Introducing the AAF Edit Protocol

By the AAF Association, Inc.™

The Advanced Authoring Format (AAF)™ is a multimedia file format that enables content creators to easily exchange digital media and metadata across platforms, and between systems and applications. The AAF simplifies project management, saves time, and preserves valuable metadata that was often lost when transferring media between applications in the past.

The AAF Association introduces the AAF Edit Protocol™, a companion to the Advanced Authoring Format Specification, and the AAF Developers Toolkit. The Edit Protocol is designed to codify best practices for the storage and exchange of program metadata in AAF files. It defines constraints to the more generalized AAF Specification in order to achieve predictable interoperability of rich edit metadata. The Edit Protocol defines a predictable, dependable baseline for edit interchange between products from different companies.

AAF is the result of unprecedented cooperation and collaboration between media companies including the BBC, CNN, Warner Bros., Fox, Ascent Media; as well as equipment and software manufacturers like Avid, Adobe, BBC Technology, Digidesign, Discreet, Microsoft, Nucoda, Pinnacle, Quantel, SADiE, Snell & Wilcox and Sony. AAF has been developed and refined in an open source environment, freely licensed, without any cost for using the technology, including the many thousands of lines of source code and utilities available in the AAF Developers' Toolkit and reference implementation.

The Edit Protocol is the result of contributions from AAF Association member companies with experience implementing AAF in real products. The contributors have worked to identify and document the best practices for representing essential edit metadata, and ensure that the cumulative value of the editorial process is preserved. These practices have been tested between contributing manufacturers' products to ensure they work in practice as well as in concept.

The value of the AAF Edit Protocol lies in its abstraction of the editorial process. It separates editorial decisions from the media that is used as source material. AAF is founded on the concept that everything necessary to create a finished program can be represented as composition metadata, with multiple durable references to the media essence. By separating compositional metadata from media essence, significant advances are possible in many areas including

improvements is production workflow, process automation, media management, collaboration, catalog management, rights management, change management, version control, and better integration of creative tools with business systems.

To fully understand the value of AAF Edit Protocol, we must first understand the problem that it addresses. The Edit Protocol represents both the bridging of tape and film based media archives with a new generation of digital systems, and a means of marginalizing tape through the production process. EDLs, developed in the 70's, provide a linear abstraction of video edits; and it is this linear nature that has become their greatest limitation. A variety of EDL edit modes have been defined to optimize conforming. 'A' mode EDLs favor construction of edits based on the order edit events as they occur on the record tape. 'B' Mode lists reduce the number of times source tapes must be changed. EDL metadata is stored as simple text file. Despite the relative simplicity of EDLs, interoperability has by no means been assured. A cottage industry of software products grew to enable effective and efficient interchange of EDLs. For most video editors, cleaning, editing and optimizing EDLs has been a routine part of transitioning an edit from one system to another. EDLs remain in wide use today for edit interchange. However EDLs have not kept up with the rapid pace of technological innovation. Most common EDL formats have no syntax for referencing digital media files. Most EDL formats cannot handle more than one layer of visual effects such as dissolves, wipes, keys, at a time. More sophisticated image transformation effects remain proprietary. The SMPTE Standard 258M realized many improvements such as the ability to handle some visual compositing by employing the concept of 'virtual' events, and extending audio channel capacity to 99 channels. However, EDLs remain a linear format and AAF reflects the industry's evolution from linear to non-linear production.

For Film, AAF offers significant improvements over traditional Cut Lists, and Optical Pull Lists. AAF is capable of representing sources of any frame rate including 30 or 25 fps progressive and interlaced scanned video, and 24 fps film sources, film-to-tape transfers as well audio sources. AAF can also capture the relationships between generations of format conversion so as film is scanned, manipulated and printed, the original source information including keycode can be preserved. Lists referencing film edge code, or ink numbers are not well suited for the automation of processes possible in digital film production. All of the synchronization information relating to multiple capture systems can also be preserved with AAF.
Producers of content have paid a very high price for the myriad of inefficiencies inherent in legacy linear and tape-based production workflows. Tape based media essence has been expensive to store, locate, and distribute. Locating appropriate tape based source material is difficult and time consuming, requiring expensive decks and monitors for simple viewing. Maintaining the relationships between the original film sources and video transfers requires management, and 2:3 pull down required for conversion to NTSC is a constant source of problems. Tapes are easily lost or damaged. The duplication costs and redundancies typical of tape are costly. Tape formats continue to proliferate at an alarming rate. This all adds up to significant cost.

AAF has been developed in parallel with other important metadata standards and offer comprehensive support for SMPTE KLV Metadata and MXF Metadata. The AAF Association and the Pro-MPEG Forum have agreed to a Zero Divergence Doctrine (ZDD) and continue working to ensure persistence of metadata integrity across both formats. This will ensure the persistence of important and valuable metadata through the complicated film production chain.

Goals of the AAF Edit Protocol

The goal of the AAF Edit Protocol is to provide users with the most reliable mechanism for interchange of complex program metadata.

It is of paramount importance that the behavior of tools supporting the AAF Edit Protocol be predictable. Users must have confidence in the reliability of the Edit Protocol. Users must have trust that metadata will persist and expect predictable fallback behavior when an application is not able to process some elements of a file.

To achieve these goals, creation of the AAF Edit Protocol has been guided by the following set of precepts:

Simplest Structure

The Edit Protocol defines and promotes the use of the simplest data structure for any given situation.

Accuracy and Predictability

Interchange of metadata must be performed in an accurate and predictable manner. Accuracy is defined such that at the end of an interchange, given the capabilities of the importing application, the composition "sounds and looks" as much as possible like the original exported composition. Upon import, an Edit Protocol compliant application shall clearly report any alteration to the composition during the process according to fallback behaviors that are described in the Edit Protocol.

Import/Export Model

The Edit Protocol assumes an Import/Export model where metadata is imported from or exported to an AAF file. In this model an application is not required to import, maintain and subsequently export metadata objects from the AAF file that it cannot understand. The AAF file is not edited, but rather a new AAF file is created that reflects the changes made. When a new AAF file is created a new unique identifier is assigned ensuring that version tracking and heritage can be preserved.

Application Feature Set

The Edit Protocol does not prescribe the required feature set of the target system. The Edit Protocol refers only to interpretation of AAF files into existing feature sets. For example, an audio workstation does not need to add video capability in order to be compliant; nor would a cuts-only editor need to add support for complex visual effects, nor would a metadata-only media management product be expected to perform editing functions.

Non Edit Protocol Objects and Dark Metadata

The Edit Protocol does not address interchange of valid AAF objects defined outside its scope. Metadata objects outside of the scope of the Edit Protocol can be interchanged. However, inclusion of extraneous data (i.e. non-Edit Protocol Objects and/or Dark Metadata) shall not invalidate, obfuscate or change the meaning of the core Edit Protocol data. The interpretation of AAF Edit Protocol Metadata must not be dependant on non-Edit Protocol metadata.

Importing, Fallback Handling and Logging

It is recognized that the functionality and feature sets differ significantly between products and among manufacturers. The goal of the importing and fallback handling specified in the Edit Protocol is to ensure that differences in metadata handling are handled gracefully on import to an application, so that the user experiences a work environment where there are "no surprises" and where AAF exchanges behave in a consistent way.

Makeup of an AAF Edit Protocol File

An Edit Protocol file is a structured storage based instantiation of the powerful AAF data model. The file contains a collection of object-based data including the file *Index* which locates all the other objects in the file, *Material Objects* which represent AAF metadata, a *Dictionary* for defining metadata objects that extend the AAF data model, and possibly *Essence Data,* the actual encoded media.

The Edit Protocol defines baseline of metadata required to facilitate sharing of complex compositions. Edit decision information, such as source and record time codes, source tracks, physical source names, frame- and sample-accurate clip definitions, clip- and time-based comments, clip names and track names are supported by the Edit Protocol. Metadata capturing visual effects information, including dissolves, SMPTE wipes, 2D DVE spatial positioning and zooming effects, frame repeat effects, motion and speed change effects, flip and flop effects, as well as composite layering effects are also specified. There is support for audio data, such as clip- and track-based gain, stereo pan, fade in and out, symmetrical and asymmetrical crossfades and MIDI data.

The Edit Protocol also accommodates the optional embedding of media essence within a file, such as production audio files, and non-AAF files, such as scripts, logs, etc.

Metadata and Material Objects

AAF uses an object based data model to represent complex metadata relationships. The items of material metadata are called Material Objects or Mobs. There are seven kinds of Material Objects that form the building blocks for AAF. An AAF file typically contains a number of Mobs. The Mobs reference one another to describe a derivation chain or Mob Chain. The derivation chain describes the relationships between edit decisions, clips, file source material and physical source material such as film reel, sound or video tape.

The Edit Protocol provides three ways to specify the source material associated with a clip:

- Clips with media essence stored internally to the AAF file together with the physical source metadata
- Clips that reference media essence stored externally to the AAF file together with the physical source metadata
- Clips that reference physical source metadata only

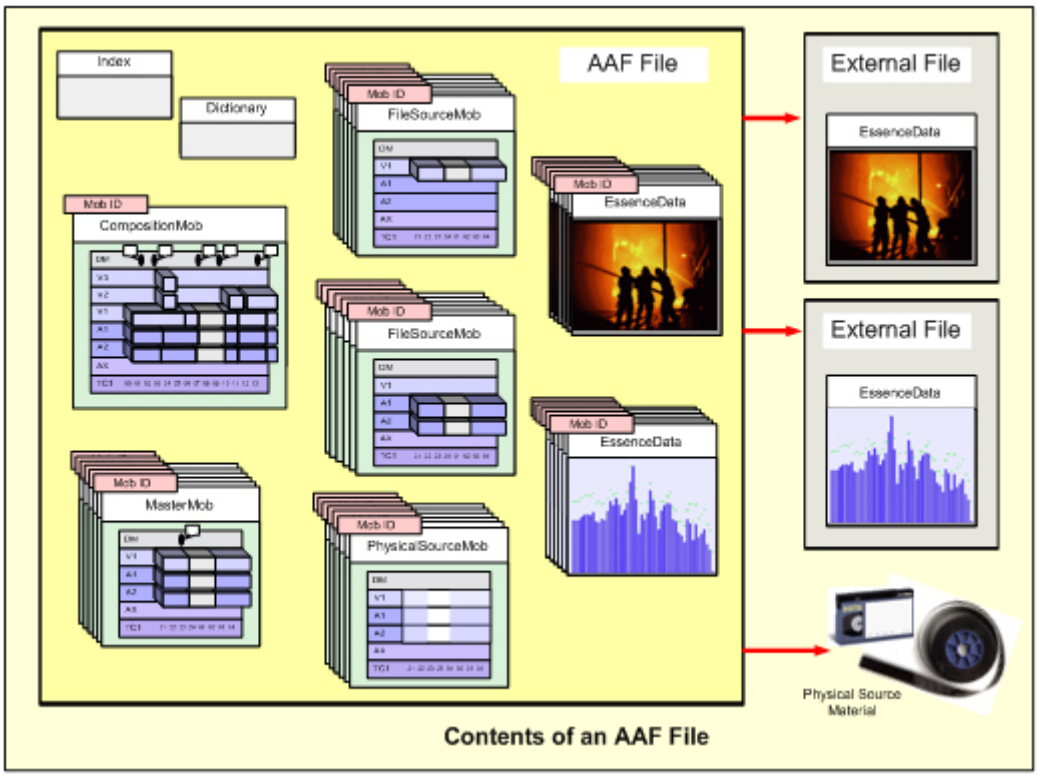

Figure 1: Typical contents of an AAF file

Mob IDs

Every Mob has a unique identifier or Mob ID. The Mob ID is a universally unique identifier that enables indelible referencing of other material objects, both within files, and externally. The unique Mob IDs also enable powerful database applications supporting the AAF data model. Unique identifiers for object based data are very common in the software industry. A number of unique identifier standards are supported in AAF including SMPTE UMIDs and software GUIDs. Vendor and user defined unique identifiers may also be used as the Mob ID. The Mob ID functions like a 'license plate' for every metadata object so that they are easily and accurately identifiable. It would not be unusual for an edited scene to include thousands of Material Objects, each with its own unique identifier.

Compositions

Edit decisions are represented as a composition in AAF and are specified using a Composition Mob. The Composition Mob contains tracks for video, audio, timecode and other temporal and static metadata. A Composition Mob can reference another Composition Mob, a sub-clip Composition Mob or a Master Mob.

The metadata contained in a Composition Mob may include:

- Edit Decision information, such as source and record time codes, source tracks, physical source names, frame- and sample-accurate clip definitions, clip- and time-based comments, clip names and track names.
- Visual Effects information, such as dissolves, SMPTE wipes, 2D DVE spatial positioning and zooming effects, frame repeat effects, motion and speed change effects, flip and flop effects, as well as composite layering effects.

- Audio Data, such as clip- and track-based gain, stereo pan, fade in and out, symmetrical and asymmetrical crossfades and MIDI data.
- Embedded media files, such as video and audio files, as well as non-AAF files, including scripts, logs, etc.

Compositions reference, or are derived from other compositions, sub-clips and clips. This is the same as saying that a composition uses compositions, sub-clips and clips as source materials. An AAF file may contain any number of compositions. There are also several special types of compositions each designed for usage in ways that should be familiar to those with content creation experience. The special case sub clip composition represents the editorial.

Clips

Clips are represented by Master Mobs in AAF. The Master Mob does not contain the media essence but instead describes, and points to the media essence. This creates a powerful level of indirection, and is key to how AAF enables interoperability between a variety of tools, from simple Web based browsing and logging applications to high definition confirming products.

AAF provides three methods of specifying the source material associated with a clip:

- Reference to source material stored internally to the AAF file and physical source material
- Reference to file source material stored externally to the AAF file and physical source material
- Reference to physical source material only, such as video tape or film

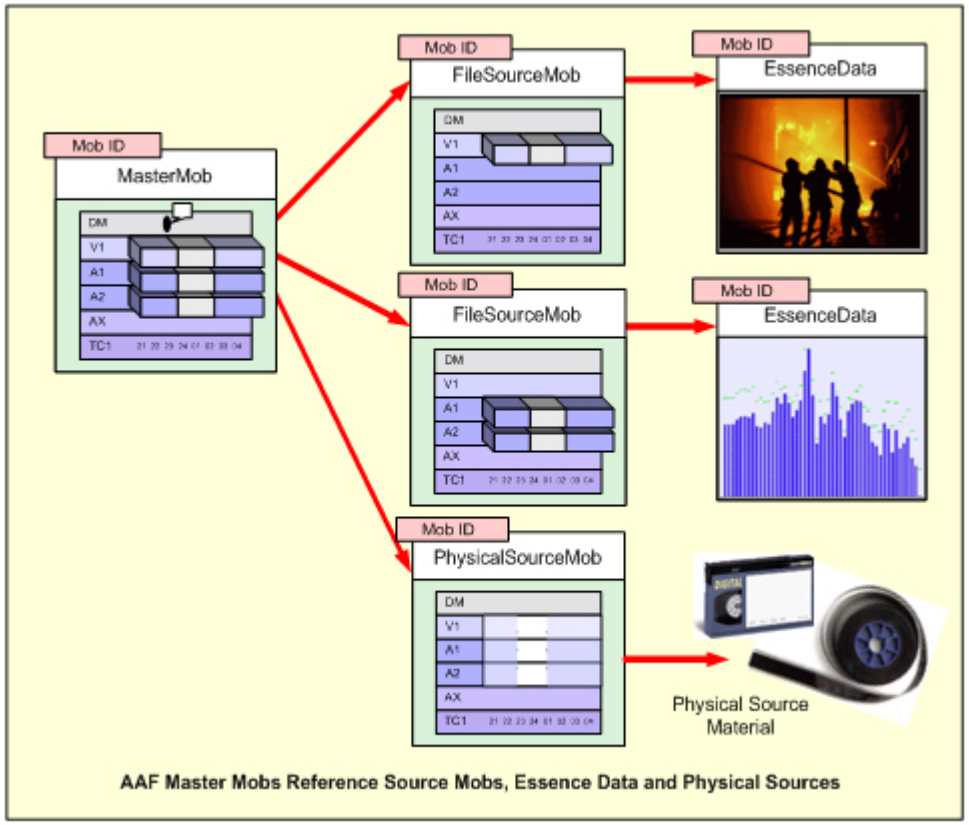

Figure 2: Master Mobs Reference Source Mobs, Essence Data, and Physical Sources

The illustration above shows the relationship between a segment in the Composition Mob and the Master Mob that it references. The composition identifies the tracks, offset and range of the clip. All other clip related metadata remains an attribute of the clip. Changes to the clip metadata will be available by reference from the composition.

Clips reference the following kinds of source material:

- File sources
- Imported sources
- Tape sources
- Film sources

Effects

AAF employs the powerful concept of Operation Groups to express effects. Operational Groups may be used to represent segment or transition effects. Effects are one of the most challenging areas of interchange and the AAF Edit Protocol has made great strides to improve interoperability over earlier edit interchange standards. For effects for which standardized metadata definitions are not available, Operational Groups may be rendered, generating new media essence clips to ensure successful interchange. Below is a list of effects for which support is defined in the AAF Edit Protocol.

Effects Defined for Interoperability Using AAF	
Dissolve Effects Wipe Effects Motion Effects Frame Repeat Effects Flip & Flop Effect Spatial Positioning and Zooms (2D DVE) including: • Moving the Image • Cropping of the image • Scaling the image • Rotating the image • Corner pinning	Layered 2D DVE Effects Key Effects • Alpha Channel Matte Key Definition • Alpha Key Over Video • Luminance Key • Chroma Key Effect Audio Gain Effects Audio Clip Gain and Track Gain Audio Track Pan Effect Audio Fade Effect

Figure 3: AAF effects supported in the Edit Protocol

Conclusion

The AAF Edit Protocol represents significant investment over a number of years to solve a problem that has plagued this industry. The issues of cross-platform, multi-vendor metadata interchange have been addressed collaboratively by the AAF Association members. The AAF Edit Protocol represents a watershed for the end-user community, significantly raising the bar for editorial interchange. The AAF Edit Protocol together with the AAF Specification and AAF Developers' make implementing the complexities of rich edit interchange achievable for all manufacturers.

The AAF Edit Protocol contributes significantly to simplifying the task of developing AAF support for new and existing applications. AAF Association members have taken a major step forward by codifying the best practices learned as a result of implementing AAF in their products and sharing their experiences openly with one another. Companies that are otherwise staunch competitors have come together to achieve this common goal, and deliver on an important promise to the industry.

References

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4. IETF RFC 1738 – Uniform Resource Locators (URL)
5. IETF RFC 2396 – Uniform Resource Identifiers (URI)
6. SMPTE 320M – Channel Assignments and Levels on Multichannel Audio Media
7. SMPTE 258M – Transfer of Edit Decision Lists
8. MIDI Specification Version 1
9. The AAF Developers' Toolkit, available as open source at http://sourceforge.net/
10. AAF Association Web Site, http://www.aafassociation.org

About the Advanced Authoring Format Association

With representatives from major industry players, The Advanced Authoring Format Association, Inc.™ (www.aafassociation.org) is dedicated to the development, promotion and adoption of AAF technology throughout the media industry. The Advanced Authoring Format (AAF) is a multimedia file format that enables content creators to easily exchange digital media and metadata across platforms, and between systems and applications. The Advanced Authoring Format simplifies project management, saves time and preserves valuable metadata that is often lost when transferring media between applications.

Incorporated in 2000, the AAF Association™ is represented by leading players in the industry including Adobe Systems Inc., Ascent Media, Autodesk, Avid, British Broadcasting Corporation, DiskStream Inc., Metaglue, Microsoft, Quantel, Siemens Business Services, Snell & Wilcox, and Turner/Time Warner.

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