



The AMWA Family of Application Specifications for MXF

Abstract

The Advanced Media Workflow Association (AMWA) is an open, community-driven organization formed of media companies and vendors. It focusses on the creation of specifications and technologies for networked media workflows. Several of AMWA's specifications target the simplified use of MXF, a file wrapper standard from SMPTE. This paper focuses on four related Applications Specifications (AS). It reviews their place in the media workflow and summarizes their operational characteristics. MXF, in all its glory, gives the implementer a long leash. These four AMWA AS's strive to button-down the usage profiles and thereby improve interoperability.

Introduction

AMWA has finalized or is drafting four Application Specifications based on restricted operational patterns for MXF media files. Each is targeted for use in a particular sector of a broadcast workflow; namely production, contribution, program delivery, and commercial delivery. AMWA supports other AS documents but these four are tightly related in the methods used to restrict MXF. The bottom line to end-users is this; the AS model makes creating, using and exchanging MXF files a reality by restricting the range of what MXF can do. If you are new to MXF see the Appendix "A Quick Tour of Wrappers and MXF".

Each AS defines a different restricted profile of the larger full featured MXF parameter set. For example, AS-03 (program delivery) limits the max compression data rate to 50 Mb/s while AS-10 (production) permits higher rates. Key to the concept of restricting data sets is the AS "shim". Each AS defines a maximum capability parameter set while a shim further reduces this parameter set. Shims may address a particular type of programming or programming genres, or they may address requirements of particular broadcast station groups.

Figure 1 outlines these key concepts;

1. Full featured view of the unconstrained MXF parameter set;
2. AS restricted MXF parameter set;
3. Shims that further limit the AS parameter set.

Each provision within the general specification and within each individual shim is categorized as one of the following. Note that shims always express stronger constraints than the general specification:

- Unconstrained - everything permitted by SMPTE ST 377 (MXF base standard)
- Gently constrained - a range of values (ex, bit rates) or choices (ex, essence types) is stated by

the general AS; individual shims may further restrict

- Strongly constrained - a set of values or choices that individual shims must choose between
- Most constrained - a single choice or parameter value that all AS applications will use identically

Currently the shims are defined in tables in each AS document. It is the intent of AMWA to convert these to "machine readable" likely by using a formal XML implementation for each. Only one shim is applied per AS implementation.

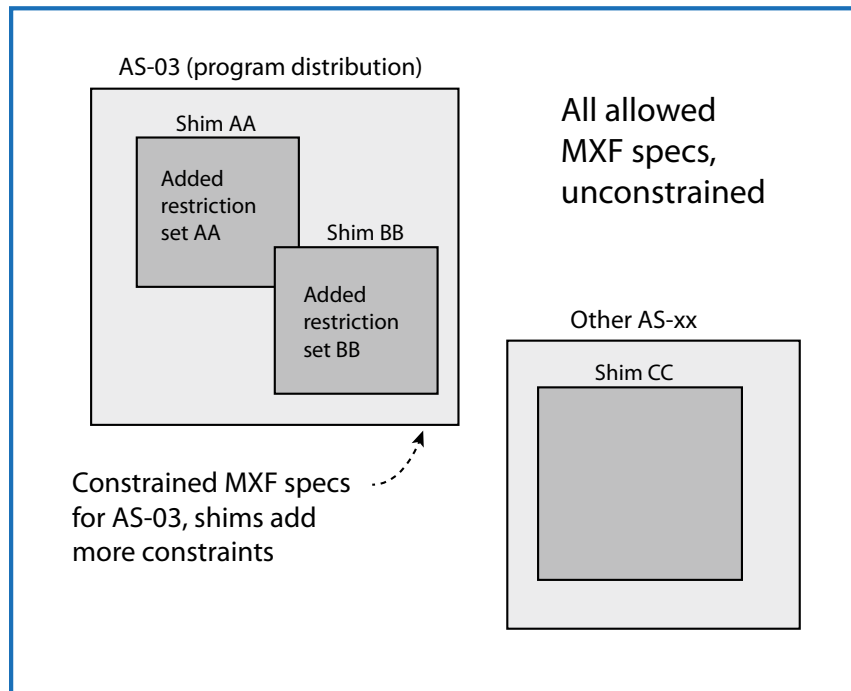


Figure 1. Fully featured MXF specs of SMPTE ST 377 and related

AS Review

In early 2012, the four Application Specifications considered in this paper are;

- AS-03 : MXF for Program Delivery (**Final**)
- AS-10 : MXF for Production (Draft spec)
- AS-11 : MXF for Contribution (**Final**)
- AS-12 : MXF for Commercial Delivery (**Final**)

Notably, AS-02 (MXF Versioning) is not listed above. AS-02 is a unique type of spec that is designed for the versioning of MXF programs. It is a completed AMWA specification and in use by industry. AS-02 is allied but significantly different from the four AS types discussed here and is not expanded on¹.

Table 1 illustrates several shared and differentiating features of the AS's. There are additional parameters

not shown but the table is instructive of some common ones. The table shows a view of the total available capability of a given AS. However, for each AS, a shim could be used to further reduce functionality. For example, the AS-03 shim "AS-03 Shim for PBS HD Playout" limits the video bit rate to 18 Mb/s for H.264. Note that AS-03 permits up to 50 Mb/s rates without a shim.

¹ AS-02 enables unique versions of a program to be readily assembled from a shared set of essence elements. As a chef uses a recipe to make a dish, AS-02 applies MXF recipes that define each program version. So, picking from an inventory of audio and video clips, many different program versions can be assembled. AS-02 is useful when compiling multi-language and multi-platform versions of the same base program..

Table 1

Some Common Restricted MXF Parameters per AS

Restricted Feature	AS-03	AS-10	AS-11	AS-12
Application Domain	Program Delivery	Production	Contribution	Ad Delivery
Video Bit Rate	SD/HD 5-50 Mb/s	(depends on codec)	HD@ 100 Mb/s	SD/HD 5-50 Mb/s
Codec Format	MPEG2, H.264 LGOP	MPEG-2 MP@HL , MPEG-2 422P@HL MPEG-2 MP@H14, LGOP	AVC-Intra	MPEG2, H.264 LGOP
MXF Pattern	Op-1a	Op-1a	Op-1a	Op-1a
Audio channels	Up to 16	2 to 8	Up to 64	Up to 16
Metadata "Slate" Scheme	DMS-AS-03 (program slate)	TBD	DMS-AS-11-UK/DPP [†]	Ad-ID based slate metadata
Closed Caption	CEA 608/708	CEA 608/708	CEA 608/708	CEA 608/708

[†] UK Digital Production Partnership specific

Conclusion

MXF is a powerful container/wrapper method. Unfortunately, it was designed with such flexibility that widespread interoperability has been elusive. AMWA's Application Specifications are just what our industry needs to put a fence around MXF for specific workflow domains. The AS concept brings the promise of true MXF interop to reality — *Interoperability for Real*.

Of course, there is more to the AS than this brief introduction. Read the individual AS documents² for a detailed view. Also, AMWA is making progress on a validation and certification program for each AS. The intent is for AMWA to provide recommended test methods (per AS implementation) and issue a certi-

fication when passed. For example, company X can state that their AS-03 application has passed the validation test suite and thereby offers a certified implementation. The certification program will add confidence that a company's AS capability is tested to rigid standards.

Stay tuned for more on the AMWA validation and certification program. In the meantime, several AS implementations are available for use in MXF workflows with individual program suppliers and vendors supporting domain interoperability.

² Completed AMWA Specifications can be downloaded for free at <http://www.amwa.tv>. To see specifications in development, you can join the AMWA. Information on joining can also be found on the website.

Appendix

A Quick Tour of Wrappers and MXF

Audio/Video files are the golden assets of a broadcast facility and production company. There are 100's of different media file formats for video, audio, graphics, text, metadata and more. It's a potpourri enough to confuse anyone. However, at a high level there are just two types of media file formats; *essence-only*³ and *wrapper-based*. A wrapper is sometimes called a container.

Here are few file formats you may have heard of; MPEG2, JPG, HDV, DV, and MP3. These are *essence-only* formats. On the other hand, MOV (QuickTime), AVI, and MXF are *wrapper* formats. How do they differ? Let's see.

As a paper bag can carry different types of sandwiches and chips, a wrapper file can, in principal, carry

various types of A/V essence and other data. Wrapper formats apply mapping recipes to pack the media data inside. Roughly, a wrapper is similar to the common ZIP file that carries many different formats simultaneously in one package. Some wrapper formats only support a few essence types while others support a wide range.

Importantly, a wrapper is not a pure compression format like MPEG video or MP3 audio! This is a common confusion. Wrappers may carry compressed data but this does not make them a codec format.

Why use wrappers for media? The wrapper is an ideal way to guarantee that packaged A/V, metadata (ex, slate), closed caption text and critical index points stay synchronized. Managing time is central to the

³ An essence-only format is defined as basic A/V or graphic data, compressed or not. For example, JPEG data is graphic essence and PCM audio is raw sound essence. Metadata and closed caption subtitles, on the other hand, are not strictly essence but are fundamental data types.

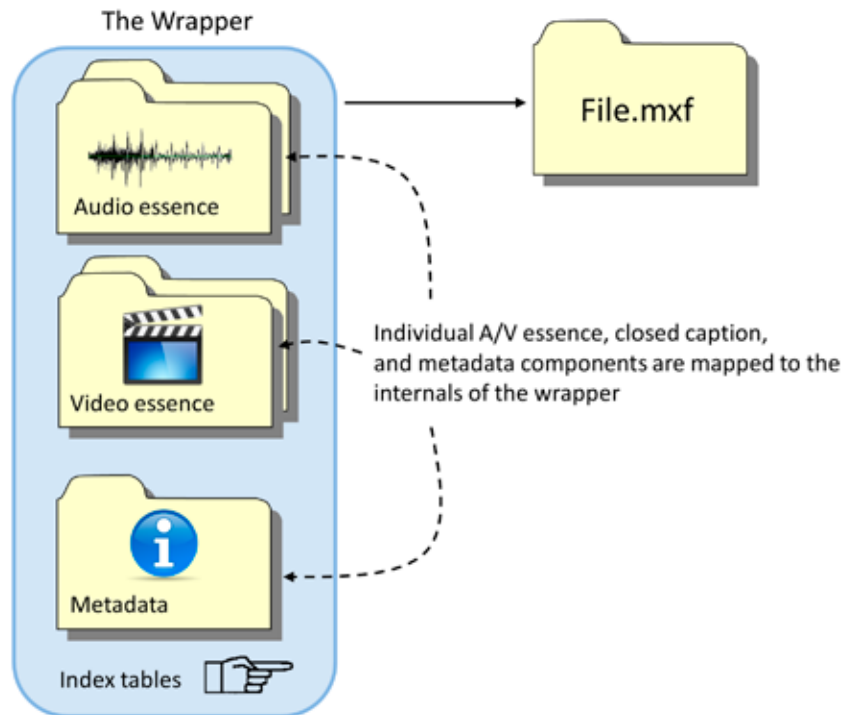


Figure 2. The Essentials of a Wrapper File

file's usability. Wrappers can carry many different kinds of essence and keep them aligned; this is non-trivial. Plus, the inside pieces won't become lost -- they are bound together by the wrapper. The wrapper format also defines how metadata should be formatted to guarantee wide use and interchange.

Figure 2 illustrates the wrapper concept. The internals are composed of time-interleaved (or not) A/V streams and other data types. A common use case is to pack one video program with 4 stereo (8 channels total) foreign language audio tracks. Additionally, there may be a closed caption text stream for each language.

So, is there an "ideal wrapper format" for the media facility? Well, many have been tried over the years but the Material eXchange Format (MXF) has been custom designed for use by the media professional. Its characteristics make it ideal for the capture, editing, distribution, playout and archiving of media. In 2012, cameras export it, editors compile with it, facilities transfer it, and cinemas show movies using it. Today, there are 100's of millions of MXF files in use. MXF is the true lingua franca of the media facility.

⁴ MXF supports more essence mappings than listed here. See SMPTE ST 377, the overall master standard, to dig deeper.

Its life began in 1999 and initial standardization was started by SMPTE in 2003 with essence mapping rules and revisions added along the way. SMPTE, with industry advocates, has standardized essence mapping rules⁴ for MPEG2, H.264, JPEG2K, DV, VC-1, VC-2, VC-3, audio formats, metadata and closed caption formats. MXF is truly a rich format for the media facility.

A key MXF attribute is flexibility but this has become the format's greatest liability. The universal nature of MXF permits too many ways to get the same job done leading to some incompatible implementations. Flexibility is a double edged sword for achieving interoperability. This is where the AMWA specs step in; reduce MXF's complexity by limiting what it can do. AMWA's Application Specification family is a tonic for MXF, creating solid usage templates that provide Interoperability for Real.

This white paper was written for the AMWA by Al Kovalick, Media Systems Consulting.

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