MXF for Program Contribution, AS-11

AMWA White Paper

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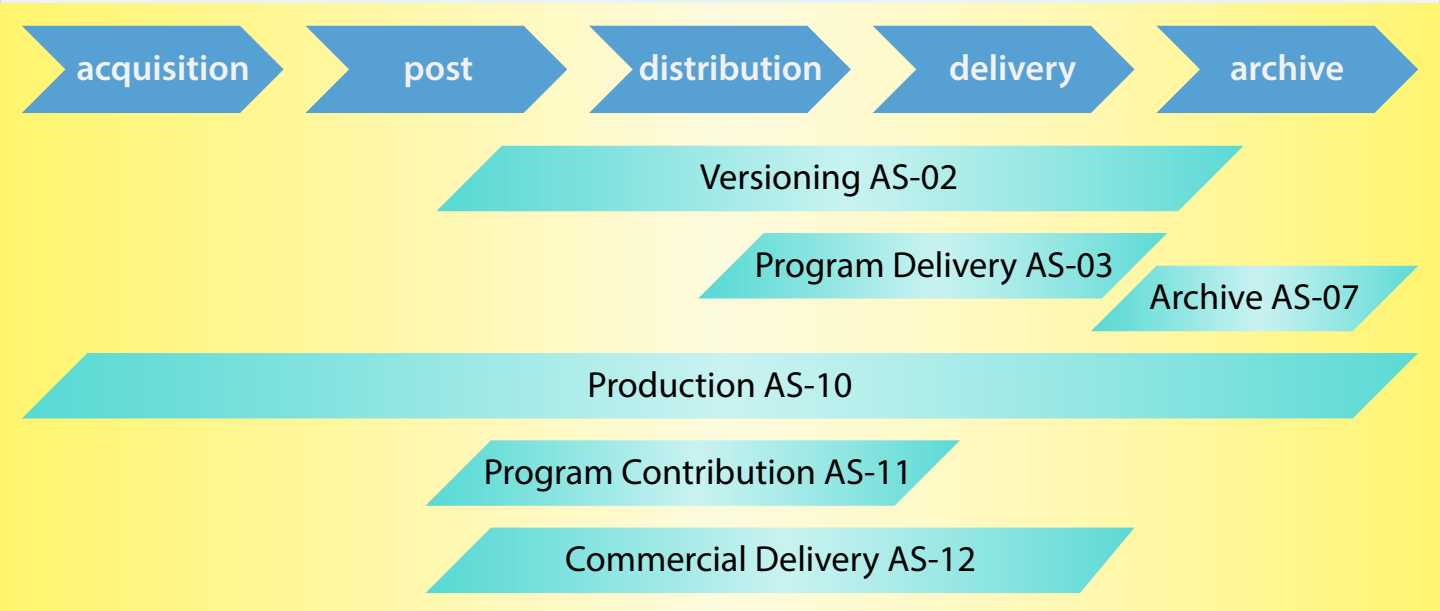
MXF for Program Contribution, AS-11, is a specification that describes a file format for the delivery of finished programming from program producers to broadcast stations or program origination facilities.

AS-11 is a constrained version of MXF. It includes the functionality of MXF Program Delivery, AS-03, and extends it to include AVC-Intra 100 coding. It also supports a minimum set of editorial and technical metadata.



The AMWA helps the media industry improve its business by supporting improved workflows. To accomplish this goal the Association leverages existing standards, and describes how to use standards in a particular application area. These are called Application Specifications.

MXF Program Contribution

This paper describes the development of MXF for Program Contribution, AS-11. It was developed by the AMWA with the U.K.'s Digital Production Partnership (DPP).

Many European broadcasters use delivery workflows that support editorial compliance, versioning and the creation of promotions.

The program as delivered from the post-production house (the contribution) may go through several additional processes before it is delivered for linear playout or on-demand distribution (see figure 1). It is important that video and audio quality is maintained through all workflows.

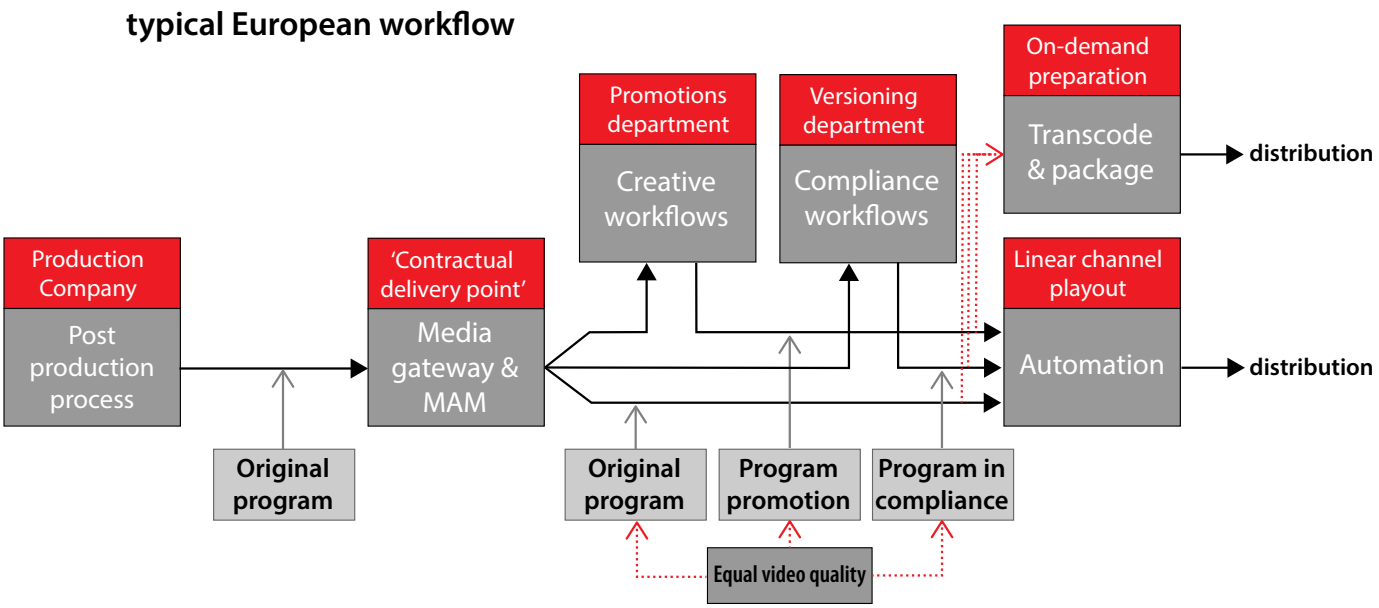


Figure 1

Red Bee Workflow

Traditionally, it was a relatively simple issue for Red Bee to receive programs on tape. Programs arrived on Digital Betacam or HDCAM SR cassettes. Interoperability was good with little opportunity for variation. There may have been some issues around audio track allocation, but compatibility issues were minor.

However, as production companies moved away from tape-based workflows, Red Bee had a business problem to solve: the consistent, volume delivery of high bit-rate finished HD program content by file.

There are well-established processes for delivering HD content on tape using the HDCAM SR format. In the U.K. most broadcasters have agreed common track configurations for audio, including stereo and surround. In the U.K. tape is ubiquitous, it is interoperable, everyone is familiar with it, but it is inefficient. Production companies might use file-based production workflows but ultimately need to transfer their programs to tape, and ship them to the playout facility where they are re-ingested. This workflow is slow and expensive.

Of course the migration to file delivery of programs and commercials is already happening, but in the U.K. it was developing in an ad-hoc manner. There are different video codecs, different file wrappers, different ways to handle audio tracks, and limited management of descriptive metadata.

Red Bee Media

Red Bee Media provides services to broadcasters including TV Playout, identity and branding, access services like captioning, and VOD. Headquartered in London, U.K., the company has offices in France, Spain, Germany and Australia. Clients include BBC, Channel 4, UKTV, PBS, and NHK.

Red Bee plays out 129 streams, amounting to 520,000 hours of programming per year. It also prepares in one year 356,000 hours of VOD programs for 33 platforms.

It has operated file-based workflows since 2005, and is a volume user of MXF. As Red Bee operates a multi-client platform, interoperability is strategically important to simplify their playout and VOD operations.

Red Bee Media is a member of the AMWA.

www.redbeemedia.com.

Scenario

The delivery problem for files, before the introduction of AS-11 could be like this:

1. Production company A delivers MPEG-2, 50Mb/s long GOP video in a QuickTime wrapper to Broadcaster A.
2. Broadcaster B requests MPEG-2 100Mb/s I-frame in an MXF wrapper from Production Company A.

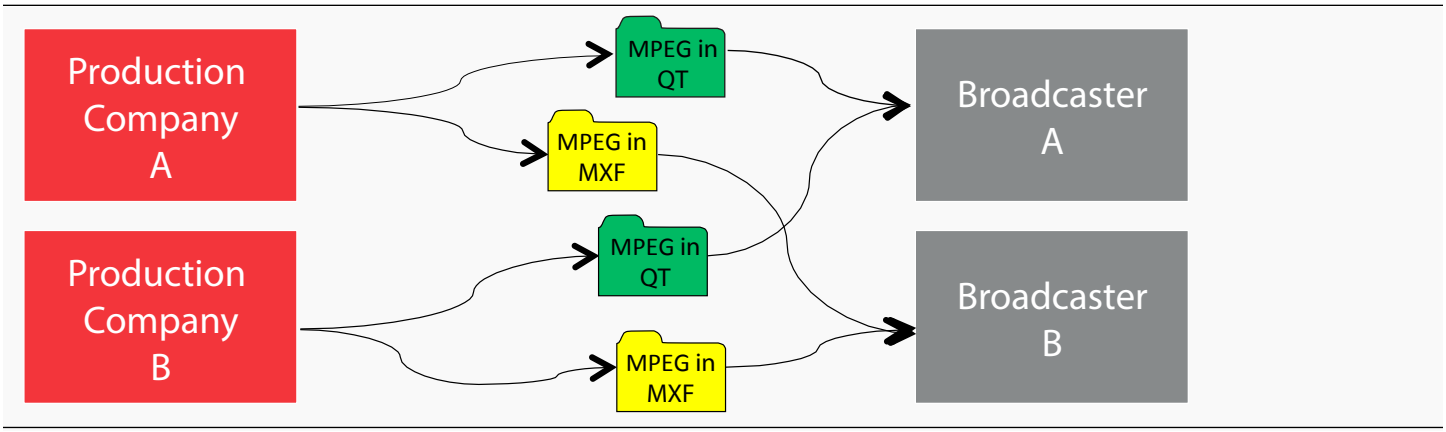


Figure 2. Two productions companies working with two broadcasters.

Production Company A must therefore produce two versions of the file.

3. Production Company B is commissioned by broadcasters A & B, so similarly must deal with two different file formats (see figure 2).

It gets more complex.

4. Broadcaster C commissions a program from Production Company C. This broadcaster has yet to define their exact file delivery format. As the program is shot on P2, the production company decides to deliver AVC in an MXF wrapper.

5. Broadcaster B commissions a program from Production company C. This production team uses an all-Apple workflow so deliver ProRes in a QuickTime wrapper.

6. Broadcaster C commissions a program from Production Company A. They want a high bit rate version to archive. Production Company A uses an Avid workflow, so delivers DNxHD in an MXF wrapper (see figure 3).

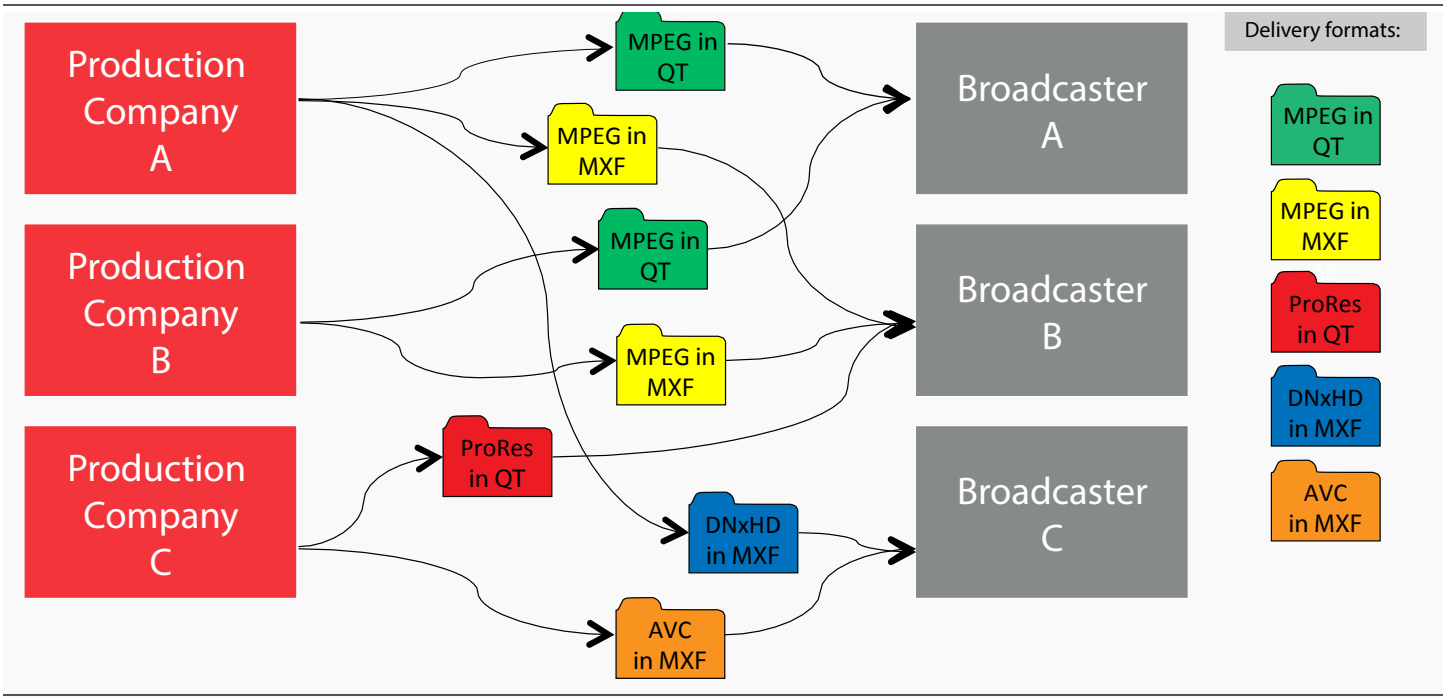


Figure 3. Add more companies and it gets more complex.

The complexity compounds. In this simple scenario there are the following options:

- video codecs – MPEG-2 (Long GOP and I-frame), AVC, ProRes and DNxHD
- wrappers – MXF and QuickTime

Add to that different bit rates, and different audio configurations, and the combinations become very complex and impractical. To prevent further unmanaged organic growth the stakeholders were looking for some leadership and coordination to bring order to the developing chaos.

This is where the Digital Production Partnership comes in.

What is the DPP?

The Digital Production Partnership (DPP) is an initiative formed in 2010 by the U.K.'s Public Service Broadcasters to help the industry maximise the potential benefits of digital production. It is funded by ITV, BBC and Channel 4, with representation from other broadcasters and the independent sector.

Managed digital production can potentially make things simpler, more efficient and lower cost for all parties.

Why is DPP needed?

The broadcast industry is undergoing major change with the transition from tape-based to file-based workflow. HD has become the standard production format, there is mass uptake of tapeless cameras and IT technologies are increasingly used as standard components of the production workflow.

Production teams need guidance to manage file based production workflows if they are to avoid significant confusion about codecs, file formats and delivery standards.

DPP objectives:

- To achieve common HD file-based delivery and metadata delivery standards for all major U.K. broadcasters. This specification was published Jan 2012.
- To make a complete move to file based delivery to broadcasters in the U.K. between 2012 and 2014. A joint commitment was announced Fall 2011 with implementation underway.
- For industry co-ordination around new file based workflows for producers and broadcasters including advice on best practice workflows. A DPP report was published May/June 2012.

Content delivery standard

The DPP has a common tape delivery specification already in place. It describes:

- program content (line-up, slate, program etc)
- video and audio levels
- QC requirements

What was needed for files?

In two words an 'Application Specification'.

The AMWA specification MXF for Delivery, AS-03, met many of the DPP requirements but did not support some of the technologies required by DPP to meet the workflows discussed previously. Principally they were:

- AVC-Intra Class 100 video encoding in an MXF OP1a wrapper
- Support for discrete stereo and multichannel audio
- Transport for production metadata to replace 'a paper form in the tape box'

It was decided that a sensible approach would be to work with the AMWA, and to start with AS-03 and evolve a super set of requirements within a new Application Specification dubbed MXF for Contribution, AS-11. As a member of the AMWA, Red Bee was the proposer and sponsor of AS-11 for DPP in U.K.

MXF Program Contribution, AS-11

Without AS-11 a production company might have to reference 29 different standards or specifications, then select the relevant parts before encoding their files.

With AS-11 all the information required is brought together in a single specification document.

AS-11 is based on MXF Program Delivery, AS-03, but adds the following:

- Video bit rates above 50Mb/s, specifically AVC-Intra encoding at 100Mb/s
- Legacy support for standard definition 50Mb/s D10 with AES audio (compliant with SMPTE ST 386)
- Program segmentation
- Custom metadata specific to a shim, which could replace the paper form in the tape box

The AS-11 specification is completely standards-based, referencing 29 standards and specifications. AS-11 details how those standards should be used in a constrained manner in order to create an interoperable file.

An AS-11 file contains a single program, with video, audio, closed captions, and ancillary data, in an MXF OP1a wrapper. It also permits shims, of which more later.

The AVC-Intra encoding is in accordance with SMPTE RP2027-2011, and uses Class 100, High Intra 4:2:2 profile at level 4.1.

Audio support:

- For SD video, an 8 channel AES3 stream
- For HD video, PCM pairs (up to 64 channels), AC-3 and Dolby E

See figure 4 for the key features of AS-11.

Segmentation

The majority of broadcasters will need to segment a program around commercial breaks. An MXF segmentation track is the preferred method of allowing a program to be interrupted for the insertion of the break (see figure 5 for details). AS-11 allows for several schemes including:

- single part program
- hard-parted program using filler objects
- soft-parted program with optional break points

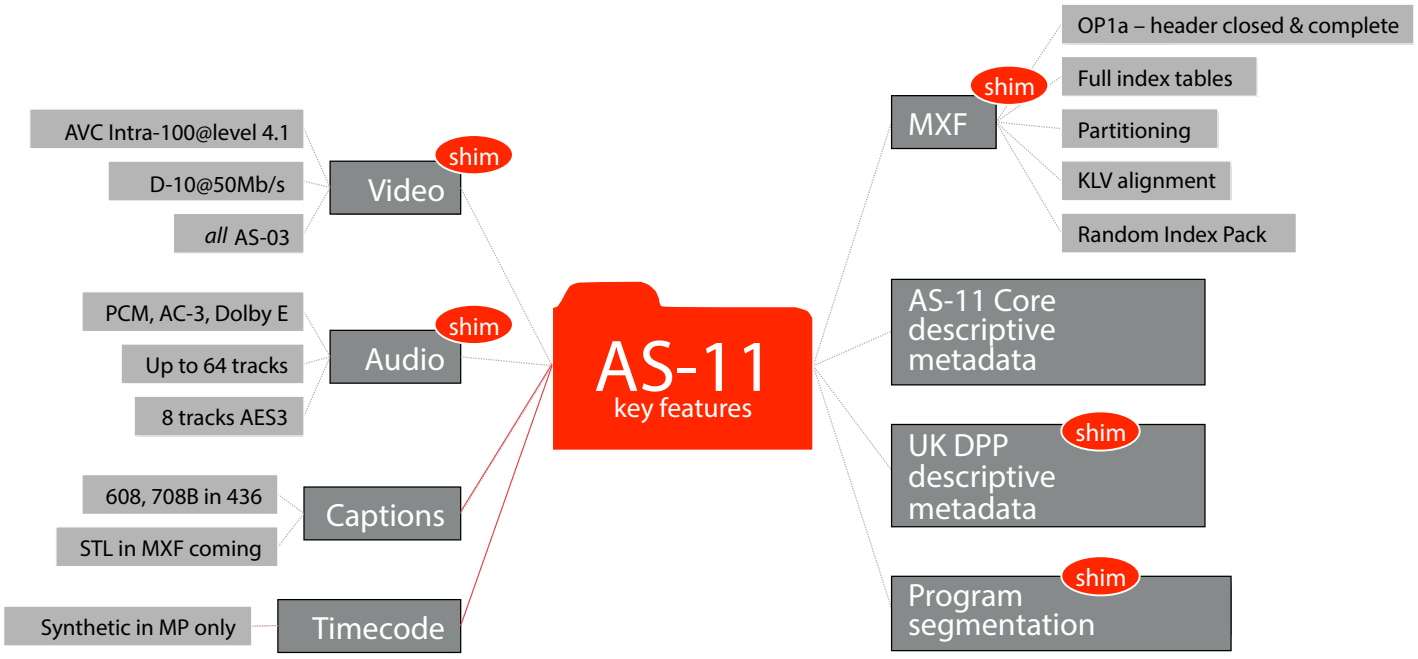


Figure 4. Key Features of AS-11.

Metadata

For U.K. use AS-11 will carry descriptive metadata that replaces the paper form in the tape box. The specification includes a small number of mandatory fields based on AS-03. In addition there are a number of optional fields that are specific to the U.K. DPP but can be used by any other organization, or alternatively replaced by their own set. Using this mechanism the metadata can flow from many diverse organisations through to the delivery point without error, uniquely identifying the program content for downstream usage.

Shims

Shims allow AS-11 to be constrained to the requirements of a broadcaster. For example a U.S. broadcaster may define video as 1080i59.94 or 720p59.94, excluding frame rates of 25 or 50 fps.

This allows AS-11 to be suitably generic, and meet the need of many broadcasters, but each individual broadcaster can tailor their own requirements without departing from the Specification.

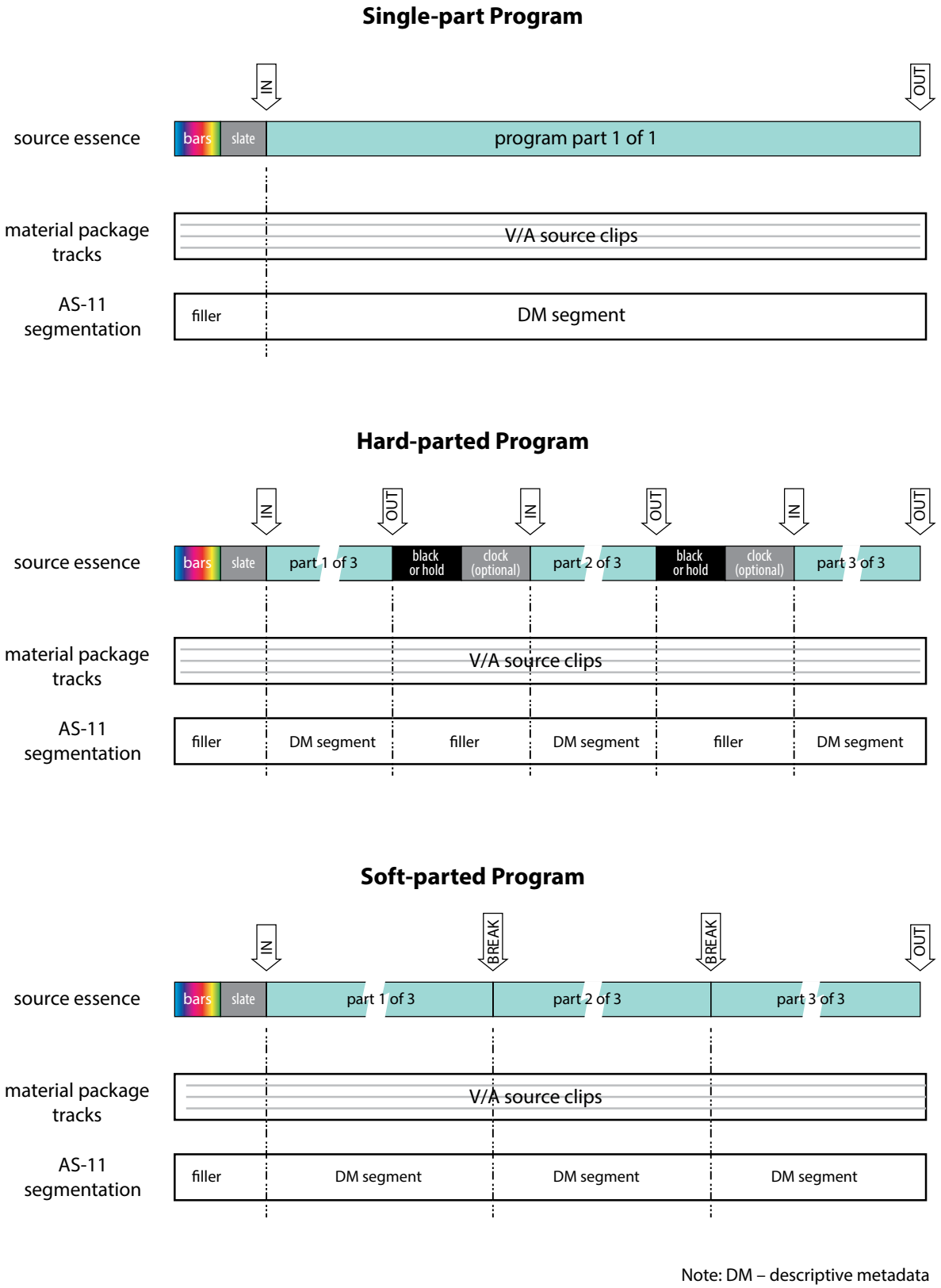
A broadcaster can define its own shim. Designated parameters within the Specification can be constrained. See Table 1 for the AS-11 parameters that support a shim.

For example, a shim could define the audio encoding to be AES, PCM and AC-3, and exclude Dolby E.

AS-11 is designed to be easily used by other organisations, take the base specification and simply define a new shim that suits your requirement!

Shim Parameter	Description
Video Encoding	One of: SD D-10, HD AVC-Intra, or an AS-03 video compliant encoding.
Video Format	One of: 480i, 576i, 720p50, 720p59.94, 1080i50 & 1080i59.94.
Audio Encoding	One of: AES3, PCM, AC-3, or Dolby E.
Audio Track Allocation	The set of permissible EBU R 48 and EBU R 123 track allocation names.
Closed Caption Presence	Whether the presence of closed captioning is required, not required, or optional.
Closed Caption Standard	One of CEA 608, CEA 7088. Note, future revisions of this specification may permit EBU-STL.
Timecode Mode	Drop frame or non-drop frame.
Default Timecode	The Default Timecode Value.
Additional Descriptive Metadata Schemes	The names of additional metadata schemes that must be included in the file.
Program Segmentation	Whether a Segmentation Track is required, not required, or optional.
Index Strategy Frame	Defines the position of the index tables in the MXF file.
Essence Partition Strategy	Defines whether the essence is a single partition or divided into multiple partitions.
Permitted AFD Set	Permitted AFD values drawn from the full set in SMPTE ST 2016-1: 2009.

Table 1. Parameters that support the use of a shim.



Note: DM – descriptive metadata

Figure 5. AS-11 metadata can be used to define the segmentation of a program into parts.

Questions about AS-11

Why use AS-11?

» As AS-11 gains acceptance amongst equipment vendors, the processes of file exchange become simpler. Content providers can create one version for delivery rather than many.

Who should use AS-11?

» Post-production facilities
» Transmission service providers
» Broadcasters
» Captioning facilities

Technical Specifications

» Video Compression
  • AVC-I 100
  • D10 MPEG-2
  • other codecs as specified in AS-03
» Audio
  • PCM, AC-3, or Dolby E
» AS-11 can also carry closed captions and other ancilliary data

For further information:

AMWA: www.amwa.tv

AS-11: www.amwa.tv/projects/AS-11.shtml

DPP: www.digitalproductionpartnership.co.uk

This paper was first presented at NAB 2012. To view the recordings visit:
http://vimeo.com/45514243
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If you are interested in becoming a member of the AMWA, please visit the AMWA web site at www.amwa.tv/join.shtml.