component Depth* types that may be present in the file	permitted_component_depth_CDCI	Moderate	If CDCI Descriptor: Any permitted by SMPTE ST 377-1:2011, sections F.4.2 and G.2.26.
Permitted J2C layout (CDCI)	if Descriptor is CDCI, *J2CLayout* types that may be present in the file, if the Descriptor is CDCI	permitted_J2C_layout_CDCI	Moderate	Shall not be present.
Picture format (RGBA)	If Descriptor is RGBA, picture raster, aspect ratio, and frame rate	picture_format_RGBA	Moderate	If RGBA Descriptor, any picture format permitted by ST 352:2013. Other specialized rasters may be added in future editions of RDD 48.
Permitted pixel layout (RGBA)	*PixelLayout* types that may be present in the file, if the Descriptor is RGBA	permitted_pixel_layout_RGBA	Moderate	If RGBA Descriptor, any permitted by SMPTE ST 384:2005, SMPTE 377-1:2011, sections F.4.3 and G.2.36.
Permitted J2C layout (RGBA)	*J2CLayout* types that may be present in the file, if the Descriptor is RGBA	permitted_J2C_layout_RGBA	Moderate	Shall not be present.
Picture bitrate	Maximum bits per second in real time	picture_bitrate	Gentle	SD 360 Mbps HD 1.5 Gbps Will expand in future
Permitted pixel layout	*PixelLayout* types that may be present in the file	permitted_pixel_layout	Moderate	Any
Permitted ITU-R format standards	ITU-R formats that may be present in the file, or an equivalent format if fully specified in a shim	permitted_ITU-R_formats	Gentle	BT.601 (SD) BT.709 (HD) BT.2020 (UHDTV) Specified in a shim Will expand in future
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 RDD 48 as it is extended in future editions:

Dimension	RDD 48 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. Standardized means that there is a SMPTE mapping of the

bitstream to the Generic Container. At this writing such mapping exist for the eight picture essence formats listed in section 6.2.10.4.2 and, in addition, the mappings for JPEG 2000 (SMPTE ST 422:2014, see 6.2.10.2) and uncompressed picture (SMPTE ST 384:2005, see 6.2.10.3). Some of the mappings listed in 6.2.10.4.2 call for clip-wrapping, representing the main exception to RDD 48's generally preferred structure for frame-wrapping.

In addition to the picture essence types listed in section 6.2.10.4.2, an archive could also acquire and wish to retain essences that employ JPEG 2000 encodings as native bitstreams. For RDD 48, these are to 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

Conformant encoders shall produce files that 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 385:2012
- 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 381-3:2013

In order to accommodate RDD 48 timecode (section 6.4), VBI and ancillary data (6.2.13), and content integrity (6.7.2) elements, essence containers from the preceding standards shall use frame-wrapping rather than clip-wrapping, unless an exception is provided by a shim in the form of a file structure that accommodates both frame-wrapped VI, ANC, sound, and data, and a clip-wrapped picture element.

6.2.10.4.3 Retained source encoding decoder requirement

Conformant 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	RDD 48 Constraint	RDD 48 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	Any raster permitted by ST 352:2013 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 385:2012 SMPTE ST 386:2004 SMPTE ST 387:2004 SMPTE ST 2019-1:2009 SMPTE ST 2037: 2009 SMPTE ST 381-3:2013

				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 385:2012 SMPTE ST 386:2004 SMPTE ST 387:2004 SMPTE ST 2019-1:2009 SMPTE ST 2037: 2009 SMPTE ST 381-3:2013 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 could be uncompressed PCM audio data, compressed data or raw data as in BWF, AES3, or SMPTE ST 337:2008 carried in a single AES3 stream. As specified below, RDD 48 calls for 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 RDD 48 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 RDD 48 Baseband Shim (annex 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, conformant 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 ST 382.

For AC-3 audio data, conformant encoders shall create files that carry each AC-3 track in a SMPTE ST 337:2008, ST 338:2008, ST 339:2008, or ST 340:2008 container in a SMPTE ST 382:2007-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, conformant encoders shall produce files that 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)

RDD 48 shims can 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 called for by a shim. However, when a shim does restrict soundtracks to certain languages, tagging is a necessity. As indicated in annex 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

RDD 48 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 RDD 48 soundtracks to certain languages, tags are required.

6.2.11.6 Shim Parameter Table for Audio Essences

Dimension	Description	Shim parameter	RDD 48 Constraint	RDD 48 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)

RDD 48 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 might 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 RDD 48 files and seek metadata that labels the tracks in a manner that will serve future users.

Source material audio tracks will or will not be labeled according to a standard or industry convention. When so labeled, the tagging could be in terms of such standards as SMPTE Multi-Channel Audio (MCA; SMPTE ST 377-4:2012), 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.

Annex B in this initial publication of RDD 48 provides identifiers for certain audio layouts. Users of RDD 48 will wish to note that these identifiers are likely to be modified or extended in the future in order to keep pace with layout-specification developments within the community.

RDD 48 files that conform to the requirements that follow will carry identifiers in the AS_07_Core_DMS_AudioTrackLayout element and could also carry comments in the AS_07_Core_DMS_AudioTrackLayoutComment element (Section 6.6.1 and annex D.1). When carrying SMPTE ST 377-4:2012 MCA, RDD 48 files will also 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 annex 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 annex 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

Conformant encoders shall produce files that identify audio track layouts by placing the coded values listed in annex B in the AS_07_Core_DMS_AudioTrackLayout element (Section 6.6.1 and annex 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 should make a best effort to identify the tracks and to use codes as defined in tables 0 through 5 in annex B.

6.2.11.7.3 Audio Track Layout Comments in AS_07_Core_DMS

Conformant encoders shall provide a method for encoding organizations to input comments in the AS_07_Core_DMS_AudioTrackLayoutComment element (Section 6.6.1 and annex D.1).

6.2.11.7.4 Audio Track Layout Descriptors and Subdescriptors for SMPTE MCA

When the audio content in an RDD 48 file consists of SMPTE Multi-Channel Audio (MCA; SMPTE ST 377-4:2012), and when such information is provided by the encoding organization, conformant encoders shall produce files that provide the Descriptors specified in SMPTE ST 377-1:2011 and the Subdescriptors specified for MCA in SMPTE ST 377-4:2012. 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

Conformant decoders shall present sound track data with the appropriate audio track layout information described in 6.2.11.7.2, 6.2.11.7.3 and/or 6.2.11.7.4.

6.2.11.8 Other Provisions

6.2.11.8.1 DialNorm Metadata
If the input to the MXF-file production system includes DialNorm metadata, conformant encoders shall produce files that include this DialNorm data in the MXF Sound Descriptor GenericSoundEssenceDescriptor:DialNorm.

6.2.11.8.2 NICAM Audio (informative)
NICAM audio, when encountered in historical PAL and SECAM recordings, will need a wrapping specification that has not been developed for this version of RDD 48. Such a wrapping is anticipated for a future version.

6.2.12 Captions, Subtitles, and Timed Text

6.2.12.1 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.

6.2.12.2 Preservation and Archiving Goals for Caption, Subtitle, Timed Text, and Teletext 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 RDD 48 archive files.

The presence of captions in the file is recorded in the AS_07_Core_DMS_Captions item in the RDD 48 Core Descriptive Metadata Scheme. See section 6.6.1.1.

The following table lists the four main types of entities that represent captions, subtitles, timed text, and teletext and provides a summary overview of how they are carried and described in an RDD 48 file.

Entity type	Where carried?	How described in file metadata?	Main informative and normative sections
ANSI/CTA-608-E (CEA-608) and ANSI/CTA-708-E (CEA-708)	ANC Packet with track in TLSP	ANCDataDescriptor for track, no GSP-related DMS	6.2.12.3 6.2.12.5 6.2.13
Teletext	ANC Packet with track in TLSP	VBIDataDescriptor for track, no GSP-related DMS	6.2.12.4 6.2.12.5 6.2.13
SMPTE Timed Text	GSP with track in TLSP	Descriptors for track, no GSP-related DMS	6.2.12.6
EBU Timed Text and EBU STL	GSP with track in TLSP	Descriptors for track, no GSP-related DMS	6.2.12.7

6.2.12.3 ANSI/CTA-608-E (CEA-608) and ANSI/CTA-708-E (CEA-708) (informative)

The sections that follow provide the RDD 48 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 ANSI/CTA-608-E (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 ANSI/CTA-608-E (CEA-608) in line 21 while digital instances will vary, including ANSI/CTA-608-E (CEA-608) as a digital representation ("dots and dashes") of line 21 or as vertical interval ancillary data (VANC) caption data or even as both. Meanwhile, video servers are likely to employ various semi-proprietary formats to carry VANC and digital line 21. Beyond that, digital legacy MPEG-2

compressed sources could have ANSI/CTA-608-E (CEA-608) embedded in the MPEG "Video User Private" bits, while legacy MXF files might have VANC or digital line 21 in ST 436-1:2013 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 ANSI/CTA-708-E (CEA-708) format.

In addition to closed caption (CC) data, ANSI/CTA-608-E (CEA-608) also defines XDS or Extended Data Services (previously known as EDS). XDS is used by TV stations, TV networks, and TV program syndication distributors in the USA for several purposes including "autoclock" time data for automatically setting the clock of newer TVs and VCRs sold in the USA, station identification and V-chip content ratings data. Like ANSI/CTA-608-E (CEA-608) CC data, XDS data is also carried on line 21.

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

In RDD 48, ANSI/CTA-608-E (CEA-608) and ANSI/CTA-708-E (CEA-708) are considered forms of ancillary data (ANC). See section 6.2.13 for information on ANC.

6.2.12.4 Teletext (informative)

Teletext is the text-only closed captioning system for European television.

In RDD 48, teletext is considered a form of ANC. See section 6.2.13 for information on ANC.

6.2.12.5 RDD 48 Encoder Requirements for ANSI/CTA-608-E (CEA-608), ANSI/CTA-708-E (CEA-708), and Teletext

6.2.12.5.1 ANSI/CTA-608-E (CEA-608) and ANSI/CTA-708-E (CEA-708) Data Carriage
If ANSI/CTA-608-E (CEA-608) (CC and XDS) data or ANSI/CTA-708-E (CEA-708) DTV captioning data is present, conformant encoders shall produce files that carry such data in a SMPTE ST 334-1/-2:2007 compliant ANC packet within a frame-wrapped Data Element in the Generic Container as described in SMPTE ST 436-1:2013; using 8 bit encoding. Section 6.2.13 provides more information on ANC packet carriage in RDD 48.

In addition to mandatory carriage in the ANC packet:

1. If ANSI/CTA-608-E (CEA-608) (CC and XDS) data or ANSI/CTA-708-E (CEA-708) DTV captioning data is present in the source material, conformant encoders shall produce files that preserve ANSI/CTA-608-E (CEA-608) and ANSI/CTA-708-E (CEA-708) in their native binary format, *and*
2. If ANSI/CTA-608-E (CEA-608) (CC and XDS) signals are present in the source material, either as an analog signal or as a digital representation thereof, conformant encoders shall produce files that preserve these signals.

Note the exception when using ST 386:2004 “Mapping Type D-10 Essence Data to the MXF Generic Container.” In that case, the ANSI/CTA-608-E (CEA-608) or ANSI/CTA-708-E (CEA-708) caption data shall be retained embedded in the stream as delivered.

6.2.12.5.2 Translation of ANSI/CTA-608-E (CEA-608), and ANSI/CTA-708-E (CEA-708) to SMPTE Timed Text
Conformant encoders should translate ANSI/CTA-608-E (CEA-608) and ANSI/CTA-708-E (CEA-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, conformant 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.

6.2.12.6 SMPTE Timed Text

6.2.12.6.1 Carriage of SMPTE Timed Text (informative)
The RDD 48 specification 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 GSP carriage necessary for this purpose in RDD 48, 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.

RDD 48 files need not include SMPTE TT unless it is present in the source file or created from the translation of line 21, ANSI/CTA-608-E (CEA-608), and ANSI/CTA-708-E (CEA-708) data. If SMPTE TT is present in the source file, it is to be maintained in the RDD 48 file.

6.2.12.6.2 RDD 48 Encoder Requirements for SMPTE Timed Text

As described in SMPTE 429-5:2009, each Ancillary Resource in a Timed Text Track File shall be entirely contained within an MXF Generic Stream Partition defined by SMPTE ST 410:2008. Section 6.2.4 provides more details.

When SMPTE Timed Text is present in an RDD 48 file, conformant encoders shall produce files that reference the Timed Text in tracks in the file's Material Package and Top Level Source Package as described in SMPTE 429-5: 2009. The Top Level Source Package shall contain one Data Essence Track with a single Data Source Clip. A single Material Package shall be present which shall contain one Data Essence Track with a single Data Source Clip referencing the Top Level Source Package. The operational pattern is designated as OP1b.

The Top Level Source Package shall include a strong reference to a TimedTextDescriptor, which shall describe the Timed Text resource according to SMPTE 429-5:2009, Annex A2. In accordance with SMPTE 429-5:2009 Annex A3, the Timed Text resource may be additionally described by the TimedTextResourceSubdescriptor set which may be strongly referenced by the TimedTextDescriptor via the MXF Generic Descriptor (as defined in SMPTE 377-1:2011).

As described in SMPTE 429-5:2009, If the Timed Text references one or more Ancillary Resources, the TimedTextDescriptor shall contain the same number of strong references to TimedTextResourceDescriptors, one for each Ancillary Resource. A TimedTextResource Descriptor contains the AncillaryResourceID and MIMEMediaType of the respective resource, and also the BodySID of the Generic StreamPartition containing the Ancillary Resource data.

Note: It is anticipated that additional Subdescriptor specifications will be developed in future.

6.2.12.7 EBU STL and EBU Timed Text

6.2.12.7.1 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 6.2.12.2), when placed in RDD 48 files, EBU-based content will provide subtitling data as Timed Text. Thus, when source material offers only EBU STL, this RDD states the necessity of converting it 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 could be employed in RDD 48 files but not in lieu of conversion and carriage as Timed Text.

RDD 48 files need not include EBU-STL unless it is present in the source file. If EBU-STL is present in the source file, it is to be maintained in the RDD 48 file.

6.2.12.7.2 RDD 48 Encoder Requirements for EBU STL

Conformant 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, conformant encoders may produce files that 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 RDD 48 file, conformant encoders shall produce files in which the EBU STL resource is described by a Top Level Source Package as described in SMPTE ST 2075:2013. The Top Level

Source Package shall contain one Data Essence Track with a single Data Source Clip. A single Material Package shall be present which shall contain one Data Essence Track with a single Data Source Clip referencing the Top Level Source Package and that the operational pattern is designated as OP1b.

The Top Level Source Package shall include a strong reference to the STLEssenceDescriptor according to SMPTE 2075: 2013, including the STLSubdescriptor to describe multiple languages that are stored in a single STL file which is mapped into a single MXF file.

6.2.12.7.3 RDD 48 Encoder Requirements for EBU TT

As described in SMPTE 429-5:2009, each Ancillary Resource in a Timed Text Track File shall be entirely contained within an MXF Generic Stream Partition defined by SMPTE ST 410:2008. Section 6.2.4 provides more details.

When EBU Timed Text is present in an RDD 48 file, conformant encoders shall produce files that reference the Timed Text in tracks in the file's Material Package and Top Level Source Package as described in SMPTE 429-5:2009. The Top Level Source Package shall contain one Data Essence Track with a single Data Source Clip. A single Material Package shall be present which shall contain one Data Essence Track with a single Data Source Clip referencing the Top Level Source Package. The operational pattern is designated as OP1b.

The Top Level Source Package shall include a strong reference to a TimedTextDescriptor, which shall describe the Timed Text resource according to SMPTE 429-5:2009, Annex A2. In accordance with SMPTE 429-5:2009 Annex A3, the Timed Text resource may be additionally described by the TimedTextResourceSubdescriptor set which may be strongly referenced by the TimedTextDescriptor via the MXF Generic Descriptor (as defined in SMPTE 377-1:2011).

As described in SMPTE 429-5:2009, If the Timed Text references one or more Ancillary Resources, the TimedTextDescriptor shall contain the same number of strong references to TimedTextResourceDescriptors, one for each Ancillary Resource. A TimedTextResource Descriptor contains the AncillaryResourceID and MIMEMediaType of the respective resource, and also the BodySID of the Generic StreamPartition containing the Ancillary Resource data.

EBU-TT is not required in RDD 48 unless it is present in the source file or created from the translation of EBU STL data. If EBU-TT is present in the source file, it shall be maintained in the RDD 48 file.

6.2.12.8 Encoder Provision of Timed Text to External Applications

Conformant encoders shall be capable of providing a copy of SMPTE or EBU Timed Text (if any) to connected applications, e.g., indexing and database systems. Section 6.2.12.10 provides more information pertaining to decoders.

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

Dimension	Description	Shim parameter	RDD 48 Constraint	RDD 48 Values
Caption	Carriage of ANSI/CTA-608-E (CEA-608) or ANSI/CTA-708-E (CEA-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	ANSI/CTA-608-E (CEA-608) in SMPTE ST 436-1:2013 ANSI/CTA-708-E (CEA-708) in SMPTE ST 436-1:2013
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 ANSI/CTA-608-E (CEA-608), ANSI/CTA-708-E (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

6.2.12.10 RDD 48 Decoder Requirements for Captions, Subtitles, and Timed Text

Conformant decoders shall read all forms of captions, subtitles, and Timed Text specified in section 6.2.12. Decoders shall provide for the display of all forms of these elements and for the provision of Timed Text to connected applications.

6.2.13 VBI and Other Ancillary Data (ANC)

6.2.13.1 VBI and ANC in RDD 48 (informative)

Ancillary data is information other than the main picture and audio essences and it is carried in a manner that associates it with the essence data. Ancillary data could include forms of captions or metadata or what is called "opaque data." Depending on the type of video at hand, this ancillary data can be carried within the Vertical Blanking Interval lines (VBI lines or VBI data) and/or as Ancillary Data Packets (ANC packets). There are many possible types of ancillary data and, in general, SMPTE ST 436-1:2013 is followed when creating an MXF file. For clarity in RDD 48, however, we provide detailed instructions for binary caption data below, consistent with SMPTE ST 436-1:2013. (See 6.2.12.1 for additional information about CEA 608 CC and XDS, CEA 708 DTV and teletext.)

6.2.13.2 RDD 48 Encoder Requirements for VBI and ANC

6.2.13.2.1 ANC Packet Carriage of Ancillary Data

When present in the source material, RDD 48 shall carry ANSI/CTA-608-E (CEA-608) (CC and XDS) data, ANSI/CTA-708-E (CEA-708) DTV captioning data, teletext or other ancillary data in a SMPTE ST 334-1/-2:2007 compliant ANC packet within a frame-wrapped Data Element in the Generic Container as described in SMPTE ST 436-1:2013; using 8 bit encoding. This carriage is in addition to the carriage specified in section 6.2.12.5.1.

Conformant encoders shall produce files that reference the ANC packet containing the ancillary data in data tracks in the file's Top Level Source Package.

A single Material Package shall be present which shall contain a Data Essence Track with a single Data Source Clip referencing the Top Level Source Package.

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 ANSI/CTA-608-E (CEA-608) or ANSI/CTA-708-E (CEA-708) caption data shall be retained in the form in which it is delivered as described in 6.2.12.5.1.

6.2.13.2.2 ANSI/CTA-608-E (CEA-608) and ANSI/CTA-708-E (CEA-708) Descriptors

If ANC packets containing ANSI/CTA-608-E (CEA-608) or ANSI/CTA-708-E (CEA-708) data exist in an RDD 48 file, the Top Level Source Package shall include a strong reference to the ANC Data Descriptor as detailed in SMPTE ST 436-1:2013. The descriptor shall be associated with a Data Track via the MXF Generic Descriptor (as defined in SMPTE 377-1:2011).

Note: It is anticipated that additional CaptionLabelSubdescriptor specifications will be developed in future.

6.2.13.2.3 Teletext Descriptors

If ANC packets containing Teletext data exist in an RDD 48 file, the Top Level Source Package shall include a strong reference to the VBI Data Descriptor as detailed in SMPTE ST 436-1:2013. The descriptor shall be associated with a Data Track via the MXF Generic Descriptor (as defined in SMPTE 377-1:2011).

Note: It is anticipated that additional CaptionLabelSubdescriptor specifications will be developed in future.

6.2.13.3 Shim Parameter Table for VBI and ANC

Dimension	Description	Shim parameter	RDD 48 Constraint	RDD 48 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 436-1:2013] [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]

6.2.13.4 RDD 48 Decoder Requirements for VBI and ANC Data

Conformant decoders shall read all forms of VBI and ANC specified in section 6.2.12.1 and 6.2.13.2.

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

6.2.14.1 Active Format Description (AFD)

RDD 48 files shall have an AFD value for the duration of the Picture Track. conformant encoders shall produce files that carry AFD (and Bar Data, if present) values formatted 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 436-1:2013-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, conformant encoders shall produce files that 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, conformant encoders shall produce files that preserve and map this data to the appropriate places in the RDD 48 file, including the Generic Container.

An AFD value shall be assigned. If the source video does not include an AFD value, conformant encoders shall insert in files the value '0000' as well as enabling the user to change this and to specify a value of the users' 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). RDD 48 implementers are directed to SMPTE ST 377-1:2011 paragraph G.2.5.

6.2.14.2 Pan-Scan Information

Pan-Scan Information is not required in RDD 48 files, but it may be present. If included in RDD 48 files, conformant encoders shall produce files in which Pan-Scan Information has been formatted according to SMPTE ST 2016-2:2007 and SMPTE ST 2016-4:2007, and stored in a SMPTE ST 436-1:2013-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, conformant encoders shall produce files that 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, conformant encoders shall produce files that preserve and map this data to the appropriate places in the RDD 48 file. Conformant 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.

6.2.14.3 Shim Parameter Table for AFD and Pan-Scan

Dimension	Description	Shim parameter	RDD 48 Constraint	RDD 48 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 RDD 48 Operational Patterns for Item, Segmented, and Collection Files (informative)

RDD 48 files employ three standardized MXF Operational Patterns: OP1a, OP1b, and OP3c. The impact of these three patterns for RDD 48 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 RDD 48 concepts are explained in the following paragraphs.

Simple Item Files

- OP1a. The bread-and-butter work to be supported by RDD 48 is the reformatting of old videotapes, or other incoming baseband signal, analog or digital. The resulting files are generally 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 could 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 annex 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 RDD 48 Baseband Shim.

Comment: We recognize and respect the overlap in terms of function between the RDD 48 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

Conformant encoders shall produce files that comply with the MXF Operational Patterns required by a given RDD 48 shim. The full set of RDD 48 Operational Patterns shall be limited to the following: OP1a (SMPTE ST 378:2004), OP1b (SMPTE ST 391:2004), and OP3c (SMPTE ST 408:2006), and these shall be implemented for RDD 48 Item Files and RDD 48 Collection Files, as specified in the sections that follow.

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

Conformant 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

Conformant encoders shall produce Item Files with internal essences that comply with MXF Operational Pattern OP1a (SMPTE ST 378:2004) or OP1b (SMPTE ST 391:2004), and are labeled as OP1a or OP1b in the Operational Pattern property of all Partition packs and the Preface Set.

RDD 48 Item Files may be segmented as specified in section 6.7.5 (Program Segmentation).

RDD 48 Item Files may or may not be required by a given shim.

6.3.4 Operational Patterns -- Collection Files

Conformant encoders shall produce Collection Files that reference sets external essences that consist of valid instances of RDD 48 Item files. RDD 48 Collection Files shall comply with MXF Operational Pattern OP3c (SMPTE ST 408:2006), and are labeled as OP3c in the Operational Pattern property of all Partition packs and the Preface Set.

RDD 48 Collection Files (External Essences) may or may not be required by a given shim.

6.3.5 Operational Pattern Labeling

Conformant encoders shall label 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	RDD 48 Constraint	RDD 48 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)

Normative requirements for carriage of Timecode are listed in sections that follow the informative paragraphs. Of particular importance are the requirements for Master Timecode (sections 6.4.4.2, 6.4.4.3 and 6.4.4.4), labeling of Timecodes (section 6.4.3.2) and Historical Source Timecode (sections 6.4.5.2 through 6.4.5.6)

RDD 48 files can 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 R 122, *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*. RDD 48 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. RDD 48 Historical Source Timecode could take various forms, including but not limited to, LTC, VITC and ATC, and it can be of various frame rates and frame counting modes. Historical Source Timecode is often discontinuous and is not suitable for use as the Master Timecode in RDD 48 files.

RDD 48 files can contain many timecodes (one Master Timecode, many Historical Source Timecodes). Each timecode is represented by a Timecode Track, and the timecode data can occur simultaneously in several places:

- The Master Timecode can be stored in the Material Package, in the Top Level Source Package and in the System Item of an Essence Container (section 6.4.4)
- A Historical Source Timecode can be stored in the Top Level Source Package, in the System Item of an Essence Container, in the essence on a picture, sound or data Essence Container essence, or in a Lower Level Source Package (section 6.4.5).

All occurrences of a Timecode convey the same timecode values in every place, except that timecode data within essence can contain errors or interruptions, whereas the timecode data in Timecode Tracks and in System Items can be filtered to conceal such errors.

6.4.2 Timecode Sources (informative)

RDD 48 files will accommodate the range of timecode types outlined in the following list. Types *a* through *e* in the series are defined in EBU R 122; types *f* and *g* have been added to support RDD 48. Using RDD 48 terminology, timecode types *a*, *b*, and *c* are examples of Historical Source Timecode, types *d* or *e* mark the start value for expressions of RDD 48 Master Timecode.

a. Linear timecode (LTC) according to SMPTE ST 12-1:2014. (Example of RDD 48 Historical Source Timecode)
b. Vertical interval timecode (VITC) according to SMPTE ST 12-1:2014. (Example of RDD 48 Historical Source Timecode)
c. Ancillary Time Code (ATC) according to SMPTE ST 12-2:2008. (Example of RDD 48 Historical Source Timecode)
d. Preset timecode (Example of RDD 48 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 RDD 48 Master Timecode)
f. One or more of the timecode channels might be clock time (aka “TimeOfDay”); this will most likely include discontinuities (for example, if recording was intentionally paused); and it could include ST 309 Date and Timezone information. (Example of RDD 48 Historical Source Timecode)
g. Other potential timecode types, including Edgecode, Camera Metadata, IRIG, ST309, even “Next Generation Timecode”. Note that times can sometimes be obtained from the User Bits of the incoming timecode. (Example of RDD 48 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 RDD 48 users. One important application for RDD 48 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 often 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, RDD 48 uses elements from two SMPTE specifications: ST 405:2006 specifies a method to construct timecode arrays in essence container System Items, while ST 385:2012 provides a scheme for descriptors and subdescriptors. These descriptors and subdescriptors are associated with Timecode Tracks. In the case of Timecode~~s~~ (all types) in essence container System Items, the tracks and descriptors are to be carried in the Top Level Source Package. When Historical Source Timecode Tracks are carried in a Lower Level Source Package, the descriptors will be carried in that location as well. The subdescriptors provide additional properties to identify the essence tracks from which the timecode data was acquired.

Annex C.1 features an illustrated example of how RDD 48 employs Timecode Descriptors and Subdescriptors.

6.4.3.2 Labeling Timecode in Header Metadata (requirements)

Conformant encoders shall produce files that carry Timecode Tracks formatted in conformance with the rules of ST 377-1:2011 B.7 for Track IDs and B.15 for Track Numbers.

6.4.3.2.1 Timecode Header Label Descriptor

6.4.3.2.1.1 Timecode Header Label Descriptor (informative)

The DateTimeDescriptor for RDD 48 is as specified by ST 385:2012 table 3. The list of properties of the DateTimeDescriptor, as specified in ST 385:2012 table 3 and updated to match ST 377-1:2011, is provided in annex C.3.

Note that a single DateTimeDescriptor can simultaneously describe a Timecode Track, an Essence Timecode, and a SystemItem Timecode, with one DateTimeSubdescriptor for each.

The LinkedTrackID property specifies the ID of the Timecode Track that is described.

The DateTimeEmbedded flag indicates if the timecode data is also embedded in the essence, at the DateTimeEssenceTrackID and DateTimeChannelID given in that subdescriptor.

The DateTimeEssenceTrackID property specifies the Track in which the Timecode data is embedded; a distinguished value of 0 together with the DateTimeChannelID describe an instance within the SystemItem.

The EssenceContainer property specifies the Essence Container in which the timecode data is embedded; a distinguished value of 16 bytes of 0 indicates that the timecode data is not in any Essence Container.

6.4.3.2.1.2 Timecode Header Label Descriptor requirements

Conformant RDD 48 Baseband Shim encoders shall produce files that carry DateTimeDescriptors that conform to the specification in annex C.3.

Essence Descriptors of Top Level Source Packages and Lower Level Source Packages should include a DateTimeDescriptor as defined in annex C.1 for each Timecode Track that shall comply with the following requirements:

- When present, a DateTimeDescriptor shall use the Essence Container UL to identify the Essence Container in which the timecode data is embedded. In the case where the same timecode data is contained in several Essence Containers conformant encoders may produce files that specify any one of the Essence Container ULs; encoders should use the Essence Container that was encoded most recently. If the timecode data is not in any Essence Container, the EssenceContainerUL shall be the distinguished value of 16 bytes of 0 (zero). This distinguished value shall not be copied into the EssenceContainers batch of the Preface of the file. Note that an alternate non-zero registered UL could be assigned in the Labels Register by SMPTE in the future.
- When present, a DateTimeDescriptor shall include a SMPTE UL indicating the time code type, using a symbol registered for the timecode type UL in SMPTE ST 400:2012.
- When present, a DateTimeDescriptor should include one DateTimeSubdescriptor for each instance of the timecode data within the file. For example, when a timecode is stored in the Top Level source package of the Header Metadata, the system item and the data track, three subdescriptors shall be present.
- When present, a DateTimeSubdescriptor should use the DateTimeSymbol property to provide an alphanumeric label for the timecode instance. The symbol should be the one registered for the timecode type UL in SMPTE ST 400:2012; encoders may produce an alternate alphanumeric symbol.
- When present, a DateTimeSubdescriptor shall use the DateTimeEssenceTrackID property to indicate the track ID of the audio track where the timecode data is stored in a Top Level Source Package. If this optional property is absent, this implies that the timecode data contained in the Timecode Track is Master Timecode and there is no timecode data on essence tracks. If provided, values shall conform to SMPTE ST 377-1:2011 (table B.15): for Master Timecode, the value shall be 1 (one), and for Historical Source Timecode, even if there are multiple instances, the value shall be 0 (zero).
- When present, a DateTimeSubdescriptor shall use the DateTimeChannelID property to indicate the audio channel within the stated EssenceContainer in which the timecode is embedded. DateTimeChannelID assignment shall begin with 0 (zero). This is an optional property; if the property is absent, it is implied that the timecode is in the first channel (DateTimeChannelID=0) in the essence container. The mapping of ordinals to the available channels is defined separately for each EssenceContainer type in section 6.4.3.2.2 below.
- When present, a DateTimeSubdescriptor should include an instance of the free-text DateTimeDescription property that identifies the type and location of the Historical Timecode in the source item.

6.4.3.2.2 Timecode Header Label Subdescriptor

6.4.3.2.2.1 Timecode Header Label Subdescriptor (informative)

The main function for RDD 48 Timecode Header Label Subdescriptors is to identify and distinguish timecodes when an Essence Container carries more than one. The Subdescriptor table in annex C.4 prescribes the ordinals that will appear in the DateTimeEssenceTrackID or DateTimeChannelID properties. In addition, the DateTimeSymbol property symbolically identifies the timecode type with values specified via SMPTE ST 400:2012.

6.4.3.2.2.2 Timecode Header Label Subdescriptor requirements

Conformant encoders shall produce files that carry values for the Subdescriptors property that strongly reference a TimecodeLabelSubdescriptor derived from the ST 377-1:2011 annex B.3, and described in detail in annex C.4 of this document. For ATC (described in SMPTE ST 12-2:2008 and SMPTE ST 12-3:2016), the value shall be DBB1.

6.4.4 Master Timecode

6.4.4.1 Master Timecode (informative)

RDD 48 Master Timecode is necessary 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 called for 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 Top Level Source Package

Conformant encoders shall produce files in which RDD 48 Master Timecode is encoded in the Header Metadata Top Level Source Package that contains the Picture, Sound, and Data Essence. This essence is frame-wrapped (or custom-wrapped if so required by a shim).

Conformant encoders shall produce files in which uninterrupted, ascending RDD 48 Master Timecode has been placed as a Timecode Track and identified by the track number property of 1. There shall be only one timecode track with a track number property value of 1 in a Package. The Master Timecode EditRate, RoundedTimecodeBase, and DropFrame Properties shall match the frame rate and count mode of the Picture Essence in the file.

When recording, the RDD 48 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 Top Level Source Package.

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.

Conformant encoders shall not produce files in which Master Timecode has been placed in Top Level Source Packages other than the one that contains the frame-wrapped Picture, Sound, and Data Essence. Note that these other Packages describe Essence or metadata that is clip-wrapped (or custom- wrapped if so required by a shim).

6.4.4.3 Master Timecode in Header Metadata Material Package

Conformant encoders shall produce files that carry a timecode track for each Material Package. This is in addition to the Master Timecode encoded in the Top Level Source Package.

For RDD 48 files, the default start timecode 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 Container System Items

Conformant encoders shall produce files that carry RDD 48 Master Timecode in the Essence Container as a System Item in the Essence Container. It shall be encoded as the first element of the ST 405:2006 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.

Note that any Timecodes that are present within the Picture, Sound or Data Item are considered to be historical Source Timecodes as discussed in section 6.4.5.5 below.

Conformant encoders shall produce files that carry a DateTimeDescriptor as specified in 6.4.3 above (Labeling Timecode in Header Metadata). Note that a single DateTimeDescriptor can simultaneously describe both a Timecode Track and a System Item Timecode. The DateTime Embedded Property of the DateTimeDescriptor indicates whether SystemItemTimecode is present for the linked Track.

6.4.5 Historical Source Timecode

6.4.5.1 Historical Source Timecode (informative)

RDD 48 Historical Source Timecode is legacy timecode, e.g., from a videotape being reformatted, and it can take various forms, including but not limited to, LTC, VITC and ATC, and it could be of various frame rates and frame counting modes. Historical Source Timecode is often discontinuous and is not suitable for use as the Master Timecode.

The legacy timecodes in videotapes and other sources are sometimes layered in ways that an archive wishes to track, e.g., a videotape that carries LTC might 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 RDD 48 Manifest (section 6.7.1).

6.4.5.2 Encode Various Types of Historical Source Timecode

When present in source material, conformant encoders shall produce files that encode the following types of Historical Source Timecode:

a. Linear timecode (LTC) according to SMPTE ST 12-1:2014.
b. Vertical interval timecode (VITC) according to SMPTE ST 12-1:2014.
c. Ancillary Time Code (ATC) according to SMPTE ST 12-2:2008.

Conformant encoders should produce files that encode other Historical Source Timecode types when present in source material, e.g., 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. Special requirements may be developed for shims.

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 ST 405:2006 TimecodeArray of the ST 394 System Element. (Section 6.4.4.4 reserves the first element in TimecodeArray for Master Timecode.) Historical Source Timecode in Essence Containers shall be stored with each frame and not as a start and duration. Conformant encoders shall accommodate discontinuities in incoming Historical Source Timecode in Essence Containers and shall record matching discontinuities within the ST 405:2006 TimecodeArray.

Conformant encoders shall produce files that encode a DateTimeDescriptor in the corresponding Historical Source Timecode Track of the Top Level Source Package as specified in 6.4.3 above (Labeling Timecode in Header Metadata).

6.4.5.4 Historical Source Timecode Tracks in Header Metadata for TLSP

When Historical Source Timecode tracks are to be placed in Top Level Source Packages, conformant encoders shall produce files that accommodate discontinuities in incoming Historical Source Timecode. Discontinuous timecode shall be represented as a Sequence of TimecodeComponents (ST 377-1:2011 annex B.16). Continuous timecode shall be represented as a TimecodeComponent with Start Time and Length (ST 377-1:2011 annex B.17).

If Segments with no timecode or undecodable timecode are encountered while building the Header Metadata Top Level Source package, conformant encoders shall produce files in which the current TimecodeComponent has been ended, with a Filler (ST 377-1:2011 annex B.10), and with a data value into the ST 405:2006 array for that edit unit. Regarding the data value, conformant encoders may either (a) repeat the last known good timecode value, (b) store the spurious data from the timecode reader, (c) store zero as the value, or (d) store any other fixed value, include as an option the value 0xFFFFFFFF. For subsequent edit units, conformant encoder shall produce files in which either (a) the length of the Filler is incremented if the error persists or, if decodable timecode data is recovered, (b) the Filler ends and a new TimecodeComponent starts.

Conformant encoders should produce files that carry a DateTimeDescriptor as specified in 6.4.3 above (Labeling Timecode in Header Metadata).

6.4.5.5 Historical Source Timecodes in Essence Container Picture, Sound, and Data Items

Additional Historical Source Timecodes may also be represented:
- as SMPTE ST 12-2:2008 data in ANC packages in one or more Data Items in the Essence Container.
- as LTC in Sound Items in the Essence Container.
- as VITC in the Picture Items in the Essence Container (such as a VBI line on the picture in D10 video essence, timecode GOP Header in MPEG-2 essence, and so on).

Conformant encoders should produce files that carry 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 RDD 48 files. As specified below, RDD 48 shims might mandate, forbid, encourage, or permit this practice. In the initial RDD 48 Baseband Shim (annex 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 RDD 48 shim will specify its requirements for the carriage of RDD 48 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 405:2006 Timecode Array (section 6.4.5.3) are to 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 405:2006 Timecode Array (section 6.4.5.3) are never to 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 405:2006 Timecode Array (section 6.4.5.3) will generally have a matching LLSP track, and there could 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 405:2006 Timecode Array (section 6.4.5.3), and Timecodes for which there is no ST 405 Timecode Array element can have matching LLSP tracks. Thus there will be no correspondence between the Timecodes encoded as the second and subsequent elements of the ST 405:2006 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, conformant encoders shall produce files that accommodate discontinuities in incoming Historical Source Timecode. Discontinuous timecode shall be represented as a Sequence of TimecodeComponents (ST 377-1:2011 annex B.16). Continuous

timecode shall be represented as a TimecodeComponent with Start Time and Length (ST 377-1:2011 annex B.17). Segments with no timecode or undecodable timecode shall be represented as Filler (ST 377-1:2011 annex B.10).

Conformant encoders should produce files that carry 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	RDD 48 Constraint	RDD 48 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

Conformant decoders shall use the RDD 48 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, conformant 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

Conformant ecoders 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 RDD 48 files that carry Historical Source Timecode(s) in the SMPTE ST 12-1:2014 format, carried in the ST405:2006 TimecodeArray of the ST 394 System Element; Lower Level Source Packages; and/or Essence Container Data Items, conformant 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 12 timecodes (LTC, VITC, and ATC) are listed in section 6.4.5.2.

When decoding RDD 48 files that carry other (non-SMPTE ST 12-1:2014) Historical Source Timecode(s), conformant 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	RDD 48 Constraint	RDD 48 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 assigned the Track Number 0 (zero).	historical_source_timecode_track	Strong	Mandated*
Intimate metadata	Metadata that is intimately associated with the essences and which shall 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)

RDD 48 files with internal essences will use operational patterns OP1a or OP1b, where Top-level Source Packages are effectively the same as Top-level File Packages. SMPTE ST 378:2004 constrains OP1a to a single Top-level Source Package. SMPTE ST 391:2004 constrains OP1b files to two or more Top-level Source Packages. In contrast, RDD 48 OP3c files are used for collections, where multiple external essences will be referenced, and in accord with SMPTE ST 408:2006, RDD 48 OP3c files could carry one or more Top-level Source Packages. See section 6.3 for more information on RDD 48 Operational Patterns.

6.5.3.2 Top-Level Source Packages

Conformant encoders shall produce OP1a files with one Top-level Source Package, OP1b files with two or more Top-level Source Packages, and OP3c files with one or more Top-level Source Packages. Shims may specify a required quantity or quantity range of Top-level Source Packages. Conformant decoders shall read all Top-level Source Packages in an RDD 48 file.

6.5.3.3 Shim parameter table for Top-Level Source Packages

Dimension	Description	Shim parameter	RDD 48 Constraint	RDD 48 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 the recent update of SMPTE ST 2001-2:2014, pertaining to the mapping of registered data in XML form. The additional guidance about Lower Level Source Package properties could include features that will be implemented in future editions of RDD 48.

6.5.5 MXF Tracks

Packages in RDD 48 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 RDD 48 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 RDD 48 files shall be in compliance with SMPTE ST 330:2004.

6.6 Descriptive Metadata Parameters and Constraints

6.6.1 RDD 48 Descriptive Metadata (informative)

This RDD 48 specification defines four Descriptive Metadata Schemes (DMS) that can be included in an RDD 48 MXF file. One of the schemes pertains to the whole file; two define sets of metadata elements for additional (a) non-essence text-based or (b) non-essence binary data that might 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 could be included in RDD 48 files and the superclass DMS.

Organizations could also include other Descriptive Metadata Schemes, e.g., DMS-1, in RDD 48 files.

The expectation is that organizations creating the files will provide the data for the instances of descriptive metadata to RDD 48 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 RDD 48 Core Descriptive Metadata Scheme (informative)

RDD 48 Core Descriptive Metadata Scheme (AS_07_Core_DMS) is a critical part of all RDD 48 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 RDD 48 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 RDD 48 specifies no 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 that is needed 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 RDD 48 Core DMS Device Objects (informative)

AS_07_Core_DMS_Devices Object 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 RDD 48 DMS Identifier Objects (informative)

AS_07_Core_DMS_Identifiers Objects defines the unordered set of references that describe file- and part-identifiers in an RDD 48 file. This set of references can be used in AS_07_Core_DMS and also in other RDD 48 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_Identifiers Objects are intended to permit embedding these multiple identifiers in RDD 48 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 to be included in AS_07_Core_DMS with the IdentifierRole = Main. Beyond the main identifier, additional AS_07_Core_DMS_Identifiers sets are optional; there can be as many IdentifierRole = Additional identifiers as an organization needs.

6.6.1.3 RDD 48 Generic Stream Partition Superclass Descriptive Metadata Scheme (informative)

The RDD 48 Generic Stream Partition Descriptive Metadata Scheme (AS_07_GSP_DMS) defines the superclass metadata scheme for non-essence binary and text-based data stored in Generic Stream Partitions in RDD 48 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 MIME type.

The AS_07_GSP_DMS is a subclass of the SMPTE RP 2057:2011 generic text-based DMS and as such, means that a MIME type for text-based data is to be used to characterize the text-based entity carried in the Generic Stream Partition. In addition to carriage in the SMPTE RP 2057:2011 generic text-based DMS, MIME types for text-based data are repeated in the AS_07_GSP_DMS_MIMEMediaType in order to be referenced by the MimeType element in the Manifest. For consistency, RDD 48 asks that MIME types for binary object to be applied in the same manner as RP 2057’s requirement for text-based objects. Since some binary objects will not have MIME types, RDD 48 accepts the value of a zero-length string.

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 RDD 48 Generic Stream Partition Binary Data Descriptive Metadata Framework (informative)

For each non-essence binary data stream (see 6.2.4) in RDD 48 Generic Stream Partitions (SMPTE ST 410:2008), the files will carry RDD 48 Generic Stream Partition Descriptive Metadata Framework (AS_07_GSP_BD_DMS). In contrast, Generic Stream Partitions that consist of essence binary data, including EBU STL, are described by appropriate Descriptors as detailed in 6.2.12 instead of a DMS.

In this edition of the RDD 48 specification, this scheme is identical to the superclass described in section 6.6.1.3 above, but it could be extended in the future.

6.6.1.3.2 RDD 48 Generic Stream Partition Text-based Data Descriptive Metadata Framework (informative)

For each non-essence text-based data streams (see 6.2.4) in RDD 48 Generic Stream Partitions (SMPTE ST 410:2008 and see section 6.2.4) including Supplementary Metadata and the RDD 48 Manifest (section 6.2.4.1.4), the files will carry RDD 48 Generic Stream Partition Text-based Data Descriptive Metadata Framework (AS_07_GSP_TD_DMS). In contrast, essence text-based data including EBU or SMPTE Timed Text are described by appropriate Descriptors as detailed in 6.2.12 instead of a DMS.

AS_07_GSP_TD_DMS augments the data in AS_07_GSP_DMS to include the use of RFC 5646 language codes for the text as outlined in in 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 RDD 48 Segmentation Descriptive Metadata Scheme (informative)

For all RDD 48 files that implement essence Segmentation (see section 6.7.5), the files will carry RDD 48 Segmentation Descriptive Metadata Scheme (AS_07_Segmentation_DMS). AS_07_Segmentation_DMS will provide a description of both the individual segmented parts as well as the aggregate group of parts. Since RDD 48 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 RDD 48 Segmentation Descriptive Metadata Scheme – Parts Object (informative)

RDD 48 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 RDD 48 Descriptive Metadata Schemes Encoder Requirements

Conformant encoders shall produce files that include instances of Descriptive Metadata Schemes in compliance with SMPTE ST 377:2011 and EG 42:2004. 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 RDD 48 schemes are defined and labeled in the appendixes as listed below:

Data dictionary	Scheme label	Comment	Appendix
RDD 48 Core Descriptive Metadata Scheme	AS_07_Core_DMS		D.1
RDD 48 Core DMS Device Objects	n/a	Used by AS_07_Core_DMS	D.2
RDD 48 DMS Identifier Objects	n/a	Used by AS_07_Core_DMS and other DM schemes	E
RDD 48 Generic Stream Partition DMS Superclass	AS_07_GSP_DMS	Used by AS_07_GSP_BD_DMS and AS_07_GSP_TD_DMS	F.1
RDD 48 Generic Stream Partition Binary Data Descriptive Metadata Framework	AS_07_GSP_BD_DMS		F.2
RDD 48 Generic Stream Partition Text-based Data Descriptive Metadata Framework	AS_07_GSP_TD_DMS		F.3
RDD 48 Segmentation Descriptive Metadata Scheme	AS_07_Segmentation_DMS		G.1
RDD 48 Segmentation DMS - Parts Objects	n/a	Used by AS_07_Segmentation_DMS	G.2

RDD 48 files may contain other Descriptive Metadata Schemes unless forbidden by a specific shim.

An RDD 48 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 RDD 48 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 RDD 48 Descriptive Metadata Track Encoder Requirements

Conformant encoders shall produce files that contain 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.

Conformant encoders shall produce files that carry the MIME types for text-based data in SMPTE RP 2057:2011 generic text-based DMS and shall repeat the value in the AS_07_GSP_DMS_MIMEMediaType in order to be referenced by the MimeType element in the Manifest.

An RDD 48 file shall contain one RDD 48 Core Descriptive Metadata track. An RDD 48 file shall contain zero or more RDD 48 GSP Binary Data Descriptive Metadata Tracks and/or RDD 48 GSP Text-based Data Descriptive Metadata Tracks. An RDD 48 file shall contain zero or one RDD 48 Segmentation Descriptive Metadata Tracks. RDD 48 files may contain other Descriptive Metadata Tracks unless forbidden by a specific shim.

Conformant 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 RDD 48 shim (constraint set) applies to the file.

6.6.2.2 RDD 48 Descriptive Metadata Track Decoder Requirements

Conformant 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.
Conformant 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	RDD 48 Constraint	RDD 48 Values
AS_07_GSP_BD_DMS non-essence binary data	Requirement to carry AS_07_GSP_BD_DMS for non-essence binary data in Generic Stream Partitions	AS_07_GSP_BD_DMS	Strong	Permitted*
AS_07_GSP_TD_DMS non-essence text-based data	Requirement to carry AS_07_GSP_TD_DMS for non-essence 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 Schemes	Carriage of additional descriptive metadata schemes, e.g., DMS-1	additional_DMS	Gentle	Mandated, Forbidden, Encouraged, Permitted

* Mandated when non-essence binary data is carried in a Generic Stream Partition, otherwise permitted.
** Mandated when non-essence text-based data is carried in a Generic Stream Partition, otherwise permitted.
*** Mandated when segmented essences are carried in an RDD 48 file, otherwise permitted.

6.6.4 Redundant Metadata

Custom metadata included in an RDD 48 file by a shim should not duplicate metadata elements that are already carried in MXF Structural Metadata or are already part of the RDD 48 Core Metadata Scheme. In the event of disagreement between redundant and/or duplicate metadata items present in an RDD 48 MXF file, conformant decoders should accord the highest priority to MXF Structural Metadata and RDD 48 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 RDD 48 MXF files, implementations should include a KLV Fill of at least 8 kilobytes in length following the metadata in the header partition.

6.6.6 Static Descriptive Metadata Requirements

RDD 48 files shall conform to the Descriptive Metadata Track structure described by SMPTE EG 42:2004. RDD 48 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 RDD 48 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 shall 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 Manifest is a form of non-essence text-based data to be carried in a Generic Stream Partition in an RDD 48 file. See 6.2.4 for more information on non-essence data in GSPs.

The RDD 48 Manifest supports preservation and good housekeeping by offering an inventory of the RDD 48 file's parts and expresses the relationships between them. Overall, 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 RDD 48-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.

6.7.1.2 Manifest Structure

The top-level element in the Manifest shall be designated Manifest. Section 6.7.1.5 provides more information on file naming and annex H provides 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 RDD 48 file. Each unique RDD 48 file shall have a universally distinct and persistent file identifier.

This element shall contain the same value as the AS_07_Core_DMS_Identifiers value where AS_07_DMS_IdentifierRole = Main in the AS_07_Core_DMS (section 6.6 and annex D provide more information). Section 6.7.1.4 provides the 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 (section 6.6 and annex E provide more information). Section 6.7.1.4 provides the 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 (section 6.6 and annex D provide more information). Section 6.7.1.4 provides the 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 RDD 48 MXF file including essences and Generic Stream Partitions (section 6.2.4 provides more information). 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 RDD 48 file such as an essence track or Generic Stream Partition contents (section 6.2 provides more information), etc. Each part shall be described by a part element. The XML schema declaration in section 6.7.1.5 and annex H provides 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 can change. Universally unique identifiers, on the other hand, will remain constant over time. Parts could have more than one unique identifier but a good practice is for one to 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 (section 6.2.4 provides more information), the PartID element shall contain the same value as AS_07_GSP_DMS_Identifier from AS_07_GSP_DMS (annex F.1 provides more information).

If the part contains no universally unique identifier, then the creator of the Manifest file shall generate one. Section 6.7.1.4 provides more information about 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 (section 6.6 and annex E provides more information). Section 6.7.1.4 provides more information about 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 RDD 48 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 (section 6.2.4 provides more information), the data description element shall contain the same value as

AS_07_GSP_DMS_DataDescription. Section 6.7.1.4 provides more information about Manifest encoder requirements.

6.7.1.3.3 MIME media type

The MIME media type (MimeType) element is used to describe the data type of the part object. When the MIME media type (MimeType) describes an object in a Generic Stream Partition (section 6.2.4 provides more information), the MIME media type element shall contain the same value as AS_07_GSP_DMS_MIMEMediaType.

IANA MIME type shall be used if one has been established. If no IANA MIME type has been established, implementers shall register a new MIME type with IANA (http://www.iana.org/form/media-types), following procedures also described in RFC 6838) and use that MIME type, or use a zero-length string as the value.

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

Conformant encoders may produce files in which an RDD 48 Manifest is embedded as specified in the following subsections. The inclusion of a Manifest may be mandated, forbidden, encouraged, or permitted by a shim.

Conformant encoders shall produce files in which the Manifest is wrapped according to SMPTE RP 2057:2012 and carried as a form of non-essence textual data in a Generic Stream Partition as specified in section 6.2.4.1.4 The Manifest shall conform to the formal element definition in the XML schema declaration as specified in annex H. The Manifest shall require an instance of AS_07_GSP_TD_DMS as described in 6.6.1.3.

6.7.1.4.2 Detailed Manifest Requirements

The following requirements apply when a conformant encoder embeds a Manifest in an RDD 48 file.

Conformant encoders shall produce files that carry a value in the FileID element in the Manifest that is determined by identifying and extracting the value from the AS_07_Core_DMS_Identifiers value, where AS_07_DMS_IdentifierRole = Main in the AS_07_Core_DMS (section 6.6 provides more information).

Conformant encoders shall produce files that carry a value in the FileIDType element in the Manifest that is determined by identifying and extracting the value from the AS_07_DMS_IdentifierType element where the AS_07_DMS_IdentifierRole = Main in the AS_07_Core_DMS.

Conformant encoders shall produce files that carry a value in the ResponsibleOrgName element in the Manifest that is determined by identifying and extracting the value from the AS_07_Core_DMS_ResponsibleOrganizationName from the AS_07_Core_DMS (section 6.6 provides more information).

Conformant encoders shall produce files that carry universally unique identifier values for each part object in the PartID element in the Manifest. 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. If a universally unique identifier has not been assigned to a given part object prior to the production of the RDD 48 file, such an identifier shall be created and inserted during the production process.

When the data description (DataDescription) element describes an object in a Generic Stream Partition (section 6.5 provides more information), conformant encoders shall produce files that carry a value in the DataDescription element in the Manifest that is determined by identifying and extracting the value from the AS_07_GSP_DMS_DataDescription from the Generic Stream Partition Data Descriptive Metadata Scheme (section 6.6 provides more information).

If new objects are added to the file, conformant encoders shall produce files that carry a value in the DataDescription element values in the Manifest as defined by section 6.7.1.3.2 and by the XSD in annex H.

Conformant encoders shall produce files that carry a value in the the MimeType element in the Manifest that is determined by identifying and extracting the value from the AS_07_GSP_DMS_MIMEMediaType.

6.7.1.5 Manifest Decoder Requirements

If conformant decoders extract the Manifest as a separate file, it shall be named manifest.xml.

6.7.1.6 Manifest XML Schema

When a shim requires a Manifest, conformant encoders shall produce files in which the RDD 48 Manifest has been encoded as XML (W3C XML 1.0), conforming to the XML schema defined in annex H.

6.7.1.7 Shim Parameter Table for the Manifest

Dimension	Description	Shim parameter	RDD 48 Constraint	RDD 48 Values
Manifest	Indicates the requirement for the RDD 48 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 RDD 48 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.

RDD 48 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.

RDD 48 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 RDD 48 files.

Frame-wrapped picture could 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 384:2005 and ST 377-1:2011 (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, the concatenated V values for pairs of KLV triplets are hashed as one. RDD 48 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 RDD 48 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, RDD 48 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 RDD 48 files, in order to allow for this rare use and also to remain consistent with ST 429-6:2006, RDD 48 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 RDD 48 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 RDD 48 file, however, the Encrypted Triplet Variable Length Pack specified by ST 429-6:2006 will generally not be used to carry the hash values. Instead RDD 48 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 might be the case for digital cinema content or because a specialized application creates and presents it to the RDD 48 production system. This will typically be a circumstance in which content wrapped in non-RDD 48 MXF is intended for re-wrapping as RDD 48. As noted in section 6.7.2.7, in this case, RDD 48 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 RDD 48 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 RDD 48, the 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 RDD 48 use of System Items and ST429-6:2006 Encrypted Triplets, RDD 48 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 RDD 48 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 the best stage in an organization's workflow to calculate the initial MIC hash value. It is worth noting, however, that many experts encourage that hash creation 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, conformant encoders shall produce files that carry 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 a shim requires integrity data, conformant encoders shall produce files that carry a Castagnoli CRC-32C for the concatenated values of the two Vs in the pair of KLVs.

For non-frame-wrapped D-10 essences, conformant encoders shall produce files that 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 RDD 48, 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 each element being the hash of each essence element in the GC content package, including Picture, Sound, Data and Compound essence, in the sequence in which the essence elements appear in the GC. 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. The integrity data shall be represented in a HashArray with a single property whose value shall be an array, in which each element shall be the hash of each essence element in the GC content package, including Picture, Sound, Data and Compound essence, in the sequence in which the essence elements appear in the GC.

6.7.2.5 Encryption data (informative)

This version of the RDD 48 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 results 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, conformant encoders shall produce files that also carry a populated Cryptographic Context Set, Cryptographic Framework, and Cryptographic Framework DM Tracks as specified in SMPTE ST 429-6:2006, with the 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. Detailed information and requirements on this interrelated set of metadata elements is provided in annex I.

6.7.2.7 Retention of Encrypted Triplet Variable Length Pack Data

When the input to an RDD 48 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, conformant encoders shall produce files that retain this data in the RDD 48 file.

6.7.2.8 Decoder Requirements

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

Conformant 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 conformant decoders to support "legacy" BBC archive files, which do not have Cryptographic Context Set, Cryptographic Framework, and Cryptographic Framework DM Tracks.

Conformant decoders shall provide the ability to output the Encrypted Triplet Variable Length Pack data to applications external to the decoder, thus permitting 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	RDD 48 Constraint	RDD 48 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 RDD 48 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	RDD 48 Constraint	RDD 48 Values
File names	File name restrictions	filenames	Gentle	No constraint [Filename pattern as described in shim specification]

6.7.4 Directory Structure (informative)

The general provisions of the RDD 48 specification do not constrain the choice of directory names or structures for storage of RDD 48 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 could be broken (interrupted) in playback. In some cases, segmentation will 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 is to 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 RDD 48 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 RDD 48 file, conformant encoders shall produce files that represent program segmentation by creating an MXF Timeline track in the file's Material Package, referred to as the Segmentation Track. Conformant encoders shall produce files in which the Segmentation Track's descriptive

metadata is constructed in accordance with the recommendations of SMPTE EG 42:2004 and SMPTE ST 377:2011. Segmentation Tracks are forbidden in RDD 48 Lower Level Source Packages.

An RDD 48 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 file'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), can 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)

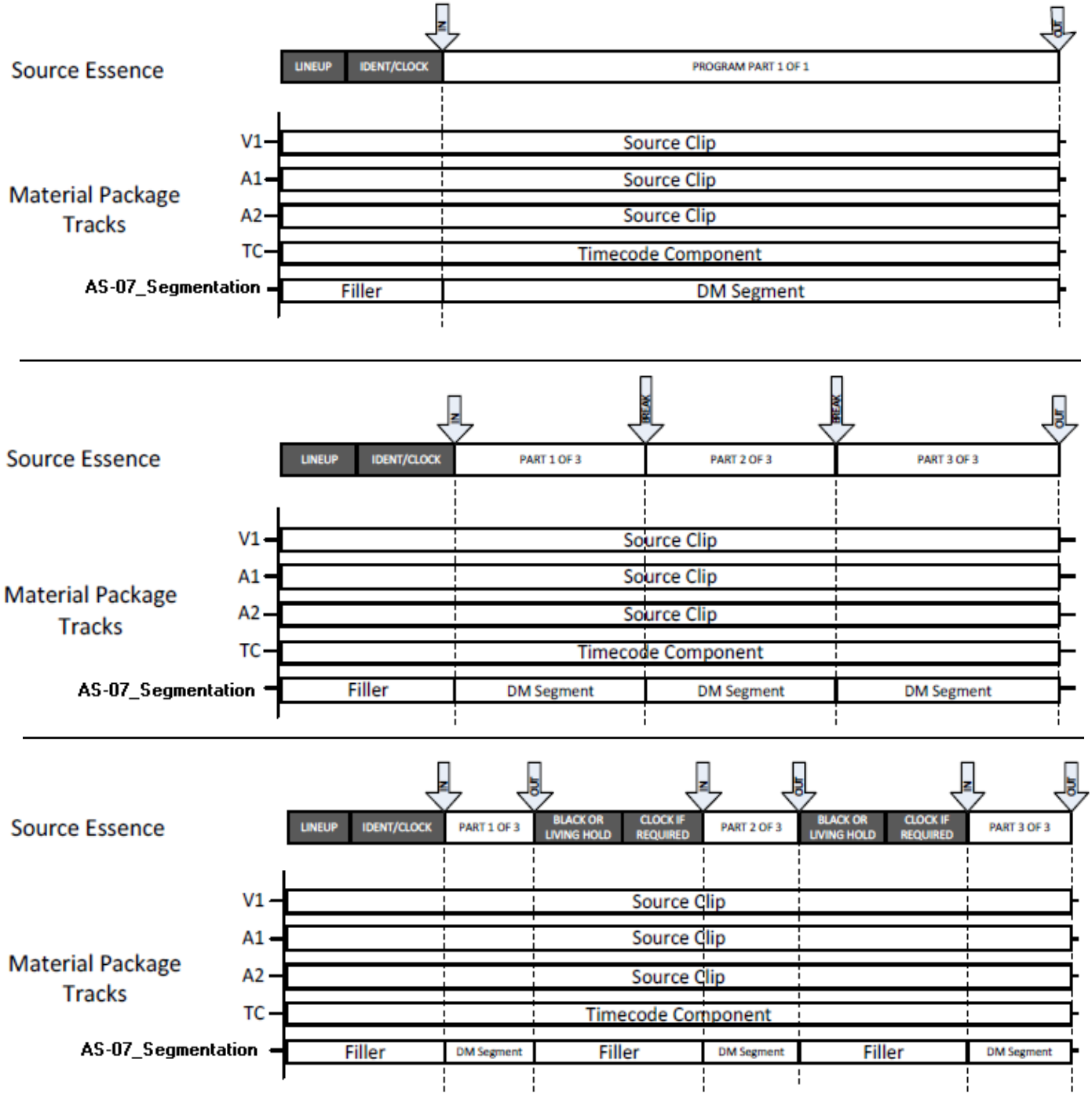
A Single-Part Program is one that has optional non-program run-in followed by uninterrupted program content. This is represented using a single DM Segment on the segmentation track.

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 could 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 will always be considered soft. Users of Soft-Parted RDD 48 files will often 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 annex 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 can interrupt playback to insert non-program content. The user could 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 inserts non-program content between segments.

6.7.5.4 Shim Parameter Table for Program Segmentation

Dimension	Description	Shim parameter	RDD 48 Constraint	RDD 48 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

The FADGI Audio-Visual Working Group (http://www.digitizationguidelines.gov/) has been producing a variety of sample files during the period in which AS-07 (now RDD 48) has been under development. Most of these have been partial "working" samples that represent the main features of the specification. The process of sample-file making continues, moving in step with the refinement of this draft of RDD 48. The latest public information about progress is shared from this page on the FADGI website: http://www.digitizationguidelines.gov/guidelines/MXF_app_spec.html.

Annex A. Recap: RDD 48 Shim Parameters and Constraints (informative)

RDD 48 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 RDD 48 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 RDD 48 shim parameters have been copied from section 6 and compiled in this informative appendix.

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Cells to carry shim constraint*	*Cells to carry shim values*
Essence Partitions (6.2.3.3)						
Essence Partition Strategy	Defines whether the essence is a single partition or divided into multiple partitions.	essence_partition_strategy	Strong	Single Multiple		
Index Tables (6.2.5.2)						
Single index location	If all Index Table Segments that compose one Complete Index Table are in one Partition, value shall be TRUE. Else (multiple Partitions), value shall be False.	single_index_location	Moderate	True False		
Single essence location	If all Essence Containers are in one Partition, the value shall be TRUE. Else, (Essence Container Segments in multiple Partitions), value shall be FALSE.	single_essence_location	Moderate	True False		
Forward index direction	If all Index Table Segments that compose one Complete Index Table precede Essence Container Segments that they index, value shall be TRUE. Else (Index Table Segments follow Essence Container Segments), value shall be FALSE.	forward_index_direction	Moderate	True False		
CBE Index Tables	Use of Index Tables for CBE essences that omit the Index Entry Array (SMPTE ST 377-1:2011, section 11.1.9).	cbe_index_table	Moderate	Mandated, Forbidden, Encouraged, Permitted		

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Cells to carry shim constraint*	*Cells to carry shim values*
VBE Index Tables	Use of Index Tables for VBE essences that employ partial or sparse tables (SMPTE ST 377-1:2011, section 11.3).	vbe_index_tables	Moderate	Mandated, Forbidden, Encouraged, Permitted		
Picture Essence – JPEG 2000 Compressed (6.2.10.2.4)						
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)		
Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor		
Picture format (CDCI)	If Descriptor is CDCI, picture raster, aspect ratio, and frame rate	picture_format_CDCI	Moderate	If CDCI Descriptor, any picture format permitted by ST 352:2013. Other specialized rasters might be added in future editions of RDD 48.		
Permitted component depth (CDCI)	if Descriptor is CDCI, *Component Depth* types that may be present in the file	permitted_component_depth_CDCI	Moderate	If CDCI Descriptor: Any permitted by SMPTE ST 377-1:2011, sections F.4.2 and G.2.26.		
Permitted J2CLayout (CDCI)	if Descriptor is CDCI, *PixelLayout* types that may be present in the file, with J2CLayout subdescriptor	permitted_J2C_layout_CDCI	Moderate	If CDCI Descriptor, any permitted by SMPTE ST 422:2014 Shall not be present.		
Picture format (RGBA)	if Descriptor is RGBA, picture raster, aspect ratio, and frame rate	picture_format_RGBA	Moderate	If RGBA Descriptor, any picture format permitted by ST 352:2013. Other specialized rasters may be		

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Cells to carry shim constraint*	*Cells to carry shim values*
				added in future editions of RDD 48.		
Permitted pixel layout (RGBA)	if Descriptor is RGBA, *PixelLayout* types that may be present in the file	permitted_pixel_layout_RGBA	Moderate	If RGBA Descriptor, any permitted in SMPTE 377-1:2011.		
Permitted J2C layout (RGBA)	if Descriptor is RGBA, *J2CLayout* types that may be present in the file, with J2CLayout subdescriptor	permitted_J2C_layout_RGBA	Moderate	If RGBA Descriptor, any permitted by SMPTE ST 422:2014 Shall not be present.		
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 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 (6.2.10.3.4)						
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 377-1:2011, annex G.2.25.		
Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor		
Picture format (CDCI)	If Descriptor is CDCI, picture raster, aspect ratio, and frame rate	picture_format_CDCI	Moderate	If CDCI Descriptor, any picture format permitted by ST 352:2013. Other specialized rasters might be added in future editions of RDD 48.		
Permitted component depth (CDCI)	if Descriptor is CDCI, *Component Depth* types that may be present in the file	permitted_component_depth_CDCI	Moderate	If CDCI Descriptor: Any permitted by SMPTE ST 377-1:2011, sections F.4.2 and G.2.26.		
Permitted J2C layout (CDCI)	if Descriptor is CDCI, *J2CLayout* types that may be present in the file, if the Descriptor is CDCI	permitted_J2C_layout_CDCI	Moderate	Shall not be present.		

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Cells to carry shim constraint*	*Cells to carry shim values*
Picture format (RGBA)	If Descriptor is RGBA, picture raster, aspect ratio, and frame rate	picture_format_RGBA	Moderate	If RGBA Descriptor, any picture format permitted by ST 352:2013. Other specialized rasters might be added in future editions of RDD 48.		
Permitted pixel layout (RGBA)	*PixelLayout* types that may be present in file, if Descriptor is RGBA	permitted_pixel_layout_RGBA	Moderate	If RGBA Descriptor, should be equal to the distinguished value in SMPTE 377-1:2011, sections F.4.3 and G.2.36.		
Permitted J2C layout (RGBA)	*J2CLayout* types that may be present in file, if Descriptor is RGBA	permitted_J2C_layout_RGBA	Moderate	Shall not be present.		
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 ITU-R format standards	ITU-R formats that may be present in the file, or an equivalent format if fully specified in a shim	permitted_ITU-R_formats	Gentle	BT.601 (SD) BT.709 (HD) BT.2020 (UHDTV) Specified in a shim Will expand in future		
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 (6.2.10.4.5)						
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	Any raster permitted by ST 352:2013 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		

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Cells to carry shim constraint*	*Cells to carry shim values*
				SMPTE ST 385:2012 SMPTE ST 386:2004 SMPTE ST 387:2004 SMPTE ST 2019-1:2009 SMPTE ST 2037:2009 SMPTE ST 381-3:2013 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 standards: SMPTE ST 381-1:2005 SMPTE ST 381-2:2011 SMPTE ST 383:2008 SMPTE ST 385:2012 SMPTE ST 386:2004 SMPTE ST 387:2004 SMPTE ST 2019-1:2009 SMPTE ST 2037:2009 SMPTE ST 381-3:2013 Forbidden		

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 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 NICAM 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 (6.2.12.9)						
Caption	Carriage of ANSI/CTA-608-E (CEA-608) or ANSI/CTA-708-E (CEA-708) captions (from source material or if newly produced)	caption_carriage	Strong	Mandated, Forbidden, Encouraged, Permitted		

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Cells to carry shim constraint*	*Cells to carry shim values*
Caption signal scheme	Captions signal schemes	caption_scheme	Strong	ANSI/CTA-608-E (CEA-608) in SMPTE ST 436-1:2013 ANSI/CTA-708-E (CEA-708) in SMPTE ST 436-1:2013		
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 ANSI/CTA-608-E (CEA-608), ANSI/CTA-708-E (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		
VBI and ANC (6.2.13.3)						
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 436-1:2013] [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]		
AFD and Pan-Scan (6.2.14.3)						
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_pattern_types	Strong	OP1a internal OP1b internal OP3c external		

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 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_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 assigned the Track Number 0 (zero).	historical_source_timecode_track	Strong	Mandated*		
Intimate metadata	Metadata that is intimately associated with the essences and which shall 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.

Top-Level Source Packages (6.5.3.3)						
Top-level source package	Quantity of top-level source packages	tlsp_quantity	Strong	Single Multiple		
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 RDD 48 file, otherwise permitted.						
Manifest (6.7.1.7)						
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		

Annex B. RDD 48 Audio Layout Configurations, Identifiers, and Expected Values

B.1 Introduction (informative)

RDD 48 audio layout configurations are specified in section 6.2.11.7. Certain values are carried under the AS_07_Core_DMS_AudioTrackLayout element and additional comments can be carried under the AS_07_Core_DMS_AudioTrackLayoutComment element. The following tables provide information about those values.

This annex contains two main parts:

- **B.2. Audio layout configuration table.** General overview table with ID values.
- **B.3 Expected layout detail tables.** These are the tables referenced in the first column of overview table B.1.

This annex covers all specified layouts for this edition of RDD 48; 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 annex section B.3.

B.2 Audio layout configuration table

Detail table refer-ence	Item UL	Text-based ID	Descriptive name for audio layout	*Comment*
AUDIO LAYOUT IDENTIFICATIONS DEFINED IN INITIAL PUBLICATION OF RDD 48				
Layouts to be identified by RDD 48 encoders				***Support Baseband Video Shim***
	060e2b34.04010101.0d0e0101.07020401	AudioLayoutSilence	No content on audio channels (AS-11 "valid silence")	*Likely to be encountered in analog tape source media*
	060e2b34.04010101.0d0e0101.07020402	AudioLayoutUnknown	Unknown, undefined	*Likely to be encountered in analog tape source media*
1	060e2b34.04010101.0d0e0101.07020403	AudioLayout1TrackUndef	One track detected, content undefined	*Likely to be encountered in analog tape source media*
2	060e2b34.04010101.0d0e0101.07020404	AudioLayout2TrackUndef	Two tracks detected, content undefined	*Likely to be encountered in analog tape source media*
3	060e2b34.04010101.0d0e0101.07020405	AudioLayout3TrackUndef	Three tracks detected, content undefined	*Likely to be encountered in analog tape source media*
4	060e2b34.04010101.0d0e0101.07020406	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	060e2b34.04010101.0d0e0101.07020407	AudioLayout1TrackAudio	One track (one audio)	*Likely to be encountered in analog tape source media*
6	060e2b34.04010101.	AudioLayout2TracksAudio	Two tracks (two audio)	*Likely to be encountered in analog tape source media*

	0d0e0101. 07020408			
7	060e2b34. 04010101. 0d0e0101. 07020409	AudioLayout1TrackAudio1TrackTimecode	Two tracks (one audio, one timecode)	*Likely to be encountered in analog tape source media*
8	060e2b34. 04010101. 0d0e0101. 0702040a	AudioLayout3TracksAudio	Three tracks (three audio)	*Likely to be encountered in analog tape source media*
9	060e2b34. 04010101. 0d0e0101. 0702040b	AudioLayout2TrackAudio1TrackTimecode	Three tracks (two audio, one timecode)	*Likely to be encountered in analog tape source media*
10	060e2b34. 04010101. 0d0e0101. 0702040c	AudioLayout4TrackAudio	Four tracks (four audio)	*Likely to be encountered in analog tape source media*
11	060e2b34. 04010101. 0d0e0101. 0702040d	AudioLayout3TrackAudio1TrackTimecode	Four tracks (three audio, one timecode)	*Likely to be encountered in analog tape source media*
	060e2b34. 04010101. 0d0e0101. 07020410	AudioLayoutEBU48_2a	EBU R 48: 2a (For 4 ch. only)	*Reference EBU standard, pattern from AS-11*
	060e2b34. 04010101. 0d0e0101. 07020411	AudioLayoutEBU123_4b	EBU R 123: 4b (For 4 ch. only)	*Reference EBU standard, pattern from AS-12*
	060e2b34. 04010101. 0d0e0101. 07020412	AudioLayoutEBU123_4c	EBU R 123: 4c (For 4 ch. only)	*Reference EBU standard, pattern from AS-13*
	060e2b34. 04010101. 0d0e0101. 07020413	AudioLayoutEBU123_16c	EBU R 123: 16c (For 16 ch. only)	*Reference EBU standard, pattern from AS-14*
	060e2b34. 04010101. 0d0e0101. 07020414	AudioLayoutEBU123_16d	EBU R 123: 16d (For 16 ch. only)	*Reference EBU standard, pattern from AS-15*
	060e2b34. 04010101. 0d0e0101. 07020415	AudioLayoutEBU123_16f	EBU R 123: 16f (For 16 ch. only)	*Reference EBU standard, pattern from AS-16*
	060e2b34. 04010101. 0d0e0101. 07020420	AudioLayoutST377_4MCA	SMPTE ST 377-4 Multichannel Audio (MCA)	*Conformant encoders shall produce files in which the descriptors and subdescriptors specified in SMPTE ST 377-1 and ST 377-4 are embedded.*
AUDIO LAYOUT IDENTIFICATIONS TO BE DEFINED IN FUTURE RDD 48 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

Annex C. Timecode Descriptors and Subdescriptors

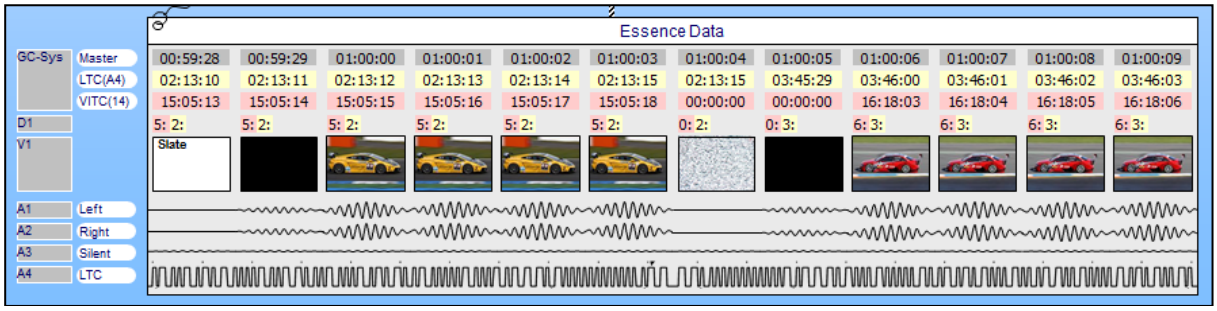
C.1 Explanatory Illustrative Diagram

C.1.1 Source videotape illustrative example

- Source: 1-inch videotape with timecode
- Picture; footage with slate and camera starts and stops.
  - *VITC* in line 14 (discontinuous, jumps to zero in gaps)
  - *Visual representation of RDD 48 MXF Essence Container carriage is offered in the diagram in the next section*.
- Audio: four channels
  - stereo audio on A1 and A2
  - silence on A3
  - *LTC* on A4 (discontinuous, repeats a frame number)

C.1.2 In the resulting RDD 48 MXF File

C.1.2.1 Essence in Generic Container



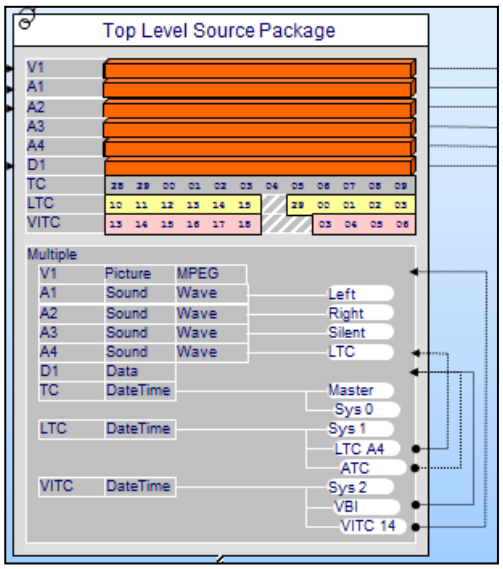
Top (labeled GC-Sys): Generic Container System Items:
- Gray: Master Timecode (synthetic), GCSys Item, element 0
- Yellow: converted LTC, additional GCSys Item
- Pink: ATC (Advanced Timecode, SMPTE ST 12-2:2008); VITC converted to ANC packets

Top (labeled D1): Packetized VITC and LTC

Middle (labeled V1): picture essence (row of images, including starts/stops/snow)

Bottom:
- **Labeled A1**: left
- **Labeled A2**: right
- **Labeled A3**: silent
- **Labeled A4**: LTC (as PCM waveform)

C.1.2.2 Top Level Source Package, with Descriptors and Subdescriptors



MXF Top Level Source Package (TLSP)

- Six essence and data tracks (orange):
  - 1 picture
  - 4 audio
  - 1 data
- Three TC tracks:
  - *Gray*: TC (Master TC)
  - *Yellow*: LTC
  - *Pink*: VITC
- At bottom:
  - Descriptors (gray)
  - Subdescriptors (white)

Master TC in two places, thus two Subdescriptors

- Master TC track, with the symbolic label *Master*
- GCSys with Master, in element 0 (zero) of the GCSys, symbolic label *Sys_0*

LTC in two places, thus two Subdescriptors

- Second item in GCSys, symbolic label *Sys_1*
- Audio track 4, symbolic label *LTC* with the added Essence TrackID property: *A4*
  - *This Subdescriptor has a LinkedTrackID to connect it to the A4 audio track (dotted line arrow)*
- ATC version of LTC, symbolic label *ATC*
  - *This Subdescriptor has a LinkedTrackID to connect it to the D1 data track (dotted line arrow)*

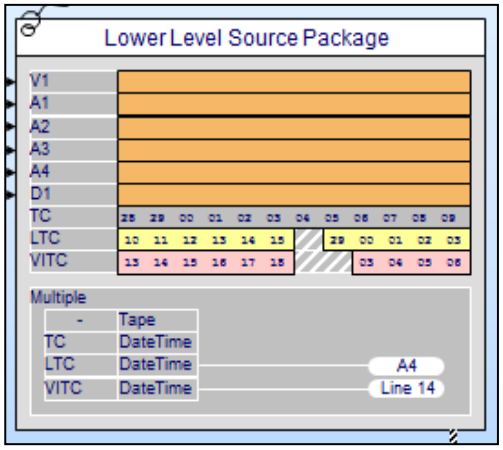
VITC in three places, thus three Subdescriptors

- VITC ingested into the GCSys, symbolic label *Sys_2*
- VBI as Data Item in GC, symbolic label *VBI*
  - *This Subdescriptor has a LinkedTrackID to connect it to the D1 data track (dotted line arrow)*
- VITC in video raster retained on line 14, symbolic label *VITC 14*
  - *This Subdescriptor has a LinkedTrackID to connect it to the V1 picture track (dotted line arrow)*

Note: TLSP track data is metadata. Note that in this example, there is a sequence of components in the LTC and VITC tracks, showing the first segment, filler, and then the second segment.

Regarding the audio tracks: Subdescriptors employ tags from SMPTE ST 377-4:2012 MCA (Multichannel Audio):
left, *right*, *silent*, *LTC.*

C.1.2.3 Lower Level Source Package

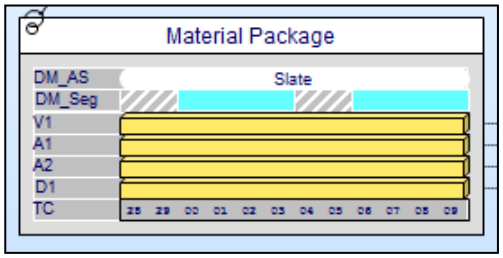


Lower Level Source Package

- Six essence and data tracks (golden):
  - 1 picture
  - 4 audio
  - 1 data
- Three TC tracks:
  - *Gray*: TC (Master TC)
  - *Yellow*: LTC
  - *Pink*: VITC
- At bottom:
  - Descriptors (gray)
  - Subdescriptors (white)

The structure of Descriptors and Subdescriptors is simpler than for the Top Level Source Package. Subdescriptors are provided only for audio track 4 and line 14 in the vertical interval. These Subdescriptors are text (not symbolic) labels.

C1.2.4 Material Package



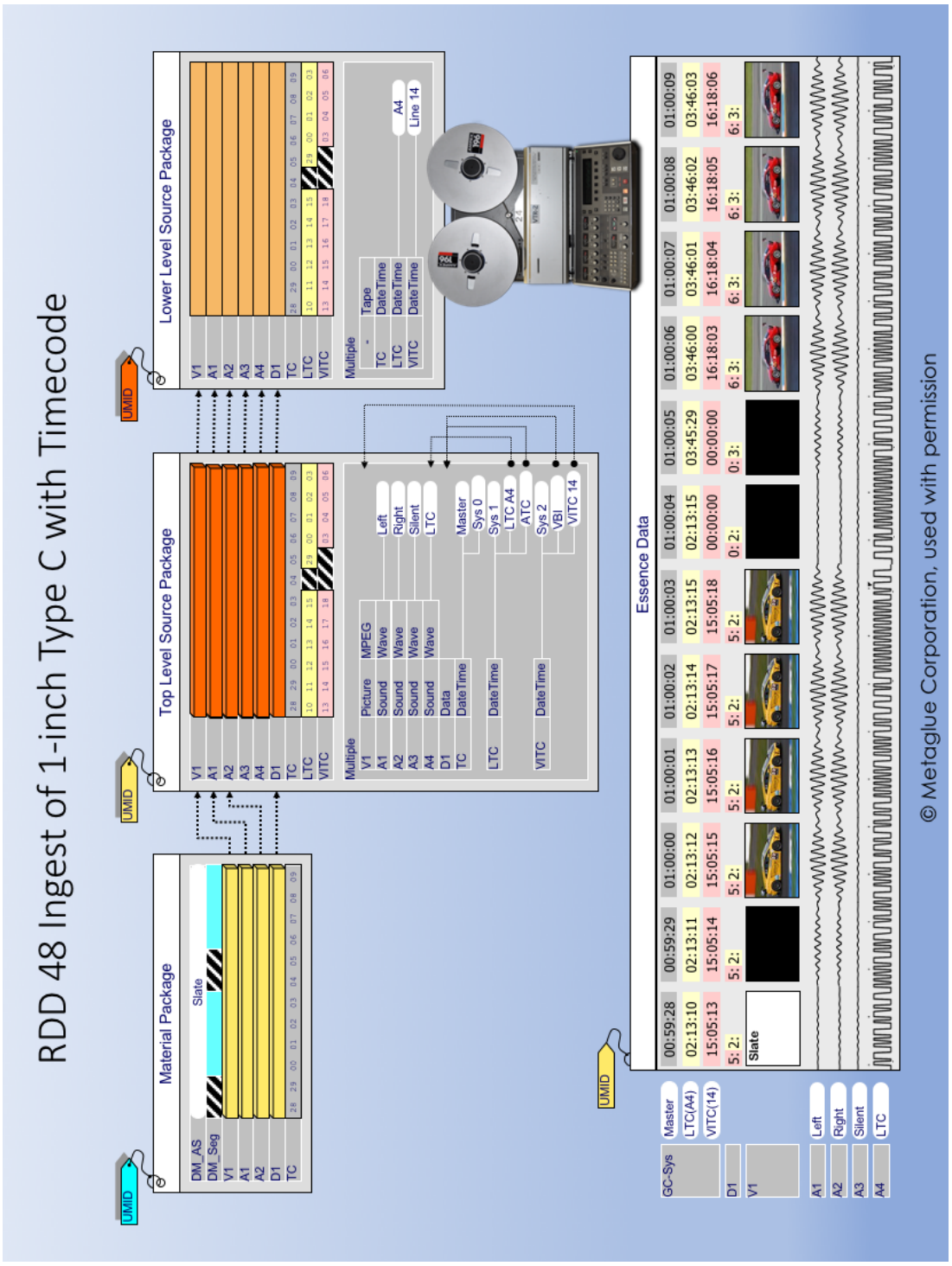
Material Package

- Governs playout of program content
- Four essence and data tracks (yellow)
  - 1 picture
  - 2 audio ("stereo")
  - 1 data
- RDD 48 DMS metadata for the slate
- RDD 48 DMS metadata for segmentation (if any)

C.1.2.5 Unified Diagram and Selected Identifiers

The next section in this annex presents all of the preceding elements in a single, unified diagram. The diagram also shows the presence and linking for some selected identifiers, all of which are part of the normal set required by the MXF family of standards. These identifiers have limited connection to the RDD 48 timecode specifications. Each of the packages--Material Package (MP), Top Level Source Package (TLSP), and Lower Level Source Package (LLSP)--has a PackageID in the form of a UMID, drawn to resemble baggage tags. In addition, the tracks inside the packages have TrackIDs that, together with other metadata, establishes the linking relationships shown as dotted arrow lines.

C.2 Unified Diagram for RDD 48 Ingest of 1-inch Type C



C.3 Timecode Header Label Descriptor

The DateTimeDescriptor for RDD 48, described in 6.4.3, is as specified by SMPTE ST 385:2012 table 3. This table is repeated below with additional informative notes.

Item Name	Type	Len	Local Tag	Item UL	Req?	Meaning	Default	*Informative Comment*
Generic Descriptor	Group UL	16		As defined in ST 377-1:2011 (see Table 19) and ST385 table 4	Req	Defines the Date/Time Descriptor		*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 377-1:2011, 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.340 1.01.01.0206. 01.01.0406.03 .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. [SMPTE ST 335:2012 Specifies a vector of references to essence locators]		*Standard MXF element and values*
Subdescriptors	Array of StrongRef (Subdescriptors)	8+ 16n	dyn	06.0E.2B.340 1.01.01.0906. 01.01.0406.10 .00.00	Opt	Array of strong references to Subdescriptor Sets (10.5.4 provides more information) [SMPTE ST 335:2012 Specifies a vector of an ordered set of references to Subdescriptor sets]		*Standard MXF element and values*
LinkedTrackID	UInt32 (Track ID)	4	30.06	06.0E.2B.340 1.01.01.0506. 01.01.0305.00 .00.00	Opt	Link to (i.e. value of) the Track ID of the Track in this Package to which the Descriptor applies. [SMPTE ST 335:2012 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.340 1.01.01.0104. 06.01.0100.00 .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) [SMPTE ST 335:2012 Specifies the number		*This element gives the duration of each timecode sample.*

						of addressable elements of essence data per second]		
Container Duration	Length	8	30.02	06.0E.2B.340 1.01.01.0104. 06.01.0200.00 .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. [SMPTE ST 335:2012 Specifies the number of addressable elements of essence data]		*Standard MXF element and values*
Essence Container	UL	16	30.04	06.0E.2B.340 1.01.01.0206. 01.01.0401.02 .00.00	Req	The UL identifying the Essence Container described by this Descriptor. Listed via SMPTE ST 400:2012. [SMPTE ST 335:2012 Specifies a reference to the format of Container of Essence Data]		*A distinguished value of 16 bytes of 0 indicates that the Timecode data is not in any EssenceContai ner*
Codec	UL	16	30.05	06.0E.2B.340 1.01.01.0206. 01.01.0401.03 .00.00	Opt	UL to identify a codec compatible with this Essence Container. Listed via SMPTE ST 400:2012. [SMPTE ST 335:2012 Specifies a reference to the codec used to create Essence Data]		*Standard MXF element and values*
DateTimeRate	Rational	8	35.01	06.0E.2B.340 1.01.01.0504. 04.01.0201.00 .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)*
DateTimeDrop Frame	Boolean	1	35.02	06.0E.2B.340 1.01.01.0504. 04.01.0202..0 0.00.00	Opt	TRUE if drop-frame is active	FALSE	*Flag to indicate whether the timecode is drop frame or not. If this optional property is not present, decoders will assume non-drop frame.*
DateTimeEmb edded	Boolean	1	35.03	06.0E.2B.340 1.01.01.0504. 04.01.0203.00 .00.00	Opt	Is it embedded in other data?	TRUE	*Flag to indicate whether the timecode also appears in the Essence of the file*
DateTimeKind	UL	16	35.04	06.0E.2B.340 1.01.01.0504. 04.01.0204.00 .00.00	Req	Date/Time format kind. Values are listed via SMPTE ST 400:2012.		*ULs to identify RDD 48 Master and Historical Source Timecode types will be added*

								via SMPTE ST 400:2012.

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

Note that the distinguished value of 16 bytes of 0 of the EssenceContainer property shall not be copied into the EssenceContainers batch of the Preface. An alternate non-zero registered UL could be assigned in the Labels Register by SMPTE in the future.

C.4 Timecode Header Label Subdescriptor

The Subdescriptors property shall strongly reference a TimecodeLabelSubdescriptor, which is derived from SMPTE ST 377-1:2011, annex B.3.

Item Name	Type	Len	Local Tag	Item UL	Req ?	Meaning	Default	*Informative comment*
TimecodeLabel Subdescriptor	Group UL	16		060e2b34.027f0101.0d0e0101.07040100	Req	Defines the TimecodeLabel subclass of the Subdescriptor Class		*ULs to identify RDD 48 Master and Historical Source Timecode types will be added via SMPTE ST 400:2012*
All items in ST 377-1:2011, B.3 except the Key or Group UL and the Length, if present	See B.3		See B.3	See ST 377-1:2011, B.3	See B.3	See B.3		*Standard MXF element and values*
DateTime Symbol	UTF16String	var	Dyn	060e2b34.010101.0d0e0101.07040101	Req	Symbol that specifies the timecode, values listed via SMPTE ST 400:2012		*Coded description of the timecode type that can be understood by humans*
DateTimeEssenceTrackID	UInt32	4	Dyn	060e2b34.010101.0d0e0101.07040102	Opt	*Link to (i.e. value of) the Track ID of the audio track where the timecode data is stored in a Top Level Source Package.* If this optional property is absent, this implies that the timecode data contained in the Timecode Track is Master Timecode and there is no timecode data on essence tracks. If provided, values shall conform to SMPTE ST 377-1:2011 (table B.15): for Master Timecode, the value shall be 1 (one), and for Historical Source Timecode, even if there are multiple instances, the value shall be 0 (zero).		*Standard MXF element and values if applicable*
DateTimeChannelID	UInt32	4	Dyn	060e2b34.010101.0d0e0101.07040103	Opt	The numerical channel identifier within the essence, if applicable. DateTimeChannelID assignment shall begin with 0 (zero), except for ATC (described in SMPTE ST 12-2:2008	0	*The number of the audio channel on which the timecode data is stored.*

						and SMPTE ST 12-3:2016), the value shall be DBB1.		
DateTime Description	UTF16String	var	Dyn	060e2b34.01010101.0d0e0101.07040104	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.*

Annex D. Data Dictionary for RDD 48 Core Descriptive Metadata Scheme and DMS Device Objects

A reminder that the DMS Item Names include references to AS-07 but are understood to represent RDD 48.

D.1 Data Dictionary for RDD 48 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 RDD 48 files (section 6.6 provides more information).

Item Name	Type	Len	Local Tag	Item UL	Req?	Occurs	*Meaning*
General Information							
AS_07_Core_DMS	DM_Scheme			060e2b34.04010101.0d010701.07010000			*Required Core Metadata for RDD 48 Archiving and Preservation Format*
AS_07_Core_DMS_Framework	DM_Framework			060e2b34.027f0101.0d0e0101.0701010			*RDD 48 Descriptive Metadata*
AS_07_Core_DMS_ShimName	UTF16String	Var		060e2b34.01010101.0d0e0101.07010101	Req	1	*Controlled vocabulary string value indicating the RDD 48 Shim Name, e.g., Derived from video serial interface*
File Identifiers							
AS_07_Core_DMS_Identifiers	Batch of StrongRef (AS_07_DMS_Identifier)	8+ 16n		060e2b34.01010101.0d0e0101.07010102	Req	1and n	*Unordered batch of strong references to all AS_07_DMS_Identifier sets. At least one AS_07_DMS_Identifier Objects set shall be used with the IdentifierRole = Main. Other AS_07_DMS_IdentifierObjects sets are optional.*
Responsible Organization Information							
AS_07_Core_DMS_ResponsibleOrganizationName	UTF16String	Var		060e2b34.01010101.0d0e0101.07010103	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		060e2b34.01010101.0d0e0101.07010105	Opt	0	*A familiar abbreviation of entity name.*
AS_07_Core_DMS_NatureOfOrganization	UTF16String	Var		060e2b34.01010101.0d0e0101.07010106	Opt	0	*The nature of an organization (e.g., limited company, government department, etc.)*

Title Information							
AS_07_Core_DMS_WorkingTitle	UTF16String	Var		060e2b34.01010101.0d0e0101.07010107	Opt	0 or 1	*Free text: Best known or working title of the production or production component*
AS_07_Core_DMS_SecondaryTitle	UTF16String	Var		060e2b34.01010101.0d0e0101.07010108	Opt	0 or 1	*Free text: Secondary title of the production or production component*
Basic Source Information							
AS_07_Core_DMS_PictureFormat	UTF16String			060e2b34.01010101.0d0e0101.07010109	Req	1	*The signal standard (frame resolution and aspect ratio) of the encoded file.* *Human readable, not controlled vocabulary, *see note following this table for suggested format.*
AS_07_Core_DMS_IntendedAFD	UTF16String			060e2b34.01010101.0d0e0101.0701010a	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			060e2b34.01010101.0d0e0101.0701010b	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	060e2b34.01010101.0d0e0101.0701010c	Opt	0 or 1	*The primary language in audio track by codes as defined by RFC 5646. Use only when language is known.*
AS_07_Core_DMS_AudioTrackSecondaryLanguage	UTF16String	Var	Dyn	060e2b34.01010101.0d0e0101.0701010d	Opt	0 or 1	*The secondary language in audio track by codes as defined by RFC 5646. 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			060e2b34.01010101.0d0e0101.0701010e	Req	1	*Appropriate values in RDD 48 Annex E.*
AS_07_Core_DMS_AudioTrackLayoutComment	UTF16String			060e2b34.01010101.0d0e0101.0701010f	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_Devices	Batch of StrongRef (AS_07_Core_DMS_Devices object)	8+ 16n		060e2b34.01010101.0d0e0101.07010110	Opt	0 and n	*Unordered batch of strong references to all AS_07_Core_DMS_Device sets used in this file*

* Note regarding AS_07_Core_DMS_PictureFormat in the preceding table. This item provides human-readable metadata and there is no required controlled vocabulary. The list that follows offers illustrative examples based on the machine-readable terminology required by MXF picture essence descriptors (sections 6.2.10.2.4 and 6.2.10.3.4 provide more information).

- 486i 4:3 (30 Hz fps)
- 486i 4:3 (29.97 Hz fps)
- 486i 16:9 (30 Hz fps)
- 486i 16:9 (29.97 Hz fps)
- 576p 4:3 (50 Hz fps)
- 576p 4:3 (25 Hz fps)
- 576p 16:9 (50 Hz fps)
- 576p 16:9 (25 Hz fps)

D.2 Data Dictionary for RDD 48-Core DMS Devices Object

AS_07_Core_DMS_Devices Object 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 annex D.1.

Item Name	**Type**	**Len**	**Local Tag**	**Item UL**	**Req?**	**Occurs**	***Meaning***
AS_07_Core_DMS_Device	Set Key	16		060e2b34.027f0101.0d0e0101.07010200	Req	1	*Defines the AS_07_Core_DMS_Device Set*
All items in SMPTE ST 377-1:2011 A.1 except the Key or Group UL and the Length, if present	*See SMPTE ST 377-1:2011 A.1*	*See SMPTE ST 377-1:2011 A.1*	*See SMPTE ST 377-1:2011 A.1*	*See SMPTE ST 377-1:2011 A.1*	*See SMPTE ST 377-1:2011 A.1*	*See SMPTE ST 377-1:2011 A.1*	
AS_07_Core_DMS_DeviceType	UTF16String	Var		060e2b34.01010101.0d0e0101.07010202	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		060e2b34.01010101.0d0e0101.07010203	Opt	0 or 1	*The manufacturer or maker of the device*

AS_07_Core_DMS_DeviceModel	UTF8String	32 chars max		060e2b34.01010101.0d0e0101.07010204	Opt	0 or 1	*Identifies the device model used in capturing or generating the essence.*
AS_07_Core_DMS_DeviceSerialNumber	UTF8String	32 chars max		060e2b34.01010101.0d0e0101.07010205	Opt	0 or 1	*Alphanumeric serial number identifying the individual device*
AS_07_Core_DMS_DeviceUsageDescription	UTF16String	Var		060e2b34.01010101.0d0e0101.07010206	Opt	0 or 1	*Free text description of the function or use of the device in the production of a specific content item*

Annex E. Data Dictionary for RDD 48 DMS Identifier Objects

A reminder that the DMS Item Names include references to AS-07 but are understood to represent RDD 48.

AS_07_DMS_Identifier Objects defines the unordered set of references that describe the file and part identifiers in an RDD 48 file. At least one AS_07_DMS_Identifier set shall be included in AS_07_Core_DMS with the IdentifierRole = Main. Other AS_07_DMS_Identifier sets are optional. AS_07_DMS_Identifier sets could also occur in other RDD 48 DMSes.

Item Name	**Type**	**Len**	**Local Tag**	**Item UL**	**Req?**	**Occurs**	***Meaning***
AS_07_DMS_Identifier	Set Key	16		060e2b34.027f0101.0d0e0101.07010300	Req	1	*Defines the AS_07_DMS_Identifier Set*
All items in SMPTE ST 377-1:2011 A.1 except the Key or Group UL and the Length, if present	*See SMPTE ST 377-1:2011 A.1*	*See SMPTE ST 377-1:2011 A.1*	*See SMPTE ST 377-1:2011 A.1*	*See SMPTE ST 377-1:2011 A.1*	*See SMPTE ST 377-1:2011 A.1*	*See SMPTE ST 377-1:2011 A.1*	
AS_07_DMS_IdentifierValue	UTF16String			060e2b34.01010101.0d0e0101.07010302	Req	1	*Identifier Value*
AS_07_DMS_IdentifierRole	UTF8String			060e2b34.01010101.0d0e0101.07010303	Req	1	*Controlled vocabulary string value identifying the role of identifier:* ***Main*** *(universally unique primary identifier for the entire RDD 48 file)* ***Additional*** *(additional, possibly local, identifier for the entire RDD 48 file. Additional identifiers are not required to be universally unique)* ***GSP*** *(universally unique identifier for GSP payload)*
AS_07_DMS_IdentifierType	UTF8String			060e2b34.01010101.0d0e0101.07010304	Req	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 330:2004, represented as a URN per ST 2029:2009;* ***UL*** *– Universal Label as defined by SMPTE ST 298:2009, represented as a URN per ST 2029:2009;* ***Other*** *–A value not included in the controlled list, including archive specific values.*
AS_07_DMS_IdentifierComment	UTF16String			060e2b34.01010101.0d0e0101.07010305	Opt	0 or 1	*Free text comment pertaining to the additional identifier*

Annex F. Data Dictionaries for RDD 48 Generic Stream Partition DMS, Binary Data DMS, and Text-based Data DMS

A reminder that the DMS Item Names include references to AS-07 but are understood to represent RDD 48.

F.1 Data Dictionary for RDD 48-Generic Stream Partition DMS Object

The scheme labeled AS_07_GSP_DMS defines the Additional GSP descriptive information for RDD 48.

Item Name	Type	Len	Local Tag	Item UL	Req?	Occurs	*Meaning*
AS_07_GSP_DMS_Object	GenericStreamTextBasedSet			060e2b34.027f0101.0d0e0101.07010400			*Additional GSP descriptive information for RDD 48*
All items in RP 2057 table 7 TextBasedObject	*DM_set*			*See RP 2057 table 7*			*Including TextBasedMetadataPayloadSchemeID, TextMIMEMediaType, RFC5646TextanguageCode, TextDataDescription*
All items in RP 2057 table 9 GenericStreamTextBasedSet	*TextBased Object*			*See RP 2057 table 9*			*Including GenericStreamSID*
AS_07_GSP_DMS_Identifiers	Batch of StrongRef (AS_07_DMS_Identifier objects)	8+ 16n		060e2b34.01010101.0d0e0101.07010401	Req	1 and n	*Unordered list of strong references to all AS_07_DMS_Identifier sets. At least one AS_07_DMS_Identifier Objects set shall be included with the IdentifierRole = Main. Other AS_07_DMSIdentifierObjects sets are optional*
AS_07_GSP_DMS_MIMEMediaType	UTF16String	Var	Dyn	060e2b34.01010101.0d0e0101.07010402	Req	1	*Text string that defines the data type of the media.* *IANA MIME type is to be used if one has been established. If no IANA MIME type has been established, implementers are to register a new MIME type with IANA (http://www.iana.org/form/media-types), following procedures also described in RFC 6838) and use that MIME type, or use a zero-length string as the value.*
AS_07_GSP_DMS_DataDescription	UTF8String	Var	Dyn	060e2b34.01010101.0d0e0101.07010403	Req	1	*A controlled vocabulary string identifying the role of the data within the RDD 48 file:* • *Graphic/image* • *RelatedDocument* • *SupplementaryMetadata* • *AssociatedMaterial* • *Trailer/preview*

							• *QualityControl/reviewData* • *Other (explain in AS_07_GSP_DMS_Note)*
AS_07_GSP_DMS_Note	UTF16String		Var	060e2b34.01010101.0d0e0101.07010404	Opt	0	*A free text note pertaining to the GSP data payload.*

F.2 Data Dictionary for RDD 48-Generic Stream Partition DMS

The scheme labeled *AS_07_GSP_DMS* defines the superclass metadata scheme for data stored in Generic Stream Partitions in RDD 48 files (section 6.6 provides more information). This scheme is further defined (as subclasses) for binary-data items and text-based-data items in appendixes F.3 and F.4 below.

Item Name	**Type**	**Len**	**Local Tag**	**Item UL**	**Req?**	**Occurs**	***Meaning***
AS_07_GSP_DMS	TextBased Framework	16		060e2b34.04010101.0d010701.07020100			*Required Metadata Scheme for data stored in Generic Stream Partitions in RDD 48 files*
All items in RP 2057 table 6 TextBased DM Framework	*DM_Framework*			*See RP 2057 table 6*			*Including TextBasedSet strong reference.* *The "Text-based Object" property of the table 6 is to be a Strong Ref of Instance UID of the instance of a "AS_07_GSP_DMS_Object" Object.*

F.3 Data Dictionary for RDD 48 GSP Binary Data Descriptive Metadata Framework

The framework labeled *AS_07_GSP_BD_DMS* defines the metadata for non-essence binary data stored in Generic Stream Partitions in RDD 48 files (section 6.6 provides more information).

Item Name	**Type**	**Len**	**Local Tag**	**Item UL**	**Req?**	**Occurs**	***Meaning***
AS_07_GSP_BD_DMS_Framework	DM_Framework	16		060e2b34.027f0101.0d0e0101.07020200			*Binary Data GSP Object Group*
All items in Annex F.2	*See Annex F.2*		*See Appen-dix F.2*	*See Appen-dix C.1*	*See Ap-pen-dix F.2*		*See Annex F.2*
No added elements in this edition of RDD 48; reserved for future use.							

F.4 Data Dictionary for RDD 48 GSP Text-based Data Descriptive Metadata Framework

The framework labeled *AS_07_GSP_TD_DMS* defines the metadata for non-essence text-based data stored in Generic Stream Partitions in RDD 48 files (section 6.6 provides more information).

Item Name	Type	Len	Local Tag	Item UL	Req ?	Occurs	*Meaning*
AS_07_GSP_TD_DMS_Framework	DM_Framework	16		060e2b34.027f0101.0d0e0101.07020300			*Text Data GSP Object Group*
All items in Annex F.2	*See Annex F.2*		*See Appendix F.2*	*See Annex F.2*	*See Appendix F.2*		*See Annex F.2*
AS_07_GSP_TD_DMS_PrimaryRFC5646LanguageCode	UTF16String	Var	Dyn	060e2b34.010101.0d0e0101.07020301	Req	1	*Identifies the primary language in Timed Text by codes defined by RFC5646.*
AS_07_GSP_TD_DMS_SecondaryRFC5646LanguageCode	UTF16String	Var	Dyn	060e2b34.010101.0d0e0101.07020302	Opt	0 or 1	*Identifies the secondary language in Timed Text by codes defined by RFC 5646. 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.*

Annex G. Data Dictionaries for Segmentation DMS and Parts Objects

A reminder that the DMS Item Names include references to AS-07 but are understood to represent RDD 48.

G.1 Data Dictionary for Segmentation DMS

The scheme labeled *AS_07_Segmentation_DMS* defines the metadata scheme for RDD 48 files that segment essence data (section 6.6 provides more information).

Item Name	Type	Len	Local Tag	Item UL	Req?	Occurs	*Description*
AS_07_Segmentation_DMS	DM_Scheme			060e2b34.04010101.0d010701.07030000			*Required Metadata Scheme for RDD 48 files that segment essence data*
AS_07_Segmentation_DMS_Framework	DM_Framework			060e2b34.027f0101.0d0e0101.07030100			*Metadata for RDD 48 files that segment essence data*

G.2 Data Dictionary for RDD 48 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			060e2b34.01010101.0d0e0101.07030101	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			060e2b34.01010101.0d0e0101.07030102	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.*

Annex H. RDD 48 Manifest XML Schema

A reminder that the Manifest XML schema includes references to AS-07 in the target namespace but are understood to represent RDD 48.

```
<?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) -
->
<!-- RDD 48 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:IdType"/>
			<xs:element name="FileIDType" type="mft:IdTypeType"/>
			<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="PartIDType" type="mft:IdTypeType"/>
			<xs:element name="DataDescription" type="mft:DataDescription"/>
			<xs:element name="MimeType" type="xs:string"/>
			<xs:element name="Size" type="xs:nonNegativeInteger"/>
			<xs:element name="Location" type="xs:anyURI" minOccurs="0"/>
			<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>
	<!-- IdTypeType -->
	<xs:simpleType name="IdTypeType">
		<xs:restriction base="xs:string">
			<xs:enumeration value="UUID"/>
			<xs:enumeration value="UMID"/>
			<xs:enumeration value="UL"/>
			<xs:enumeration value="Other"/>
		</xs:restriction>
	</xs:simpleType>
	<!-- 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}"/>
		</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="graphic/image"/>
			<xs:enumeration value="related document"/>
			<xs:enumeration value="associated material"/>
			<xs:enumeration value="supplementary metadata"/>
			<xs:enumeration value="trailer/preview"/>
			<xs:enumeration value="quality control/review data"/>
			<xs:enumeration value="other"/>
		</xs:restriction>
	</xs:simpleType>
	<xs:element name="Manifest" type="mft:ManifestType"/>
</xs:schema>
```

Annex I. Cryptographic Structures

This annex details the RDD 48 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 RDD 48-Cryptographic Framework

Item Name	**Type**	**Len**	**Item UL**	**Rec**	**Meaning**	***Compare to SMPTE ST 429-6:2006 (informative)***
CryptographicFrameworkKey	Set Key	16	*See SMPTE ST 429-6:2006 table 3*	Req	Defines the Cryptographic Framework Set	*No change*
Length	BER Length	var	*See SMPTE ST 429-6:2006 table 3*	Req	Set length	*No change*
InstanceID	UUID	16	*See SMPTE ST 429-6:2006 table 3*	Req	Unique identifier for the framework.	*No change*
GenerationUID	UUID	16	*See SMPTE ST 429-6:2006 table 3*	Opt	Optional Generation Identifier	*No change*
ContextSR	Strong Ref	16	*See SMPTE ST 429-6:2006 table 3*	Req	Strong reference to the associate Cryptographic Context Set	*No change*

I.2 RDD 48-Cryptographic Context Set

Item Name	**Type**	**Len**	**Item UL**	**Rec**	**Meaning**	***Compare to SMPTE ST 429-6:2006 (informative)***
CryptographicContextKey	Set Key	16	*See SMPTE ST 429-*	Req	Defines the Cryptographic Context Set	*No change*

			6:2006 table 5			
Length	BER Length	var		Req	Set length	*No change*
InstanceID	UUID	16	*See SMPTE ST 429-6:2006 table 5*	Req	Unique identifier for the context used by Cryptographic Framework to refer to the Context.	*No change*
GenerationUID	UUID	16	*See SMPTE ST 429-6:2006 table 5*	Opt	Optional Generation Identifier	*No change*
Context ID	UUID	16	*See SMPTE ST 429-6:2006 table 5*	Req	Unique identifier used by Encrypted Triplets to refer to the Context.	*No change*
SourceEssenceContainerLabel	UL	16	*See SMPTE ST 429-6:2006 table 5*	Req	Essence Container Label for the source essence, prior to encryption	*No change*
CipherAlgorithm	UL or zero	16	*See SMPTE ST 429-6:2006 table 5*	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	*See SMPTE ST 429-6:2006 table 5*	Req	Algorithm used for Triplet integrity, if any.	*MICAlgorithm_CRC32C urn:smpte:ul: 060e2b34. 04010101. 0d0e0101. 07040201*
CryptographicKeyID	UUID	16	*See SMPTE ST 429-6:2006 table 5*	Req	Unique identifier for the cryptographic key.	*Use a Zero value*
MICCarriage	UL	16	*060e2b34. 04010101. 0d0e0101. 07040300*	Opt	Informs decoder where to find MIC value	*Added item for RDD 48.* *Value = SystemItem 060e2b34. 01010101. 0d0e0101. 07040101 indicates RDD 48 usage; absent Value indicates use of Encrypted Triplets*

Annex J. RDD 48 Baseband Shim: Single Items from Baseband Video

RDD 48 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). RDD 48 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*	*RDD 48 constraint*	*RDD 48 values*	*Baseband shim constraint*	*Baseband shim values*
Essence Partitions (6.2.3.3)						
Essence Partition Strategy	Defines whether the essence is a single partition or divided into multiple partitions.	essence_partition_strategy	Strong	Single Multiple	Strong	Single Multiple
Index Tables (6.2.5.2)						
Single index location	If all Index Table Segments that compose one Complete Index Table are in one Partition, value shall be TRUE. Else (multiple Partitions), value shall be False.	single_index_location	Moderate	True False	Moderate	False
Single essence location	If all Essence Containers are in one Partition, the value shall be TRUE. Else, (Essence Container Segments in multiple Partitions), value shall be FALSE.	single_essence_location	Moderate	True False	Moderate	False
Forward index direction	If all Index Table Segments that compose one Complete Index Table precede Essence Container Segments that they index, value shall be TRUE. Else (Index Table Segments follow Essence Container Segments), value shall be FALSE.	forward_index_direction	Moderate	True False	Moderate	True
CBE Index Tables	Use of Index Tables for CBE essences that omit the Index Entry Array (SMPTE ST 377-1:2011, section 11.1.9).	cbe_index_table	Moderate	Mandated, Forbidden, Encouraged, Permitted	Moderate	Permitted
VBE Index Tables	Use of Index Tables for VBE essences that employ partial or sparse tables (SMPTE ST 377-1:2011, section 11.3).	vbe_index_tables	Moderate	Mandated, Forbidden, Encouraged, Permitted	Moderate	Permitted

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Baseband shim constraint*	*Baseband shim values*
Picture Essence – JPEG 2000 Compressed (6.2.10.2.4)						
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) Conform to ISO/IEC 15444-1:2004/Amd 8:2015; Profiles for an interoperable master format IMF	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).
Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor	Strong	Any of: CDCIDescriptor RGBADescriptor
Picture format (CDCI)	If Descriptor is CDCI, picture raster, aspect ratio, and frame rate	picture_format_CDCI	Moderate	If CDCI Descriptor, any picture format permitted by ST 352:2013. Other specialized rasters might be added in future editions of RDD 48.	Moderate	If CDCI Descriptor, subset of SMPTE ST 352:2013: any of: 486i 4:3 or 16:9 (30 or 29.97 Hz fps) 486p 4:3 or 16:9 (60, 59.94, 30, 29.97, 24, or 23.98 Hz fps) 576i 4:3 or 16:9 (25 Hz fps) 576p 4:3 or 16:9 (50 or 25 Hz fps) 720p (60, 59.94, 50, 30, 29.97, 25, 24, or 23.98 Hz fps) 1080i (30, 29.97, 25 Hz fps) 1080p (60, 59.94, 50, 30, 29.97, 25, 24, or 23.98 Hz fps) Other specialized rasters might be added in future editions of RDD 48.

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Baseband shim constraint*	*Baseband shim values*
Permitted component depth (CDCI)	if Descriptor is CDCI, *Component Depth* types that may be present in the file	permitted_component_depth_CDCI	Moderate	If CDCI Descriptor: Any permitted by SMPTE ST 377-1:2011, sections F.4.2 and G.2.26.	Strong	8, 10, 12, 16
Permitted J2CLayout (CDCI)	if Descriptor is CDCI, *PixelLayout* types that may be present in the file, with J2CLayout subdescriptor	permitted_J2C_layout_CDCI	Moderate	If CDCI Descriptor, any permitted by SMPTE ST 422:2014 Shall not be present.	Strong	If CDCI Descriptor, subset of SMPTE ST 422:2014: any of { 'Y', 8, 'U', 8, 'V', 8, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'Y', 10, 'U', 10, 'V', 10, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'Y', 12, 'U', 12, 'V', 12, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'Y', 16, 'U', 16, 'V', 16, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 }
Picture format (RGBA)	if Descriptor is RGBA, picture raster, aspect ratio, and frame rate	picture_format_RGBA	Moderate	If RGBA Descriptor, any picture format permitted by ST 352:2013. Other specialized rasters might be added in future editions of RDD 48.	Moderate	If RGBA Descriptor, subset of SMPTE ST 352:2013: any of: 486i 4:3 or 16:9 (30 or 29.97 Hz fps) 486p 4:3 or 16:9 (60, 59.94, 30, 29.97, 24, or 23.98 Hz fps) 576i 4:3 or 16:9 (25 Hz fps) 576p 4:3 or 16:9 (50 or 25 Hz fps) 720p (60, 59.94, 50, 30, 29.97, 25, 24, or 23.98 Hz fps) 1080i (30, 29.97, 25 Hz fps) 1080p (60, 59.94, 50, 30, 29.97, 25, 24, or 23.98 Hz fps) Other specialized rasters might be added in future editions of RDD 48.

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Baseband shim constraint*	*Baseband shim values*
Permitted pixel layout (RGBA)	if Descriptor is RGBA, *PixelLayout* types that may be present in the file	permitted_pixel_layout_RGBA	Moderate	If RGBA Descriptor, any permitted in SMPTE 377-1:2011.	Moderate	If RGBA Descriptor, value subset from SMPTE 377-1:2011; any of { 'R', 8, 'G', 8, 'B', 8, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'R', 10, 'G', 10, 'B', 10, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'R', 12, 'G', 12, 'B', 12, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'R', 16, 'G', 16, 'B', 16, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'R', 8, 'G', 8, 'B', 8, A, 8, 0, 0, 0, 0, 0, 0, 0, 0 } { 'R', 10, 'G', 10, 'B', 10, A, 10, 0, 0, 0, 0, 0, 0, 0, 0 } { 'R', 12, 'G', 12, 'B', 12, A, 12, 0, 0, 0, 0, 0, 0, 0, 0 } { 'R', 16, 'G', 16, 'B', 16, A, 16, 0, 0, 0, 0, 0, 0, 0, 0 }
Permitted J2C layout (RGBA)	if Descriptor is RGBA, *J2CLayout* types that may be present in the file, with J2CLayout subdescriptor	permitted_J2C_layout_RGBA	Moderate	If RGBA Descriptor, any permitted by SMPTE ST 422:2014 Shall not be present.	Strong	If RGBA Descriptor, subset from SMPTE ST 422:2014; any of { 'Y', 8, 'U', 8, 'V', 8, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'Y', 10, 'U', 10, 'V', 10, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'Y', 12, 'U', 12, 'V', 12, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'Y', 16, 'U', 16, 'V', 16, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'R', 8, 'G', 8, 'B', 8, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 }

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Baseband shim constraint*	*Baseband shim values*
						{ 'R', 10, 'G', 10, 'B', 10, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'R', 12, 'G', 12, 'B', 12, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'R', 16, 'G', 16, 'B', 16, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'R', 8, 'G', 8, 'B', 8, A, 8, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'R', 10, 'G', 10, 'B', 10, A, 10, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'R', 12, 'G', 12, 'B', 12, A, 12, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 } { 'R', 16, 'G', 16, 'B', 16, A, 16, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 }
Picture bitrate	Maximum bits per second in real time	picture_bitrate	Gentle	SD 360 Mbps HD 1.5 Gbps Will expand in future	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 YUV12 YUV16 RGB8 RGB10 RGB12 RGB16
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 (6.2.10.3.4)						
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 377-1:2011, annex G.2.25.	Gentle	Uncompressed carried in a SMPTE ST 384-compliant GC Element, using bitstream codings as specified in SMPTE ST 377-1:2011, annex G.2.25.
Permitted descriptors	*Essence Descriptors* that may be present in the file	permitted_essence_descriptors	Moderate	Any of CDCIDescriptor RGBADescriptor	Moderate	Any of CDCIDescriptor RGBADescriptor
Picture format (CDCI)	If Descriptor is CDCI, picture raster, aspect ratio, and frame rate	picture_format_CDCI	Moderate	If CDCI Descriptor, any picture format permitted by ST 352:2013.	Moderate	If CDCI Descriptor, subset of SMPTE ST 352:2013: any of:

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Baseband shim constraint*	*Baseband shim values*
				Other specialized rasters might be added in future editions of RDD 48.		486i 4:3 or 16:9 (30 or 29.97 Hz fps) 486p 4:3 or 16:9 (60, 59.94, 30, 29.97, 24, or 23.98 Hz fps) 576i 4:3 or 16:9 (25 Hz fps) 576p 4:3 or 16:9 (50 or 25 Hz fps) 720p (60, 59.94, 50, 30, 29.97, 25, 24, or 23.98 Hz fps) 1080i (30, 29.97, 25 Hz fps) 1080p (60, 59.94, 50, 30, 29.97, 25, 24, or 23.98 Hz fps) Other specialized rasters might be added in future editions of RDD 48.
Permitted component depth (CDCI)	if Descriptor is CDCI, *Component Depth* types that may be present in the file	permitted_component_depth_CDCI	Moderate	If CDCI Descriptor: Any permitted by SMPTE ST 377-1:2011, sections F.4.2 and G.2.26.	Strong	If CDCI Descriptor: 8, 10, 12, 16
Permitted J2C layout (CDCI)	if Descriptor is CDCI, *J2CLayout* types that may be present in the file, if the Descriptor is CDCI	permitted_J2C_layout_CDCI	Moderate	Shall not be present.	Strong	Shall not be present
Picture format (RGBA)	If Descriptor is RGBA, picture raster, aspect ratio, and frame rate	picture_format_RGBA	Moderate	If RGBA Descriptor, any picture format permitted by ST 352:2013. Other specialized rasters might be added in future editions of RDD 48.	Moderate	If RGBA Descriptor, any of: 486i 4:3 or 16:9 (30 or 29.97 Hz fps) 486p 4:3 or 16:9 (60, 59.94, 30, 29.97, 24, or 23.98 Hz fps) 576i 4:3 or 16:9 (25 Hz fps) 576p 4:3 or 16:9 (50 or 25 Hz fps) 720p (60, 59.94, 50, 30, 29.97, 25, 24, or 23.98 Hz fps)

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Baseband shim constraint*	*Baseband shim values*
						1080i (30, 29.97, 25 Hz fps) 1080p (60, 59.94, 50, 30, 29.97, 25, 24, or 23.98 Hz fps) Other specialized rasters might be added in future editions of RDD 48.
Permitted pixel layout (RGBA)	*PixelLayout* types that may be present in the file, if the Descriptor is RGBA	permitted_pixel_layout_RGBA	Moderate	If RGBA Descriptor, any permitted by SMPTE ST 384:2005, SMPTE 377-1:2011, sections F.4.3 and G.2.36.	Moderate	If RGBA Descriptor, any permitted by SMPTE ST 384:2005, SMPTE 377-1:2011, sections F.4.3 and G.2.36.
Permitted J2C layout (RGBA)	*J2CLayout* types that may be present in the file, if the Descriptor is RGBA	permitted_J2C_layout_RGBA	Moderate	Shall not be present.	Strong	Shall not be present
Picture bitrate	Maximum bits per second in real time	picture_bitrate	Gentle	SD 360 Mbps HD 1.5 Gbps Will expand in future	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	Strong	Any of YUV8 YUV10 YUV12 YUV16 RGB8 RGB10 RGB12 RGB16
Permitted ITU-R format standards	ITU-R formats that may be present in the file, or an equivalent format if fully specified in a shim	permitted_ITU-R_formats	Gentle	BT.601 (SD) BT.709 (HD) BT.2020 (UHDTV) Specified by a shim Will expand in future	Gentle	BT.601 (SD) BT.709 (HD)
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.	Moderate	Any frame-wrapped container permitted by SMPTE ST 384:2005.
Picture Essence – Retain Source Encoding as Acquired (6.2.10.4.5)						
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

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Baseband shim constraint*	*Baseband shim values*
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
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 385:2012 SMPTE ST 386:2004 SMPTE ST 387:2004 SMPTE ST 422:2014 SMPTE ST 2019-1:2009 SMPTE ST 2037: 2009 SMPTE ST 381-3:2013 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 385:2012 SMPTE ST 386:2004 SMPTE ST 387:2004 SMPTE ST 422:2014 SMPTE ST 2019-1:2009 SMPTE ST 2037: 2009	Strong	Forbidden

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Baseband shim constraint*	*Baseband shim values*
				SMPTE ST 381-3:2013 Forbidden		

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 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 (6.2.12.9)						
Caption	Carriage of ANSI/CTA-608-E (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	ANSI/CTA-608-E (CEA-608) in SMPTE ST 436-1:2013 ANSI/CTA-708-E (CEA-708) in SMPTE ST 436-1:2013	Strong	ANSI/CTA-608-E (CEA-608) in SMPTE ST 436-1:2013 ANSI/CTA-708-E (CEA-708) in SMPTE ST 436-1:2013

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Baseband shim constraint*	*Baseband 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	Strong	Mandated
SMPTE or EBU Timed Text	Carriage of SMPTE or EBU Timed Text (when converted from ANSI/CTA-608-E (CEA-608), ANSI/CTA-708-E (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
VBI and ANC (6.2.13.3)						
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 436-1:2013] [Any, all]	Strong	[List from SMPTE ST 436-1:2013] [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 436-1:2013] [Any, all]
AFD and Pan-Scan (6.2.14.3)						
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
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

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Baseband shim constraint*	*Baseband shim values*
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*
Intimate metadata	Metadata that is intimately associated with the essences and which shall 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)						

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Baseband shim constraint*	*Baseband shim values*
Top-level source package	Quantity of top-level source packages	tlsp_quantity	Strong	Single Multiple	Strong	Single Multiple
Descriptive Metadata Schemes (6.6.3)						
AS_07_GSP_BD_DMS non-essence binary data	Requirement to carry AS_07_GSP_BD_DMS for non-essence binary data in Generic Stream Partitions	AS_07_GSP_BD_DMS	Strong	Permitted*	Strong	Permitted*
AS_07_GSP_TD_DMS non-essence text-based data	Requirement to carry AS_07_GSP_TD_DMS for non-essence 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 non-essence binary data is carried in a Generic Stream Partition, otherwise permitted. ** Mandated when non-essence text-based data is carried in a Generic Stream Partition, otherwise permitted. *** Mandated when segmented essences are carried in an RDD 48 file, otherwise permitted.						
Manifest (6.7.1.7)						
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
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)						

Dimension	*Description: what may be constrained*	*Shim parameter*	*RDD 48 constraint*	*RDD 48 values*	*Baseband shim constraint*	*Baseband shim values*
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