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FADGI Application Specification
AS-AP MXF Archive and Preservation
August 15, 2011 (rev 1h)

Document Status

This document-in-progress is being drafted by the Audio-Visual Working Group of the Federal Agencies Digitization Guidelines Initiative (FADGI; http://www.digitizationguidelines.gov/audio-visual/). The Working Group will transmit a refined version of this MXF Application Specification for Archive and Preservation (AS-AP) for finalization and publication by the Advanced Media Workflow Association (AMWA). Finalization will also depend upon the resolution of some technical matters that are dependencies for this specification. These dependencies are highlighted in the explanatory notes within this specification and in the accompanying document *Preservation Video File Format Issues and Considerations* (http://www.digitizationguidelines.gov/audio-visual/documents/FADGI_MXF_ASAP_Issues_20110815.pdf).

This document has been drafted in the style of other AMWA application specifications (http://www.amwa.tv/projects/application_specifications.shtml), has borrowed a number of features from AS-03, and refers to AS-02. Since AS-02 has not been published at this writing, this document (especially Annex B) includes wording copied from draft versions of that specification.

Executive Summary

This document describes a vendor-neutral subset of the MXF file format to use for long-term archiving and preservation of moving image content and associated materials including audio, captions and metadata. Archive and Preservation and files (AS-AP files) may contain a single item, or an entire series of items. Various configurations of sets of AS-AP files are discussed in the Overview.

AS-AP files are intended to be used in combination with external finding aids or catalog records. At the same time, AS-AP files may stand alone, and thus also contain baseline catalog records that could be used to regenerate external finding aids when needed.

Contents

1   Scope

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

Archive and Preservation and files (AS-AP files) may contain a single item, or an entire series of items.

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

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

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.

AS-AP MXF Archive and Preservation

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 language; then figures; and then any other language forms.

3   Reference Documents

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

AMWA AS-02 MXF Versioning
AMWA AS-03 MXF Program Delivery
AMWA AS-04 Language Tagging
AMWA AS-xx Content Integrity

SMPTE ST 337:2008 through ST 340:2008 Format for Non-PCM Audio
SMPTE ST 334-1- and -2-2007 – Vertical Ancillary Data Mapping for Bit-Serial Interface and Caption Distribution Packet (CDP) Definition
SMPTE ST 377-1:2009 – Material Exchange Format (MXF) File Format Specification
SMPTE ST 378:2004 – (Archived 2010) MXF Operational Pattern OP1a
SMPTE ST 379-1:2010 and -2:2010 – MXF Generic Container and MXF Constrained Generic Container
SMPTE ST 381-1:2005 (Archived 2011) – Mapping MPEG streams into the MXF Generic Container (Dynamic)
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 392:2004 – MXF Operational Pattern OP2a
SMPTE EG42:2004 – MXF Descriptive Metadata
SMPTE ST 410:2008 – MXF Generic Stream Partition
SMPTE ST 422:2006 – Mapping of JPEG 200 Codestreams into the MXF Generic Container
SMPTE ST 429-6:2006 – D-Cinema Packaging – MXF Track File Essence Encryption
SMPTE ST 436:2006 – MXF Mappings for VBI, and ANCillary Data Packets
SMPTE ST 2016-1:2007 – Active Format Description (AFD) [Do we want to cite "-1"? And also "-2" thru "-5"?]

CEA 608E – Closed Captioning Data on line 21
CEA 708E – DTV Closed Captioning
ISO 13818 – MPEG-2
ISO 15444-1 – JPEG 2000
ISO 15444-1 amd 4:2010 – Broadcast Profiles
ITU H.264 – Advanced Video Coding (a.k.a. ISO 14496-10 MPEG-4 part 10)
SCTE 35 – Splice Point Markers

4   Overview

4.1 Summary of File Format Configurations

Archive and Preservation and files (AS-AP files) may contain a single item, or an entire series of items.

AS-AP files may include one or several renditions of the items. Different renditions may arise from different original sources of the item; different renditions may also be created from multiple encodings of the original

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source using different image compression or encoding schemes. AS-AP files are not intended for direct online access, however they may include renditions intended for viewing without further processing.

AS-AP files may be grouped together into "bundles" in which individual files contain single items, and the bundle represents an entire series or a collection of items. File bundles may also include metadata-only files for preservation of metadata records pertaining to the series or collection.

AS-AP files are intended to be used in combination with external finding aids or catalog records. The external finding aids are used for day to day access to the archive collection.

At the same time, AS-AP files must stand alone, so they would retain their value even if they were the only extant copy of an item.

The metadata in AS-AP files is a representation of the metadata records as they 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. This could be used to regenerate external finding aids or catalog records when needed.

4.2 General AS-AP and Shims

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

General provisions apply to all AS-AP files and thus represent the maximum required capability of the Archive and Preservation format.

Each shim provides a further set of constraints that reduce the range of variability that may be needed in well-defined categories of applications. These categories may address particular types of sources (such as films, analog videotapes, born-digital media), or they may address requirements of particular archive collections and uses (which may, for instance, dictate specific encoding formats or specific metadata).

4.3 Use-cases for Shims

The purpose of a Shim is to describe the content that may be present in a particular variant of AS-AP 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
- To guide quality assurance equipment that is used to verify input submissions
- To guide cataloguers (both archivists and automated scanners) as to what metadata to expect in examining an input submission.

4.4 Derivation of Shims

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

Shims may directly constrain the general provisions, or they may add further constraints to other less specialized shims.

For example, within the general AS-AP there might be a Shim that describes preservation of analog videotape and dictates the use of an uncompressed or J2K-lossless-compressed picture essence together with the provision of metadata for signal quality metrics.

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 can not relax constraints or provide alternative parameters.

4.5 Combinations of Shims

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

For example, within the general AS-AP there might be a Shim that describes preservation of film sources. This might dictate the use of uncompressed image sampling and the provision of metadata for spatial parameters, illumination and color grading. A second Shim might be declared for an archive that could contain items derived from videotape and items derived from film.

5   Parameters and Constraints

Each provision within the general specification and within each individual shim is categorized as one of the following:
- Unconstrained - everything permitted by SMPTE 377 MXF
- Gently constrained - a range of values (for example, bit rates) or choices (for example, DMS or Essence types) is stated by the general AS-03, that individual shims may further restrict
- Strongly constrained - a set of values or choices is listed that individual shims must choose between
- Most constrained - a single choice or parameter value that all AS-AP applications will use identically

Shims always express stronger constraints than the general specifications from which they are derived.

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).

5.1 Essence Track Parameters and Constraints

Each provision within the general specification and within each individual shim is categorized as one of the following: (a) Unconstrained - everything permitted by SMPTE 377-1:2009; (b) Gently constrained - a range of values (for example, bit rates) or choices (for example, DMS or Essence types) is stated by the general AS-AP, that individual shims may further restrict; (c) Strongly constrained - a set of values or choices is listed that individual shims must choose between; (d) Most constrained - a single choice or parameter value that all AS-AP applications will use identically. Shims always express stronger constraints than the general specification.

5.1.1 General

AS-AP files shall contain a single program consisting of moving image content ("video"), audio services, associated essences (still images, scripts, etc.), metadata (other than DMS), closed captioning and other ancillary data.

> *Additional or explanatory comment (temporary to draft versions of this AS):* If a multi-program Transport Stream is received by an organization, the presumption is that each program in the Transport Stream will be converted to another encoding (e.g., uncompressed video or JPEG 2000 frame images) and each of these converted programs will assume the role of primary essence in their own MXF file. Organizations may choose to retain the original Transport Stream as an associated essence. The Manifest (5.5.1) will list everything in a given file.

5.1.2 Interleaving

Essence in each Generic Container in AS-AP Files may be interleaved or non-interleaved frame-by-frame. Essence may be framewrapped or clipwrapped, except where custom wrapping is explicitly required by the shim. Interleaving and wrapping shall be declared in KLV metadata keys as part of the essence container syntax. Note that interlaced video carried as JPEG 2000 frame images shall conform to the requirements in section 5.1.6 (Video).

> *Additional or explanatory comment (temporary to draft versions of this AS):* Most if not all primary AS-AP essence (e.g., a digitized videotape) will be interleaved (i.e. multiplexed video/audio/captions). Associated essence (e.g., still images) will probably not be interleaved; for example, a number of stills might be appended to a file, after the primary essence is done, and these would not be interleaved. Interleaving normally implies framewrapping, and interleaving with clipwrapping would only apply to

imported essence like MPEG TS or DV DIF, so is uncommon (and DV DIF is usually represented in a different way: "compound items"). A possible future shim for slide shows with narration would probably not be interleaved, with the audio clipwrapped.

5.1.3 Partitions

Essence in AS-AP Files may optionally be divided into Partitions. If Partitions are employed, the recommended practice is that new Partitions shall be started at the following intervals: each 1 second, 10 seconds, or 1 minute of program time. Additionally, Partitions, if used, shall not be longer than 10 minutes of program time, and new Partitions may be started to meet this requirement.

5.1.4 Generic Stream Partitions

Generic Stream Partitions (SMPTE 410-2008), structured as Text-based Metadata (SMPTE RP 2057:2011), may be used to contain specific classes of data streams, e.g., data streams are either (a) essence that is unevenly distributed along the timeline (or unrelated to the timeline, e.g., still images, documents, scripts) or (b) extensive blocks of metadata that cannot suitably be stored as Header Metadata.

> *Additional or explanatory comment (temporary to draft versions of this AS):* The essences identified as (a) are associated materials that related to the "main content" in one or more of the video or audio essences while the extensive blocks of metadata identified as (b) will include such examples as library bibliographic records, extracts from archival finding aids, and specialized technical and/or preservation metadata. (AS-AP files may also contain "non-text-stream associated essences," as mentioned in the explanatory note to 5.1.2 above, in 5.2.1 below, and elsewhere in this specification.)

> The SMPTE recommended practice RP 2057:2011, *Text-Based Metadata Carriage in MXF*, defines how to carry text-based metadata with a specified text MIME type encoded using either Unicode UTF-8 or UTF-16 character encoding (such as XML) in a MXF file. One of the two methods of text-based metadata carriage in the recommendation concerns the carriage of text-based metadata using the MXF Generic Stream Partition defined in SMPTE ST 410. RP 2057:2011 specifies the Generic Stream Partition Pack for several text-based metadata formats including the KLV coding of the Generic Stream Data Element and DM Schemes.

> For additional discussion of metadata and AS-AP, see "Preservation Video File Format Issues and Considerations" (http://www.digitizationguidelines.gov/audio-visual/documents/FADGI_MXF_ASAP_Issues_20110815.pdf, pp. 10-11).

5.1.5 Index Tables

If AS-AP files use Partitions, then they shall also include full MXF Index Tables. The required combination of Index Tables will be defined for each Shim. If used, the full Index Tables shall index every Frame of every Track in the file. Segments of the full Index Table should be positioned in the Partition that immediately follows the Essence they index. The last segment of the full Index Table shall be placed in a Body Partition with no essence (the Footer Partition contains the sparse Index Table, when present). Encoders shall place all Segments of Index Tables in isolated Partitions, that is, Partitions that do not contain any Header Metadata or Essence. The zero position of the Index corresponds to the start of actual program including pre-charge. Therefore, the first IndexTableSegment shall indicate an IndexStartPosition equal to zero. Enumeration and description shall be in the Manifest (5.5.1).

> *Additional or explanatory comment (temporary to draft versions of this AS):* Generic stream partitions are generally not indexed. Associated essences may or may not need indexing, although they should always be enumerated and described ("as objects") in Packages in Header Metadata.

5.1.6 Video

Moving image content (video) may be uncompressed, lossless compressed, or lossy compressed. Uncompressed moving image content may be in any raster up to 8Kx8K, in any bit depth, color mode or space, and interlaced or progressive. All JPEG 2000 essences shall be carried in a SMPTE ST 422-compliant GC Element. Interlaced picture data in JPEG 2000 encodings shall be interleaved as field pairs, with the pair wrapped in one KLV unit and with field dominance labeled; except for lossless JPEG 2000 "legacy data" created prior to the publication of AS-AP and further described elsewhere in this document. See the explanatory note that follows for additional comments regarding the handling of interlaced picture data in JPEG 2000 frames.

If the input picture data includes AFD metadata per SMPTE 2016, then this shall be carried over and included in the MXF Picture Descriptor; if no AFD is present, it is an option for an MXF-file production system to add AFD to the MXF Picture Descriptor. The MXF Picture Descriptor is only used if AFD is constant throughout a picture element. In other case, AFD shall be carried frame-by-frame as required by SMPTE ST 436 (MXF Mappings for VBI Lines and Ancillary Data Packets). If required by a shim, primary text language shall be specified using AMWA AS-04, which embraces work in progress in SMPTE 31FS10 (Working Group on Multichannel Audio in MXF; IETF RFC 5646 is also an important reference).

Additional or explanatory comment (temporary to draft versions of this AS): The first shim to be drafted will focus on moving image content input to the MXF-file production system via SDI (SMPTE 259M), HD-SDI (292M), ED-SDI (344M), dual-link HD-SDI (372M), 3G-SDI (424M), or DVB-ASI (Digital Video Broadcasting Asynchronous Serial Interface, ETSI TR 101 891), all of these usually referred to as "video." Additional shims (not yet defined here) will focus on moving image content that results from film scanning or digital theatrical motion picture production. Pending the next drafting of this first ("video") shim, note that the following specifications will apply:

    (a) uncompressed picture information shall represent the serial stream as it is received by the MXF-file production device carried in a SMPTE 384M-compliant GC Element

    (b) lossless compressed picture information shall take the form of JPEG 2000 broadcast profiles 6 or 7 (ISO/IEC 15444-1:2004/Amd 3:2010), except for lossless JPEG 2000 "legacy data" created prior to the publication of AS-AP and further described elsewhere in this document

    (c) lossy compressed picture information in the JPEG 2000 format shall use profiles 1 through 5 (ISO/IEC 15444-1:2004/Amd 3:2010)

    (d) MPEG-compressed picture information shall be MPEG-2 MP or 422P, or H.264 (any profiles and levels), any GOP structure, at any bit rate, in compliance with ISO 13818-2 Elementary Streams and ISO/IEC 14496-10 Advanced Video Coding, with the video stream carried in a SMPTE 381M-2005-compliant MXF GC Element

    (e) other lossy compressed picture information is limited to encodings for which a SMPTE MXF GC Element has been published, and the picture data must be carried in such a GC Element.

At this writing, the handling and labeling of interlaced video is insufficiently governed by standards. There are a number of different ways to encode and label interlaced picture data in this context and, if different approaches are adopted by different production systems, and if the labeling is inadequate, there is a risk that files will not interoperate between systems. The underlying issue is not specifically about picture encoding but rather has to do with how an interlaced-picture stream is placed in an MXF file.

The most relevant standards document is SMPTE ST 422-2006 (Material Exchange Format - Mapping JPEG 2000 Codestreams into the MXF Generic Container), originally drafted to support the standardization of the digital cinema specification. Since digital cinema consists of progressively scanned images, ST 422 does not include recommendations for the handling of interlaced picture data. The writers of this Application Specification understand that SMPTE plans to revise ST 422 to address this matter during 2011 and 2012. This action by SMPTE is a dependency for AS-AP; pending action by SMPTE, we have inserted provisional interlacing language in this section (5.1.6). For additional discussion of this topic, see "Preservation Video File Format Issues and Considerations" (http://www.digitizationguidelines.gov/audio-visual/documents/FADGI_MXF_ASAP_Issues_20110815.pdf, pp. 4-6).

5.1.7 Audio

Audio shall be PCM pairs, 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 can have any values up to 192kHz at 24 bit word length. Each PCM track (mono or stereo pair) shall be carried in a SMPTE 382M-2007-compliant MXF GC Element within a BWF Container (not AIFF container). AC-3 and Dolby E tracks shall be carried within a SMPTE 337/338/339/340 container in a SMPTE 382M-2007-compliant MXF GC Element. This audio data shall be interleaved, non-interleaved, framewrapped, or clipwrapped to permit synchronization with the picture information it accompanies, except where custom wrapped data is explicitly required by the shim. NICAM audio shall be clipwrapped. If the input to the MXF-file production system includes DialNorm metadata, this DialNorm data shall be included in the MXF Sound Descriptor. Audio language and purpose shall be specified using

AMWA AS-04, which embraces work in progress in SMPTE 31FS10 (Working Group on Multichannel Audio in MXF; IETF RFC 5646 is also an important reference).

5.1.8 Closed Captioning, other VBI, and other ancillary data (ANC)

Explanatory comment (temporary to draft versions of this AS): This is a placeholder statement. The final AS may document three or more options for the placement of Closed Captioning and other VBI data carried over from a source video recording, to be placed in an AS-AP MXF file. One or more of these options may apply as well for related entities like motion picture subtitles.

(a) Using established practices for US-standard video, echo the wording found in AS-03:
If present, CEA 608 line 21 (CC and XDS) data shall be carried in a SMPTE ST 334-1:2007-and-ST 334-2:2007-compliant ANC packet within a SMPTE ST 436:2006-compliant VBI/ANC GC Element, using 8 bit encoding. If present, CEA 708B DTV captioning data shall be carried in a SMPTE 334-1:2007-and-ST 334-2:2007-compliant ANC packet within a SMPTE ST 436:2006-compliant VBI/ANC GC Element, using 8 bit encoding. Caption language shall be specified using AMWA AS-04.

(b) Emerging practice that should accommodate both US and European formats, i.e., employ the structures being standardized in SMPTE-TT Timed Text standards (ST 2052-0:2010, ST 2052-1:2010, and RP 2052-10:2010). Members of this family are being published during 2010 and 2011.

(c) The final version of this AS will acknowledge but deprecate the current practice of creating sidecar files that contain VBI and related data. Examples include a pair of ad hoc file types: *vbi* files, readable in some video server systems, and *stl* files, a class of text-plus-timecode-plus-control-character format files. In addition, we have heard references to the use of *scc* Script Files from the Scenarist application and *srt* files from the SubRip program.

For CC and also for DMS and Generic Stream Partition metadata (see section 5.4 below), many archives will wish to extract this metadata for such purposes as loading-and-indexing in a organization's collection-management or discovery-support databases.

For additional discussion of this topic, see "Preservation Video File Format Issues and Considerations" (http://www.digitizationguidelines.gov/audio-visual/documents/FADGI_MXF_ASAP_Issues_20110815.pdf, pp. 1-3).

5.2 Operational Pattern Parameters and Constraints

5.2.1 Baseline Operational Patterns

AS-AP files shall comply with MXF Operational Pattern OP1a (SMPTE 378M), OP1b (SMPTE 391M), or OP2a (SMPTE 392M). AS-AP files shall be labeled as OP1a, OP1b, or OP2a files in the Operational Pattern property of all Partition packs and the Preface Set. AS-AP files shall also include a DMS-AS-AP Descriptive Metadata Set within the MXF Material Package that indicates which specific AS-AP shim applies to the file, as described in section 5.4.2 below.

Additional or explanatory comment (temporary to draft versions of this AS): The implementation of MXF operational patterns has become less rigid during the last few years. In addition, some patterns are widely supported while others are not. Even in this relaxed context, AS-AP will articulate relevant operational patterns in the main document and in the shims. Archiving and preservation files produced when reformatting videotapes will generally be simple in form, with a single picture essence and a single sound essence and, thus, OP1a. Files that include associated essences (e.g., still images, documents, transcriptions), the normal MXF categorization would be as multi-essence files in pattern OP-1b. This categorization would also be expected for files containing essences in a related series. Meanwhile, OP-2 patterns are normally applied to segmented essences, e.g., reels within a movie or clips that are cut together into a composite reel, although it is also common for such segmented units to be indicated by cut-list metadata (aka DMS-Segmentation). This entire topic is being influenced by the increasing importance of parallel efforts like the European Broadcasting Union Subtitling Data Exchange Format (EBU STL; http://tech.ebu.ch/docs/tech/tech3264.pdf).

For additional discussion of this topic, see "Preservation Video File Format Issues and Considerations" (http://www.digitizationguidelines.gov/audio-visual/documents/FADGI_MXF_ASAP_Issues_20110815.pdf, pp. 6-7).

5.2.2 Interleaving

Interleaving or non-interleaving of Essence in AS-AP Files shall be in accordance with the specifications for each Shim.

Additional or explanatory comment (temporary to draft versions of this AS): Most if not all primary AS-AP essences (e.g., a video stream from a reformatted videotape) will be interleaved, i.e., consisting of multiplexed video, audio, and vertical interval closed captions.   Interleaving usually implies framewrapping; interleaving with clipwrapping really only applies to imported essence like MPEG Transport Streams or (possibly) DV DIF, and so this is uncommon. Other essence types will vary:
(a) audio-only essence is often clipwrapped
(b) a slide show with narration would probably be non-interleaved with the audio clipwrapped and, in general, still picture essences will be frame-wrapped
(c) associated essences (e.g., still images, transcripts, etc.) will probably not be interleaved.

5.2.3 Partitions and Generic Stream Partitions

Partitioning or non-partitioning of Essence in AS-AP Files shall be in accordance with the specifications for each Shim. See also section 5.1.3 above.

5.2.4 Index Tables

Index Tables in AS-AP files, if used, shall be compliant with SMPTE ST 377-1:2009. AS-AP files may contain full index tables that index each frame of the essence, or sparse index tables that index the start of partitions, or both. The required combination of Index Tables is defined for each Shim. See also section 5.1.5 above.

5.2.5 Container

AS-AP Files shall use the MXF Generic Container SMPTE 379M-2004. The Number of Elements in each GC is defined for each Shim. JPEG 2000 broadcast-profile codestreams (ISO/IEC 15444-1:2004/Amd 3:2010) shall be carried in a SMPTE 422M-compliant GC Element. Interlaced picture data in JPEG 2000 encodings shall be interleaved as field pairs, with the pair wrapped in one KLV unit and with field dominance labeled; except for lossless JPEG 2000 "legacy data" created prior to the publication of AS-AP and further described elsewhere in this document.

Additional or explanatory comment (temporary to draft versions of this AS): See the explanatory discussion of interlaced picture data encoded as JPEG 2000 frames in section 5.1.6 above.

5.2.6 System Item

The GC System Item may be present but is not used by AS-AP Files.

5.2.7 Timecode Track

AS-AP Files may contain many types of timecode, and these shall be placed in the unified architecture offered by the MXF specification (SMPTE ST 377-1). The synthetic timecode is required, shall be provided in the Header Metadata (related to the Timecode Track), and shall be primary. The synthetic timecode shall be used be used for the canonical representation of references into the essence from descriptive metadata. Timecode mode (drop-frame or non-drop frame) may be specified in each Shim.

Additional or explanatory comment (temporary to draft versions of this AS): AS-AP Files may contain the following types of timecode:
(1) synthetic timecode is required and shall be provided in the Header Metadata
(2) LTC timecode that may be inherited from the source recording is to be retained if present
(3) VITC timecode that may be inherited from the source recording is to be retained if present
(4) SMPTE 12M timecode that records the actual studio time when the MXF file is being produced (optional)
(5) GCSys timecode
(6) ANC timecode
(7) timecode inside 334 CDP inside ANC

(8)   an additional expression of either synthetic timecode (1 above) or the 12M local-clock timecode (4 above) in the emergent (not yet published) SMPTE timecode format

(9)   for content reformatted from motion picture film, there may be keycode or edgecode.
For additional discussion of this topic, see "Preservation Video File Format Issues and Considerations" (http://www.digitizationguidelines.gov/audio-visual/documents/FADGI_MXF_ASAP_Issues_20110815.pdf, pp. 3-4).

5.2.8 Random Index Pack

AS-AP Files (when Closed and Complete) shall contain a Random Index Pack per SMPTE ST 377-1:2009.

5.2.9   KAG Size

AS-AP Files shall employ the default KLV Alignment Grid of 1 – see SMPTE ST 377-1:2009 at Key Alignment Grid.

5.3 Header Metadata Parameters and Constraints

Header Metadata shall be compliant with SMPTE ST 377-1:2009, and with SMPTE ST 378:2004 OP1a, ST 391:2004 OP1b, or SMPTE 392:2004 OP2a.

5.3.1 Material Packages

AS-AP files shall contain one Material Package.

5.3.2 File Packages

AS-AP files may contain one or multiple File Packages.

5.3.3 Lower Level Source Packages

If present, Lower-level Source Packages shall be compliant with SMPTE ST 377-1:2009.

5.3.4 MXF Tracks

Packages in AS-AP files shall contain exactly the number of MXF Tracks required to describe the Video, Audio, Ancillary and Descriptive Metadata Tracks (including future AS-06 Content Integrity Tracks) contained in the file.

5.3.5 Descriptors

The Descriptors in the File Package of AS-AP files shall be compliant with SMPTE 377-1:2009. Descriptors shall include all properties specified by SMPTE 377 and specific parametric metadata as required by Video, Audio, Captions tracks.

5.3.6 Timecode

AS-AP files shall contain one Timecode Track in the Material Package, per SMPTE 377M-2004, defining a synthetic program run time. Timecode mode and starting time may be specified in each Shim. Additional timecodes may also be in the MXF file; see 5.2.8 above.

5.3.7 Package Labelling

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

5.4 Descriptive Metadata Track Parameters and Constraints

5.4.1 General

AS-AP files shall include MXF Descriptive Metadata in compliance with SMPTE 377M-2004 and EG42-2004. Each instance of a Descriptive Metadata Scheme shall be carried in a separate Descriptive Metadata Track. Each metadata scheme shall be listed in the MXF Preface::DMSchemes property.

Additional or explanatory comment (temporary to draft versions of this AS): As indicated in the sections that follow, AS-AP files will contain a DMS-AS-AP DM track as a part of the MXF header. This DMS-AS-AP track will contain a minimum of data. In addition to the provision of this minimalist data, most producers of AS-AP files will wish to also embed more complete representations of descriptive, administrative, and technical metadata. These representations will be placed in Generic Stream

Partitions (SMPTE ST 410-2008); see 5.1.4. The existence of these partition-based metadata streams will be linked to identificatory DM tracks, also in the MXF header.

The entire topic of descriptive metadata for AS-AP awaits more careful development; much of what follows is borrowed from AS-03 with minimal modification. There is some additional discussion of this topic in "Preservation Video File Format Issues and Considerations" (http://www.digitizationguidelines.gov/audio-visual/documents/FADGI_MXF_ASAP_Issues_20110815.pdf, pp. 10-11).

5.4.2 DMS Tracks

AS-AP files shall include one Descriptive Metadata Set within a static Descriptive Metadata Track of the MXF Material Package, that indicates which specific AS-AP shim (constraint set) applies to the file. The Descriptive Metadata Scheme shall be labeled as DMS-AS-AP (UL to be published in the SMPTE Labels Registry). To provide for addition of DMS metadata, applications should include a KLV Fill of at least [n] kilobytes in length when initially creating an AS-AP file. DMS-AS-AP shall include the following mandatory properties:

(a) AS-AP Identifier Kind – an enumerated string value indicating the kind of program identifier, e.g. "ISAN"
(b) AS-AP Identifier – the identifier, as a text string, e.g. "ISAN 0000-0001-8947-0000-8-0000-0000-D"
(c) AS-AP Shim Name – an enumerated string value
(d) AS-AP Signal Standard – an enumerated string value indicating the signal standard of video contained in this AS-AP file.

In addition, DMS-AS-AP may also contain an indicator of the Intended AFD – an enumerated string value indicating the intended display format for the program, per SMPTE ST 2016-1 table 1 a3 a2 a1 a0 with optional informative appended text e.g. "1001 Pillarbox", "0100 Letterbox." ULs for DMS_AS-AP are defined as follows:

PROVISIONAL TABLE (many borrowings from AS-03)

Symbol	Type	Use	UL	Description
DMS_AS-AP	DM_Scheme		tbd	Metadata for AS-AP Archiving and Preservation Format
DMS_AS-AP_Framework	DM_Framework		tbd	AS-AP Descriptive Metadata
DMS_AS-AP_MainIdentifierValue	UTF16String	required	tbd	for the main identifier; details tbd
DMS_AS-AP_MainIdentifierType	UTF16String	required	tbd	controlled-vocabulary string value identifying the type of identifier
DMS_AS-AP_MainIdentifierComment	UTF16String	optional	tbd	free text comment pertaining to the identifier
DMS_AS-AP_AdditionalIdentifierValue	UTF16String	optional	tbd	UL for additional identifiers; often a repeating element; details tbd
DMS_AS-AP_AdditionalIdentifierType	UTF16String	optional	tbd	controlled-vocabulary string value identifying the type of additional identifier
DMS_AS-AP_AdditionalIdentifierComment	UTF16String	optional	tbd	free text comment pertaining to the additional identifier
DMS_AS-AP_ShimName	UTF16String	required	tbd	a controlled-vocabulary string value indicating the AS-AP Shim Name, e.g., Derived-from-video-serial-interface
DMS_AS-AP_SignalStandard	UTF16String	required	tbd	a controlled-vocabulary string value indicating the signal standard of video contained in this AS-AP file
DMS_AS-AP_IntendedAFD	UTF16String	optional	tbd	AFD present if inherited from source content or added in production (optional); a 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

Symbol	Type	Use	UL	Description
DMS_AS-AP_SlateTitle	UTF16String	optional	tbd	present if inherited from source content or added in production (optional); a string that specifies a program title of the type that broadcasters display to traffic and master control operators, e.g. Sesame Street
DMS_AS-AP_NOLACode	UTF16String	optional	tbd	present if inherited from source content or added in production (optional); a string that specifies the program series code and episode number, e.g. SESA 4187
DMS_AS-AP_Rating	UTF16String	optional	tbd	present if inherited from source content or added in production (optional); a controlled-vocabulary string that specifies the V-Chip rating of the program, e.g. TV-G
DMS_AS-AP_NielsenStreamIdentifier	UTF16String	optional	tbd	present if inherited from source content or added in production (optional); a string that specifies Nielsen stream identifier for the program
DMS_AS-AP *MoreToCome*				

Additional or explanatory comments (temporary to draft versions of this AS):
    (1) AFDs in AS-AP are optional. They may be present if "inherited" from the video source or if the MXF file-making system is setup to add this data, after the operator makes a judgment about the display format.
    (2) Regarding the local identifiers, see the description of Federal Agencies Working Group ideas about identifiers, together with examples, in "Embedding Metadata in Digital Audio Files," (http://www.digitizationguidelines.gov/audio-visual/documents/Embed_Intro_090915.pdf), pages 15-20. See also the Working Group's recommendation for the Broadcast WAVE bext element "Description," in the guideline (http://www.digitizationguidelines.gov/audio-visual/documents/Embed_Guideline_090915r.pdf), pages 3-4.

5.4.3 SOM and EOM Pairs

AS-AP files may include Descriptive Metadata Sets within a timeline Descriptive Metadata Track of the MXF Material Package. If present, these Descriptive Metadata Sets will indicate specific Start Of Material (SOM) and End Of Material (EOM) pairs and/or a Mark-In and Mark-Out object pair within the file. In such instances, the Descriptive Metadata Scheme shall be labeled as DMS-Segmentation (see explanatory comment that follows). The timeline track shall be constructed of a sequence of DMSegments (or subclasses thereof) or Fillers, following the MXF timing model as described in SMPTE ST 377-1:2009. SOM or Mark-In are inferred from the start position of each DMSegment, and EOM or Mark-Out from SOM or Mark-In plus Duration. SOM and EOM or Mark-In and Mark-Out of source material may be described using DMS-Segmentation in lower level source packages within the file.

    Additional or explanatory comments (temporary to draft versions of this AS): This element is provisional as approaches for segmentation evolve. DMS-Segmentation is not yet well defined in SMPTE standards. In the interim, some producers prefer to use operational patterns in the OP2 and OP3 families in order to accommodate segmentation.

5.4.4 Other Descriptive Metadata Schemes

AS-AP files may contain other Descriptive Metadata Schemes as permitted or required by the specific shim. Each added metadata scheme shall be carried in a separate Descriptive Metadata Track, and the scheme shall be listed in the MXF Preface::DMSchemes property. Added metadata schemes may repeat metadata elements that are already carried in MXF structural metadata or in DMS-AS-AP. In the event of disagreement between metadata item repetition, decoders shall accord highest priority to MXF structural metadata and second priority to DMS-AS-AP. See also 5.4.1 above.

5.4.5 Content Integrity Tracks

AS-AP files may include one Content Integrity Track for each Essence Track in the file. Content Integrity Tracks are constructed as Descriptive Metadata Tracks that include the DMS-Crypto DM Scheme, Cryptographic Frameworks and Cryptographic Contexts per SMPTE ST 429-6:2006 (D-Cinema Packaging – MXF Track File Essence Encryption), using AMWA AS-xx Content Integrity.

5.5 Other Parameters and Constraints

5.5.1 Manifest

AS-AP files shall include a manifest that provides an inventory of the file's essences and expresses the relationships between them, as well as providing summary information about the essence item and its provenance. This manifest shall follow the specification in section 9 of AS-02 (*MXF Versioning*).

> *Additional or explanatory comment (temporary to draft versions of this AS):* AS-02 (*MXF Versioning*), has not been published as of August 2011. The following summary of the manifest specification is based on the wording in section 9 of the revision 1l, January 6, 2011. The entire pre-publication wording of section 9 of AS-02 is included in this document as Annex B; it will be deleted after AS-02 has been published.
>
> *Summary of section 9, AS-02:*
>
> > The AS-02 manifest file shall be encoded as XML. This file shall include the following mandatory elements: BundleName (contains the file name of the root-level folder of the bundle), BundleID (identifier as URN-encoded UUID), Creator (free-form, human-readable annotation), CreationDate (time and date at which the bundle was created), and FileList (list of File elements that describe the files and folders in the bundle). The manifest may also contain the optional AnnotationText (free-form, human-readable annotations).
> >
> > For each file in the FileList, there shall be a FileType element that includes the following mandatory elements: FileID (identifier as URN, three possible sources), Role (how the file is used), Size (size of file in bytes, encoded as type xs:positiveInteger), and Path (URI of the file, relative to the root of the bundle). Each FileType may also contain the optional MIC (media integrity check value for the file; of the type xs:hexBinary; may take the form of HMAC-SHA1, crc32, crc16, or md5; with scope indicated: essence_only or entire_file), and AnnotationText (free-form, human-readable annotations).
> >
> > Readers should note that the embrace of the manifest section in AS-02 is provisional and will be
>
> revisited as AS-AP continues to evolve. The AS-AP interest in a manifest is intended to be respectful of other structures that have been developed with the same intended function:
>
> (a) section 6 of the AS-01 Edit Protocol (aka AAF Edit Protocol; http://www.amwa.tv/downloads/specifications/aafeditprotocol.pdf)
>
> (b) the Bag-It specification from the digital library community (http://tools.ietf.org/html/draft-kunze-bagit-06)
>
> (c) the Interoperable Master Format Packing List, from version 1.0 of the IMF specification (http://www.etcenter.org/wp-content/uploads/mailchimp-downloads/IMF_Specification_V1.0.pdf, February 2011). The Interoperable Master Format Packing List is defined as, "A list describing the files and providing a means for authentication of the files as delivered in a package."
>
> > For additional discussion of this topic, see "Preservation Video File Format Issues and
>
> Considerations" (http://www.digitizationguidelines.gov/audio-visual/documents/FADGI_MXF_ASAP_Issues_20110815.pdf, pp. 7-9).

5.5.2 File Names

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

5.5.3 Directory Structure

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

5.5.4 Content Integrity

When permitted by individual shims, AS-AP files may include Content Integrity Tracks, and systems may also store the metadata from Content Integrity Tracks separate from the AS-AP files. When permitted by individual shims, systems may also calculate overall Content Integrity metadata that form a signature for the whole AS-AP file including Header Metadata (and thus also the Identification data within the Header).

6 Test Material

Placeholder statement: Test material [will be] provided by AMWA, consisting of Golden files (constructed with engineered test signals) and Silver files (constructed using actual program content and metadata)

7 Tabulation of AS-AP General Parameters and Constraints

This section contains tables listing the general parameters and constraints that apply to all AS-AP files. Any of these parameters and constraints may be tightened by a specific shim. Shims are specified in annexes following this section.

7.1 Picture

Different variants of this component may be selected by different Shims.

7.1.1 Picture – Compressed at Ingest (i.e., compressed by the archiving organization)

This parameter is typically selected by an archive that prefers to store a reduced-data 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.

Dimension	Description	AS-AP Constraint	AS-AP Values
Program bitrate	how many bits per second at real time	Gentle	Up to 200 Mbps
Picture format	Picture raster and aspect ratio	Moderate	480i 4:3, 576i 4:3, 576i 16:9, 720p 16:9, 1080i 16:9, 1080p 16:9 2K 4K
Picture Essence Schemes	what picture signal schemes (compression or sampling or other) are encountered in programs	Gentle	JPEG 2000 broadcast profile Level 5 through level 7 [Other JPEG 2000 profile tbd] X'Y'Z' 10 – 16 bpp

Additional or explanatory comment (temporary to draft versions of this AS): Several AMWA members have sought to increase the level of automation in the production or use of MXF files constrained by Application Specifications and their shims. This means that in addition to the various means for tagging or identifying content elements offered in SMPTE ST 377-1 (*Material Exchange Format (MXF) — File Format Specification*), the AMWA technical specialists propose additional tagging, to be specified within AMWA Application Specifications. For example, the elements in the preceding table would be formally

labeled as *picture_bitrate*, *picture_format*, and *picture_family*. These three tags and several others appear in AS-02 under the heading *shim parameter*.

7.1.2 Picture – Uncompressed (i.e., when produced by the archiving organization)

This parameter 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.

Dimension	Description	AS-AP Constraint	AS-AP Values
Program bitrate	how many bits per second at real time	Gentle	Up to 2 Gbps
Picture format	Picture raster and aspect ratio	Moderate	480i 4:3, 576i 4:3, 576i 16:9, 720p 16:9, 1080i 16:9, 1080p 16:9 2K 4K
Picture Essence Schemes	what picture signal schemes (compression or sampling or other) are encountered in programs	Gentle	Uncompressed per S384M X'Y'Z' 10 – 16 bpp

7.1.3 Picture – Retain Source Encoding (i.e., archiving organization retains native encoding)

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.

Dimension	Description	AS-AP Constraint	AS-AP Values
Program bitrate	how many bits per second at real time	Gentle	Up to 200 Mbps
Picture format	Picture raster and aspect ratio	Moderate	Per input format
Picture Essence Schemes	what picture signal schemes (compression or sampling or other) are encountered in programs	Gentle	[Depends upon SMPTE Generic Container mapping specification] MPEG-2 MP or HP H.264 DV Others TBD

7.1.4 Picture – Associated Still Images

This parameter is intended to permit the inclusion of image-based corollary materials associated with content that an archive is reformatting, e.g., documents or pictorial items stored with a source videotape.

Dimension	Description	AS-AP Constraint	AS-AP Values
Program bitrate	how many bits per second at real time	Gentle	N/A
Picture format	Picture raster and aspect ratio	Moderate	Per input format
Picture Essence Schemes	what picture signal schemes (compression or sampling or other) are encountered in programs	Gentle	TIFF Others TBD

7.2 Sound

Dimension	Description	AS-AP Constraint	AS-AP Values
Sound Essence Schemes	what sound signal schemes	Moderate	PCM 96 kHz 24 bit
Sound Language repertoire	what primary sound languages may be present	None	N/A
Track Listings	what combinations of picture sound and data tracks are encountered in programs	Strong	Main Sound (1,2 or 6 channels) SAP (0 1 or 2 ch) DVS (0 1 or 2 ch) PCM pairs shall be used for Stereo programming

7.3 Captions

Dimension	Description	AS-AP Constraint	AS-AP Values
Caption Essence Schemes	what captions signals schemes	Strong	CEA-608 in S436M CEA-708 in S436M
Caption Languages	what captions languages	None	N/A

Additional or explanatory comment (temporary to draft versions of this AS): The preceding table is limited to captions and is largely borrowed from AS-03 (*Program Delivery*). AS-03 does not provide detailed guidance for the broader extent of the ancillary data that may be found in a video stream. This draft of AS-AP acknowledges the importance of these elements in section 5.1.8 above, devoted to *Closed Captioning, other VBI, and other ancillary data (ANC)*. The authors of AS-AP recognize the need to enhance the preceding table about captioning with additional guidance about other VBI and ANC elements.

For additional discussion of ancillary data in AS-AP files, see "Preservation Video File Format Issues and Considerations" (http://www.digitizationguidelines.gov/audio-visual/documents/FADGI_MXF_ASAP_Issues_20110815.pdf, pp. 1-3).

There is some helpful wording about ancillary data in AS-02 (*MXF Versioning*). Since AS-02 content assets take the form of a *bundle* of more or less atomic MXF files (single-essence OP1a files), unlike AS-AP's many-essences-in-one-file approach, the AS-02 wording cannot be copied verbatim into AS-AP. Nevertheless, for temporary reference, this excerpt from the AS-02 section on ancillary data is included here:

> Other VBI and VANC data shall be carried in SMPTE 436M . . . . Any data in a separate SMPTE 436M file shall override any data of the same type carried within the video file. Note: To preserve data that is intimate with a timeline essence component, copy the VBI and VANC data into a separate file and when creating an AS-02 bundle. The original data should be deleted from where it is originally sourced to avoid it leaking back into the workflow. Different types of VBI and VANC data should be split up into separate files. Decoders should be able to merge different kinds of data, for example on playout.

Section 7.1.1 above described *shim parameter* tagging proposed by AMWA. In AS-02, the following shim parameters are specified in relation to legacy VBI or VANC data that may appear in an AS-02 bundle.

> *VBI_data_essence* - A list of supported data essence types including specific parameters such as VBI lines supported.
> *VBI_custom* (Boolean) - When true, VBI data shall be encapsulated in the video essence using a defined method (e.g. carriage in MPEG picture user data) as well as being present in a separate VBI essence component file.
> *VBI_render* (Boolean) - When true, VBI data shall be encoded as active video within the video image. This data should also be placed in a separate VBI essence component file. Usually, this is only true for SD images that are coded as "tall MPEG" (i.e. the VBI area is in the active picture).
> *ANC_data_essence* - A list of supported data essence types including specific parameters such as ANC packet types supported.
> *ANC_custom* (Boolean) - When true, ANC data shall be encapsulated in the video essence using a defined method (e.g. carriage in MPEG picture user data) as well as being present in a separate ANC essence component file.
> *ANC_render* (Boolean) - When true, VBI data shall be encoded as active video within the video image. This data should also be present in a separate ANC essence component file.
> *data_component_limit* - When a number is given, specifies the maximum number of VBI or VANC files that can be merged when decoding an AS-02 bundle. Note: This parameter allows a facility to document the capacity of their decoding devices, such as playout servers.
> *data_separation* (Boolean) - When true, indicates that all data essence component files for VANC and VBI data shall be split into separate files. When set to false, all VANC and VBI data is merged into a single essence component file. Note: This specification does not permit a mixture of approaches.

7.4 Operational Pattern

Different variants of this component may be selected by different Shims.

7.4.1 Operational Pattern – Item

Dimension	Description	AS-AP Constraint	AS-AP Values
MXF Structure	MXF-specific Operational Pattern	Strong	OP1a, OP1b, or OP2a internal
MXF Structure (continued)	MXF-specific Index Tables	Strong	Full Index Tables
MXF Structure (continued)	MXF-specific Partitioning	None	N/A

7.4.2 Operational Pattern - Bundle

Dimension	Description	AS-AP Constraint	AS-AP Values
MXF Structure	MXF-specific Operational Pattern	Strong	OP3c external
MXF Structure (continued)	MXF-specific Index Tables	Strong	No Index Tables
MXF Structure (continued)	MXF-specific Partitioning	None	N/A

7.5 Header Metadata

Dimension	Description	AS-AP Constraint	AS-AP Values
Program identification	what identifiers are required	Gentle	One of: ISAN UUID archive-specific
Timecode	What program timecode is supplied	Strong	One timecode track in the Material Package, synthetic and continuous
Intimate metadata	what metadata must be carried with the program item	Moderate	All of: Program Ident Track Ident Language Code other per shim
	Signal condition metadata	Moderate	Standardized measured signal parameters

7.6 Descriptive Metadata

Dimension	Description	AS-AP Constraint	AS-AP Values
Descriptive Schemes	what schemes are required	Gentle	DMS-AS-AP
Optional Descriptive Schemes	What optional schemes are permitted	Gentle	DMS-Crypto DMS-Segmentation DMS-PBCore Other per shim
Shim Name	The value of the Shim Name property	None	N/A

Annex A   AS-AP Shim for Single Items derived from Video

AS-AP files for single items derived from Video are intended to contain a single rendition of a single source item.

A.1   Picture

A.1.1   Picture – Compressed at Ingest

AS-AP Single Item files derived from Video may contain zero or one of these components, constrained as follows:

Dimension	Description	AS-AP Constraint	AS-AP Values	Shim-specific Constraint	Shim-specific Values
Program bitrate	how many bits per second at real time	Gentle	Up to 200 Mbps	TBD	TBD
Picture format	Picture raster and aspect ratio	Moderate	480i 4:3, 576i 4:3, 576i 16:9, 720p 16:9, 1080i 16:9, 1080p 16:9	TBD	TBD
Picture Essence Schemes	what picture signal schemes (compression or sampling or other) are encountered in programs	Gentle	JPEG 2000 broadcast profile Level 5 through level 7	TBD	TBD

A.1.2   Picture – Uncompressed

AS-AP Single Item files derived from Video may contain zero or one of these components, constrained as follows:

Dimension	Description	AS-AP Constraint	AS-AP Values	Shim-specific Constraint	Shim-specific Values
Program bitrate	how many bits per second at real time	Gentle	Up to 2 Gbps	TBD	TBD
Picture format	Picture raster and aspect ratio	Moderate	480i 4:3, 576i 4:3, 576i 16:9, 720p 16:9, 1080i 16:9, 1080p 16:9	TBD	TBD
Picture Essence Schemes	what picture signal schemes (compression or sampling or other) are encountered in programs	Gentle	Uncompressed per S384M	TBD	TBD

A.1.3   Picture – Retain Source Encoding

AS-AP Single Item files derived from Video may contain zero or one of these components, constrained as follows:

Dimension	Description	AS-AP Constraint	AS-AP Values
Program bitrate	how many bits per second at real time	Gentle	Up to 200 Mbps

Picture format	Picture raster and aspect ratio	Moderate	Per input format
Picture Essence Schemes	what picture signal schemes (compression or sampling or other) are encountered in programs	Gentle	[Depends upon SMPTE Generic Container mapping specification] MPEG-2 MP or HP H.264 DV Others TBD

A.2   Sound

AS-AP Single Item files derived from Video may contain zero or one of these components, constrained as follows:

Dimension	Description	AS-AP Constraint	AS-AP Values	Shim-specific Constraint	Shim-specific Values
Sound Essence Schemes	what sound signal schemes	Moderate	PCM 96 kHz 24 bit		
Sound Language repertoire	what primary sound languages may be present	None	N/A		
Track Listings	what combinations of picture sound and data tracks are encountered in programs	Strong	Main Sound (1,2 or 6 channels) SAP (0 1 or 2 ch) DVS (0 1 or 2 ch) PCM pairs shall be used for Stereo programming		

A.3   Captions

AS-AP Single Item files derived from Video may contain zero or one of these components, constrained as follows:

Dimension	Description	AS-AP Constraint	AS-AP Values	Shim-specific Constraint	Shim-specific Values
Caption Essence Schemes	what captions signals schemes	Strong	CEA-608 in S436M CEA-708 in S436M		
Caption Languages	what captions languages	None	N/A		

A.4   Operational Pattern

AS-AP Single Item files derived from Video shall be constrained as follows:

A.1.4   Operational Pattern – Item

Dimension	Description	AS-AP Constraint	AS-AP Values	Shim-specific Constraint	Shim-specific Values
MXF Structure	MXF-specific Operational Pattern	Strong	OP1A, OP1b, or OP2a internal		

MXF Structure (continued)	MXF-specific Index Tables	Strong	Full Index Tables		
MXF Structure (continued)	MXF-specific Partitioning	None	N/A		

A.5   Header Metadata

AS-AP Single Item files derived from Video shall be constrained as follows:

Dimension	Description	AS-AP Constraint	AS-AP Values	Shim-specific Constraint	Shim-specific Values
Program identification	what identifiers are required	Gentle	One of: ISAN UUID archive-specific		
Timecode	What program timecode is supplied	Strong	One timecode track in the Material Package, synthetic and continuous		
Intimate metadata	what metadata must be carried with the program item	Moderate	All of: Program Ident Track Ident Language Code other per shim		
	Signal condition metadata	Moderate	Standardized measured signal parameters		

A.6   Descriptive Metadata

AS-AP Single Item files derived from Video shall be constrained as follows:

Dimension	Description	AS-AP Constraint	AS-AP Values	Shim-specific Constraint	Shim-specific Values
Descriptive Schemes	what schemes are required	Gentle	DMS-AS-AP		
Optional Descriptive Schemes	What optional schemes are permitted	Gentle	DMS-Crypto DMS-Segmentation DMS-PBCore Other per shim		
Shim Name	The value of the Shim Name property	None	N/A		

Annex B   Manifest Specification from AS-02 (pre-publication)

For reference, here is the wording and figures from manifest specification as presented in a recent draft version of *AS-02 MXF Versioning* (revision 1l, January 6, 2011). Publication of AS-02 is anticipated in autumn 2011.

AS-02 section 9. Manifest file format

Each AS-02 bundle shall have a single manifest file, located in the root level folder of the bundle. The manifest file contains a list of all of the files and folders in the bundle, including the version and essence component files. The manifest shall be encoded as an XML document (W3C XML 1.0). The manifest file shall be named manifest.xml.

9.1 Manifest structure. The top-level element in the manifest file shall be designated Manifest, and is illustrated in figure 7. See the XML schema declaration in section 9.3 of this document for the formal element definition.
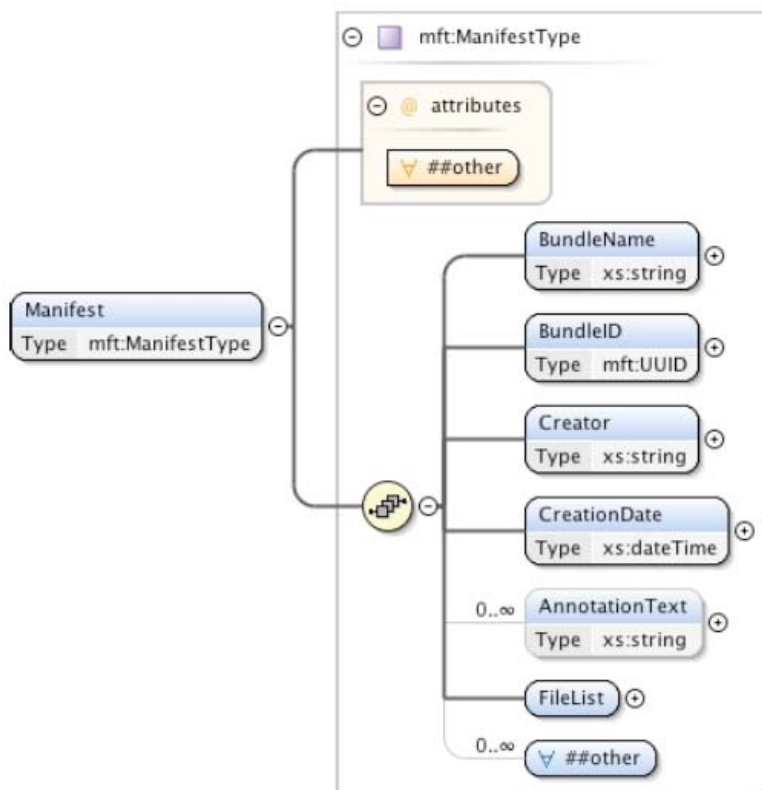

Figure 7: Manifest structure element

9.1.1 Bundle name element. The bundle name (BundleName) element uniquely contains the file name of the root-level folder of the bundle.
9.1.2 Bundle identifier element. For overall management of the asset, the bundle identifier (BundleID) element shall uniquely identify the bundle. Each unique bundle shall have a distinct bundle identifier. The bundle identifier shall be encoded as a URN-encoded UUID, as defined in IETF RFC 4122. Note: This will allow easy differentiation between bundles.
9.1.3 Creator element. The creator (Creator) element shall be a free-form, human-readable annotation describing the person, facility or system (hardware/software) that created the bundle. Note: The creator property is intended only for display as guidance to a user.

9.1.4 Creation date element. The creation date (CreationDate) element shall be set to the time and date at which the bundle was created. The creation date shall be encoded as xs:dateTime type.

9.1.5 Annotation text element (optional). Annotation text (AnnotationText) elements may be present and shall be a list of zero or more free-form, human-readable annotations describing the bundle.

9.1.6 File list element. The file list (FileList) element shall contain the list of File elements that each describe the files and folders contained in the bundle. The structure of the File element is described in section 9.2. The order of File elements in the list shall not be significant.

9.2 File element. A manifest shall contain a list of files and folders. A file (File) element shall represent any file or folder that exists in the AS-02 bundle. Each file shall be described by a file element, as illustrated in figure 8. See the XML schema declaration in section 9.3 of this document for a normative definition.
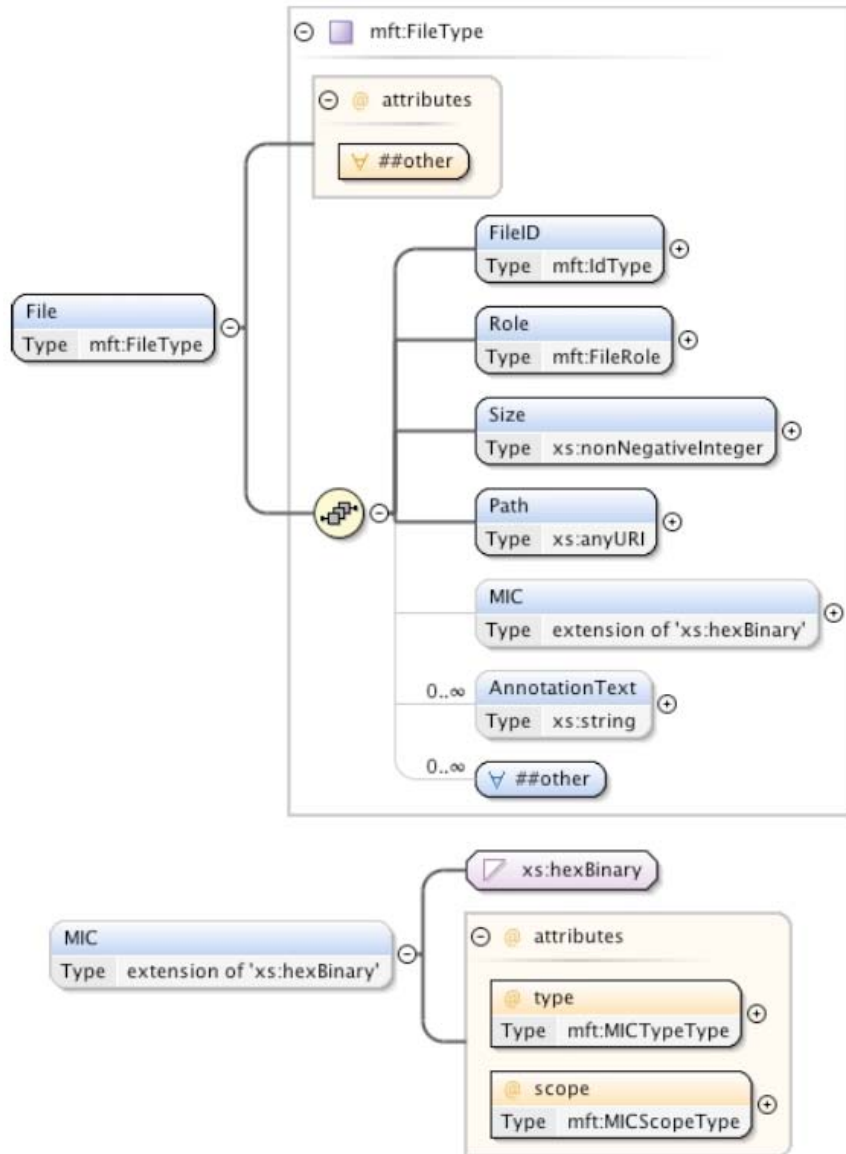

Figure 8 – File element with optional media integrity check

9.2.1 File identifier element. The file identifier (FileID) element shall represent the unique identifier associated with the described file. Where the file has its own unique identifier, such as the primary package identifier of a version file or essence component file, this value shall be extracted from the file and used in the

manifest. If the file contains no defined identifier, then the creator of the manifest file shall generate the identifier. The value of the identifier shall be encoded according to the following rules:

- Where the native identifier of the file is a SMPTE UMID (SMPTE 330M), the file identifier shall be encoded as a URN representation of the UMID according to SMPTE 2029-2009.
- Where the native identifier of the file is a SMPTE universal label, the file identifier shall be encoded as a URN representation of the universal label according to SMPTE 2029-2009.
- All other files shall have a UUID encoded as a URN according to IETF RFC 4122.

9.2.2 Role element. The role (Role) element shall be used to describe how the file is used within the bundle. The value of the element shall be used both for display as guidance for the user and as machine-interpretable information for content processing. The allowed values for the role element shall be as specified in Annex B.

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

For folders, the size value shall be present and set to zero. The manifest file shall describe the manifest file, the file size element shall be present and the value shall be set to either zero or the actual size of the file. Note: The size of the manifest file will change on inserting the size of the file. To avoid complication, the size of the manifest file can be set to 0.

9.2.4 Path element. The path (Path) element contains the relative URI of the file, relative to the root of the bundle.

9.2.5 Media integrity check element (optional). The media integrity check (MIC) element contains the media integrity check value for the file.

9.2.5.1 Element value. The value of the media integrity check element (MIC) shall be of type xs:hexBinary.

9.2.5.2 Type attribute. The media integrity check type (type) attribute shall be present and shall indicate the algorithm used to create the media integrity check value for the AS-02 asset. The possible values of this parameter shall be:

- HMAC-SHA1 - secure hash algorithm, as defined in IETF RFC 2104 and IETF RFC 3174;
- crc32 - 33-bits polynomial length cyclic redundancy check, computed according to CRC-32C (Castagnoli) polynomial;
- crc16 - 17-bits polynomial length cyclic redundancy check, computed according to the CRC-16-CCITT polynomial;
- md5 - message digest algorithm 5, as specified in IETF RFC 1321.

Note: For more information on calculating CRCs, the related Wikipedia page is a good place to start. See: http://en.wikipedia.org/wiki/Cyclic_Redundancy_Check.

9.2.5.3 Scope attribute. The media integrity check scope (scope) attribute shall be present and shall indicate the scope over which media integrity check values are calculated. The possible values of this parameter shall be:

- essence_only - the media integrity check was calculated for the wrapped essence stream of an essence component file;
- entire_file - the media integrity check value was calculated for the entire file, including essence and any wrapper.

9.2.6 Annotation text element (optional). Annotation text (AnnotationText) elements may be present and shall be a list of zero or more free-form, human-readable annotations describing the file. Note: Annotation text elements are intended only for display as guidance to a user.

9.3 XML schema for manifests. The XML Schema document presented in this section normatively defines the structure of a manifest using a machine-readable language. [Note: in this excerpt, only the first four lines are included.]

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns:mft="http://www.amwa.tv/as-02/1.0/manifest"
targetNamespace=http://www.amwa.tv/as-02/1.0/manifest . . . . [continues]
```

Annex C   AS-AP Shim for Single Items derived from Film

AS-AP files for single items derived from Film are intended to be used to contain a single rendition of a single source item.

[to be drafted]

Annex D   AS-AP Shim for Single Items "Born Digital"

AS-AP files for single items are intended to be used to contain a single rendition of a single source item.

[to be drafted]

Annex E   AS-AP Shim for Single Items "Film Strip"

[to be drafted]

Annex F   AS-AP Shim for Collections

TBD, using forthcoming AMWA Manifest Spec.

Summary Information

Title (original source):

> AS-AP MXF Archive and Preservation

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

Author: Oliver Morgan

Project: Toward an AMWA Application Specification

Revisions: 1d_cf and 1e_cf, 1f, 1g

Status: DRAFT

Comments:

Filename: FADGI_MXF_ASAP_Arch_Pres_1h_20110815.doc

Save Date: August 15, 2011

Saved By: Carl Fleischhauer

Contact: cfle@loc.gov

Change History

Rev	Date	By	Sect	Description
1a	Aug 11, 2010	Oliver Morgan	All	Initial thoughts, derived from AS-03 and WG discussions
1b	Aug 24, 2010	Oliver Morgan	7 A 4.4, 4.5	Add sub-headings; remove blank shim columns Reinstate to show one explicit Shim, with cardinality Describe derivation and combination of shims, do not explain this in terms of hierarchy or sub-shims.
1c	Sept 9, 2010	Oliver Morgan	7 7.1 A B C	Revise audio to 24 bit 96kHz, Film to 10-16 bit Add Picture Born Digital Change to "derived from video" Add from Film Add born digital
1d	Sept 26, 2010	Oliver Morgan	7.1 7.1.4 D E	Change to Compressed at Ingest, Uncompressed, Compressed at Accession Add Ancillary Picture (Still) Add TBD for Film Strip Add TBD for Collections (Manifest, BagIt)
Preceding examples had the file-naming pattern: AMWA-AS-AP-Archive&Preservation-Spec-1n-2010mmdd.doc. Following examples have the pattern: FADGI_MXF_ASAP_Arch_Pres-1n_2011mmdd.doc				
1d_cf	Oct 20, 2010	Carl Fleischhauer	General	Explanatory adjustments and some temporary deletions to prepare version 1d for dissemination prior to the AMIA/IASA-related meeting in Phila., Nov 1, 2010. Strip off all but first shim.
1e_cf	May 16, 2011	Carl Fleischhauer	5, annex B	Development of section 5 and paste-in of annex B (manifest from AS-02); plus edited introductory note on page 1.
1f	May 27, 2011	Carl Fleischhauer, Oliver Morgan	5	Edit of section 5, adjustment to introductory note on page 1.
1g	August 10, 2011	Carl Fleischhauer, Oliver Morgan	5, 7, Annex B	Notes referring to AS-02 in sections 5 and 7, other minor changes, addition of (temporary) Annex B.
1h	August 15, 2011	Carl Fleischhauer, Oliver Morgan	General	Various edits, especially to explanatory notes, including hyperlinks to "issues" document.