

The User's Guide to

META DATA



What's it all about and what
can it do for your business?

What is Metadata?

The concept of metadata in the TV production environment is nothing new. Metadata means data about the data, so any form of notation relating to video and audio can be classified as metadata. Timecode is metadata. So are edit decision lists (EDLs).

All the notebooks, clip-boards, post-it notes, floppy disks, hand written messages and schedules that accumulate in a TV production office are metadata, if they relate in some way to what appears in the final product that appears on screen. Metadata also covers the links and pointers to where contract and re-use information for programs is held.

The simplest example of metadata is the label on a videotape, that simply tells you what is recorded on the tape.

What metadata means now to those broadcasters looking to the future is a method of handling information that will be at the core of all new TV station infrastructures. These are increasingly going to be based on IT technology and rely on networked production techniques.

Metadata is going to change the way you work

Metadata is fundamental to the way broadcasting is changing – its importance can't be emphasized enough. As the economic model for broadcasters everywhere gets tighter, far more weight is placed on efficiency in every aspect of the broadcast chain, from pre-production right through to transmission and reception by the customer.

Just as the switch in newspaper publishing to electronic methods of production reduced overall costs and allowed much more flexibility in what could be published, this change in broadcasting will be a power-house for the more effective use of investment.

Digital technology has already delivered benefits throughout the broadcast chain.

Digital transmission allows broadcasters to multiply the number of channels they can broadcast in the spectrum they've been allocated. Digital technology also allows more efficient management of those channels, reducing the number of people required to manage the transmission of multiple channels, which in turn has fuelled the huge increase in satellite and cable channels.

What is more, the customer is now demanding higher levels of quality from the broadcast service. They are more likely than ever to switch channels or services if they find their viewing disturbed. We're moving toward an era where only the quality providers will suffice. Quality of service is as much to do with smooth working as economic efficiency.

MXF, AAF, EDLs and Metadata

MXF and AAF share a common data model (see panel on Metadata, Models, KLV and XML- page 4). The key properties of MXF and AAF are the representation of timelines. These new formats create robust definitions of how material is synchronized, how material is overlaid and which bits of the essence relate to timecode – even when the timecode is discontinuous.

These new formats provide rigor where the older EDL technology meant that hand editing of EDLs was nearly always required for interchange. Now that time can be reliably represented and extensible physical representations have been implemented for MXF and AAF, the addition of metadata to timelines can be implemented.

This metadata could be “structural” in nature – the description of picture size in pixels and lines or an AAF effect such as a wipe. The data could be descriptive, such as a comment, shot log, title or location name. It could also be “intimate” such as a depth map, QC control parameters or list of GOP boundaries.

The extensibility and openness of MXF and AAF allow any manufacturer to “join the club” and create their portion of workflow based solutions for the future.

However, more efficient higher quality broadcasting requires far more efficient use of the information needed to fill those channels with programming, to sell and monitor advertising, and keep the whole system running faultlessly 24 hours a day.

Now digital technology enables broadcasters to more easily re-purpose their programming for different platforms and multiple channels.

Metadata is a part of this digital revolution in broadcasting - as an integral part of the move to new workflows and as an enabler of networked production. Effectively designed metadata will underpin all the improvements to workflow that networked production is bringing to broadcasting and to the facilities world.

What will Metadata do for my business?

The use of metadata will be at the heart of the move to more cost-effective TV production and broadcast. It will play an integral part in allowing the processes involved to be networked together. This is because metadata is the core enabler for the information provision and retrieval processes. It is fundamental to the changes in working practices and workflow that will provide those efficiencies.

The cost savings of this move to networked production could be enormous. The integrated nature of the workflows it makes possible are ideally suited for the re-purposing of programming across multiple channels and multiple platforms, allowing far more output from the same pool of people, as they share the production processes.

With an enterprise-wide, dynamic information-handling system based on the use of metadata, it becomes much easier to introduce new business models and integrate services across departments.

Broadcasters are already beginning to install such systems. Typically the reasons they give for doing so include the fact that it is essential to move to a networked production system based on IT technology in order to maintain the sustainability of the whole broadcast operation.

Who is using Metadata?

This transition to networked production began in TV newsrooms (see pages 5 & 6).

The concept of the networked digital newsroom entailed a complete re-thinking of the production workflows involved – with perhaps the most publicized element being the new-found ability for journalists to edit their own video and audio on the same desktop workstation on which they wrote the script. In many cases, this has led to a huge improvement in productivity and even the quality of news broadcasts. It's estimated that the production process for news involves the manipulation within the newsroom of ten times the running time of the material that eventually makes it to air. So networking this amount of material and managing it more efficiently can greatly increase overall productivity.

Entering both the raw content and its attendant metadata just once, at the point of ingest, is an important factor in most digital newsroom implementations. It enables any journalist linked to the system to call up whatever has been ingested, as a browse copy, and begin the process of story preparation, or of re-purposing and re-versioning previously transmitted stories.

The networked system enables a more streamlined workflow. The original broadcast-quality master version of the ingested material is preserved on broadcast servers. This material is only conformed into a final cut from browse edited copies at the point of transmission, using the EDL metadata. It means that only the EDL metadata plus the ingested content needs to be stored. Some kind of media management system is required to integrate and control this and the wider processes involved, but all such systems rely on the underlying metadata.

This IT-based networked workflow, serviced by effective metadata, is already making a big impact in the news production environment. It promises to spread the same benefits to other parts of the broadcasting business.

Video facilities have benefited from networked production too.

Those facilities that have networked their edit, graphics and effects suites together, can now offer multiple teams working on one production simultaneously.

There are clear advantages for such facilities and their clients. These include the ability to share media between different work areas, condensing the time for post production, overall cost savings and flexibility in terms of what can now be done with the raw material.

Just one example is a multi-camera concert shoot, where team-working, with several edit suites networked together, working simultaneously on the rushes, can produce a program for transmission far faster than the normal post production schedule.

How much storage?

Metadata is really small in comparison with your content, but its importance should not be underestimated. The following table gives a comparison guide with different video bitrates:

kB= kilo-Byte (10³), GB=Gigabyte (10⁹)

Average OP1a MXF header	10kB
26m 40s of 5Mb/s broadcast MPEG	1GB
5m 20s of 25Mb/s DVC-Pro	1GB
4m 46s of 28Mb/s 422P Long GOP MPEG	1GB
2m 40s of 50Mb/s DVC-Pro or D-10	1GB
1m 20s of 100Mb/s DVC-Pro	1GB
0m 20s of 270Mb/s SDI	1GB
0m 22s of 360Mb/s SDI	1GB
0m 07s of 1.2Gb/s HD-SDI	1GB
0m 04s of 1920x1080x24p(10bit) RGBa	1GB

Where to start with Metadata?

In the new digital environment, metadata is the key concept enabling an enormous increase in broadcast efficiency based on information technology.

The concept of metadata as it is currently formulated for the world of TV, usually means the descriptive data about the video and audio that form the content, or 'essence' as it is sometimes called. In the editing environment, metadata can describe all the video and audio tracks, graphics and effects in an editing timeline. For finished programs, metadata can describe not just how the program was made, with links to the script, but also refer to what the rights of use to it are, and who holds them.

There are a number of different methods of noting down and storing information necessary to production currently in use. This can often mean that the same information has got to be constantly entered and re-entered into different information systems. The advent of PCs and word processing hasn't necessarily helped this process, since the addition of different systems just means more re-entering of the same data, with all the consequent opportunities for human error.

This is where an organized and facility-wide system of metadata to underpin new workflows can help broadcasters save time and make money.

But it does require broadcasters to examine their current practices and processes very carefully.

No implementation of a metadata system is likely to be successful unless the organization planning to use it has performed a comprehensive analysis of how their operation works now, what the current workflow is composed of, and what improvements need to be made in any new workflow.

The essential processes and activities involved in the operation need to be defined sufficiently so that they can be incorporated in a workflow backed up by metadata.

The metadata that different broadcasters use and how they use it may differ, but there are standards emerging in this area that can help tailor systems for individual broadcasters.

There is no 'one size fits all' approach in the use of metadata.

Once the analysis of current workflows has been done and a plan made to implement new workflows, those new workflows need a data model which will determine specifically what metadata is required to service the workflows. This data model and the sets of metadata that form it can then be represented in a suitable metadata language – some of which have been developed specifically to service the needs of broadcasting.

These data models can cover single business areas or be enterprise-wide, but consistent naming conventions and definitions are required together with the clear definition of the relationships between different data items.

The process is likely to be done with the needs of a content management system in mind, of which there are more and more in the marketplace. A careful analysis of a broadcaster's workflow requirements is also likely to suggest an appropriate level of content management. 'Clean data modeling' has emerged as a key concept in determining the successful implementation of a metadata based system.

The analysis of the business requirements for a move to a networked workflow, the data modeling of the information relationships that will drive it, and the subsequent way that data is represented, are all important elements that form the foundation of a successful move to IT-based production.

Metadata, Models, KLV and XML

Everyone's heard of XML. It's the great white hope of data interchange, but in reality it's just another language. Like all languages, it can be used well, or it can be used badly. One of the most important things to understand is that XML is just a tool for describing something. That "thing" must be well defined, or "modelled" otherwise describing it will never be well done.

An example is buying a car. You need to specify the make, model, color, interior trim and engine size to get what you want. You can use XML to carry this information, but it is just a language for carrying the information, it doesn't make the decisions on what properties are important for you.

AAF and MXF share a common data model. This means that they have the same relationships between their timelines and the underlying essence. You can physically write this onto a disk using KLV (for MXF) or structured storage (for AAF), or even XML. The most important quality brought to the industry from AAF & MXF is the fact that the relationships between a production timeline, the video, audio and data, the effects and the metadata are defined with a consistent and common data model. This data model is the key to real business oriented metadata interchange. The physical representation as KLV, XML or even database records is of secondary importance.

How to use Metadata

The general idea is to get to the position where you automatically create or enter the information – you may add further information (metadata) as more processes happen to that piece of content, but there's no longer a need to keep entering the same information to satisfy the needs of different databases. An effective metadata-based system will automatically inform appropriate databases of the information they need to know, and only that information, when that information is first entered into the system.

So where do you begin notating and adding metadata to content?

For news, it can be the point where new material is ingested into the digital newsroom system, when all the journalists have access to it. For other production areas, where more considered, long form programming is being made, different criteria will apply.

One answer is to start adding metadata at the point you first think up the content. This could start with the idea for a program.

Once that idea is generated it is entered into a pre-production database, an identifier added and its history of metadata begins.

Metadata accumulation is a dynamic process. Clearly, as a program idea progresses from idea to the research stage, to a script, production and post production, right through to transmission, all the separate processes and contract information associated with that program have to be noted and stored. Different databases may be used – for instance rights information and editing information may be stored in completely different databases - but the links to where that information is stored are carried with the content itself in its metadata file.

The ingest process will always be an important time at which to organize the addition of relevant metadata, as new content enters the broadcaster's data network. For example, at this stage some form of quality control metadata can be added, along with descriptive metadata as to the form the content is in when it enters the system, i.e. what compression system it uses, what its aspect ratio is and so on. As with news, it's also at the point of ingest that you would transfer high quality broadcast copies of new content into a broadcast server. Then you would make lower resolution proxies. These become work copies for wide distribution through the network so that different processes required on that content, with metadata carried for the later conform process. Clearly, it's important to record what happens to every piece of content once it enters a broadcaster's system all the way through its life. And that's what metadata is used for.

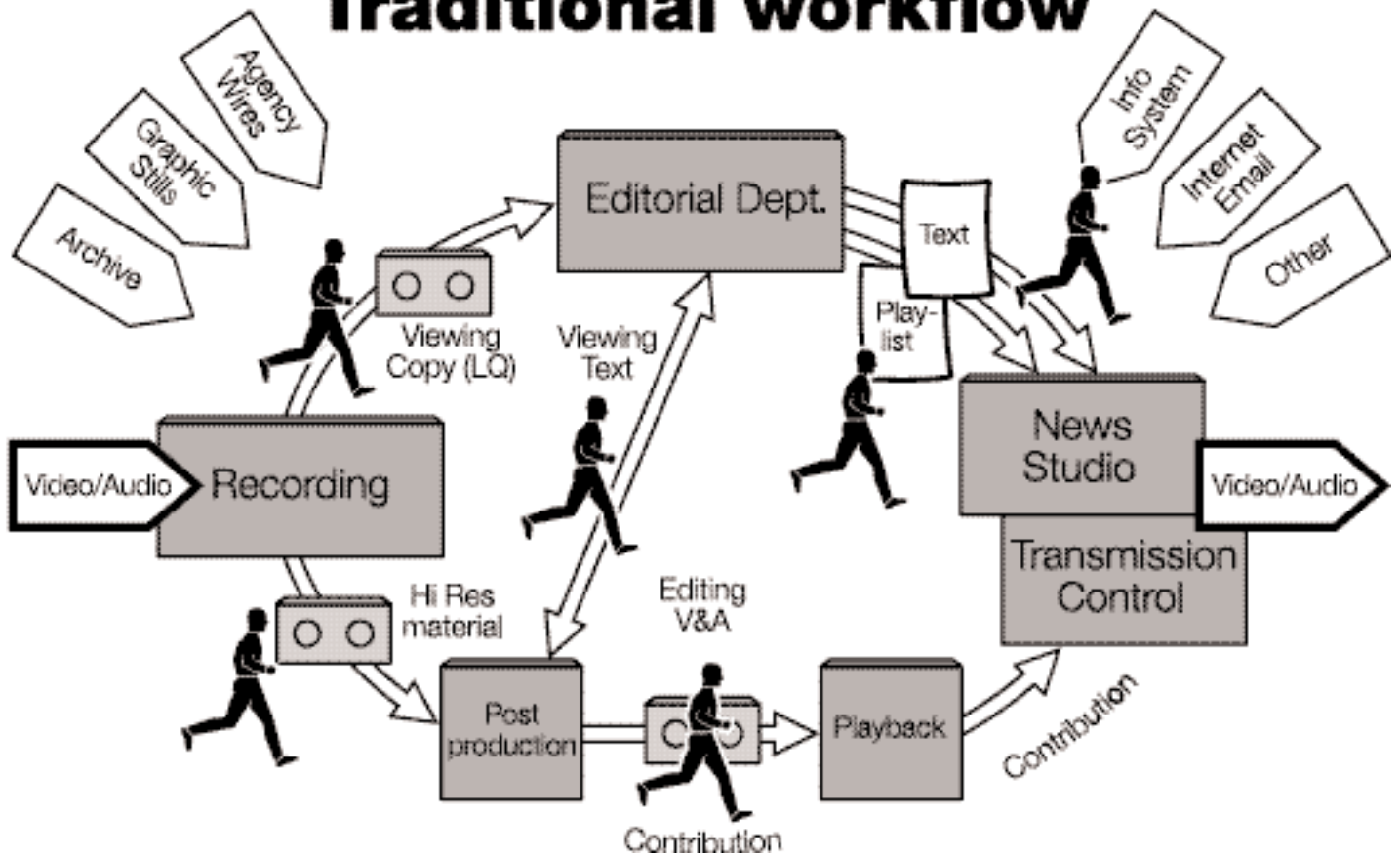
What Standards are Available?

The EBU/SMPTE joint task force on the exchange of program material as bitstreams, was one of the first TV industry initiatives to identify how important metadata was to become.

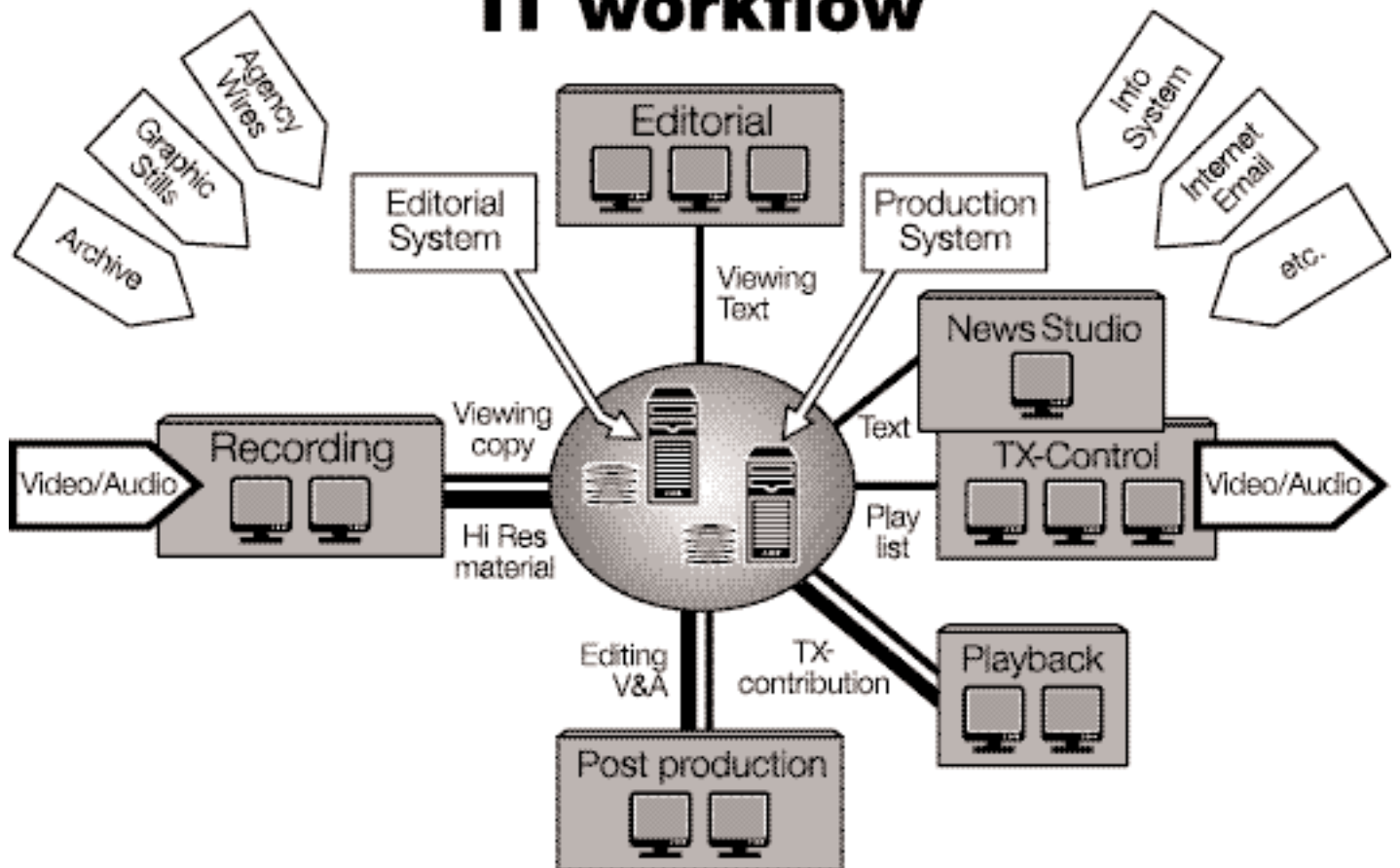
As the twentieth century drew to its close, many of the industry's leading technologists spent a couple of years researching and reporting on what was required for TV worldwide to make the most of the digital revolution at the beginning of the twenty first century.

It identified that the technology systems used within the production and distribution environment would inevitably move towards information technology, with the great advantage that networked production would become a reality. Instead of having to constantly copy or ferry around videotapes, a central store of video, distributed over a computer network, would simplify the production process by allowing far more people access to the same content. It would allow different people to perform their specific tasks on the material at the same time, and generally speed up the production and approval process – while also allowing broadcasters to know exactly the status of their program inventory, and what they could do with each element of it. It would also make it much easier to re-purpose content – another key concept in the new world of multichannel TV, when there's so much more airtime to fill.

Traditional workflow



IT workflow



AAF (<http://www.aafassociation.org>)

AAF is a non-profit industry body which is supporting a number of specifications:

1. The AAF data model specification (used by MXF)
2. An API Specification
3. A bytestream specification

in addition, there is also

4. A software developers kit
5. A registry of data types and labels
6. a lot of documentation
7. a conformance plan & protocols

Snell & Wilcox engineers are very active members of the AAF board. Snell & Wilcox engineers also chair the conformance activities of AAF which aim to get agreement amongst end users and manufacturers on the functionality and definition of effects, transitions and synchronization of essence.

The metadata which performs these functions is within the AAF data model, but the precise interpretation of its use is vital for the success of metadata based workflows in a file based environment. AAF is targeted at the post production industry and offers the possibility of true cooperation between manufacturers to provide the best solutions for the end users. The complexity of these systems should not be underestimated, that's why Snell & Wilcox has developed MetaShare – a collaborative metadata server based on AAF, which gives a fast-track to interoperability for anyone wishing to add scalable AAF and MXF functionality to their applications and products.

File Formats

It soon became clear that if IT production techniques were to come into TV, they would have to be tailored to the specific requirements of TV professionals. They would need to meet the standards of reliability required for example and to cope with the size of data file needed to store a video picture.

Just as standards made sense in the analog TV world, and in the subsequent world of digital video, notably with the 601 (SDI) standard, so it would also make sense to formulate standards for the exchange of TV programs as data in the IT environment.

Where and what to standardize for TV requirements is important however, and a consensus emerged that it would be better not to have standards for the networking and control elements of IT based systems, as there were enough choices there already to allow broadcasters with different requirements to make decisions relevant to their own needs.

It was also important not to limit the ability of broadcast equipment suppliers to compete with different production and distribution systems, and the components that fit within them, or to limit competition between different asset management systems.

What was important was to allow as much interoperability as possible between different production and networking systems - content creation systems, workstations and video servers.

There was already substantial work under way to ensure interoperability between equipment from different manufacturers using the same compression formats. What was also required was an exchange mechanism that could pass material between different systems, whatever compression format it used – one that kept not only the video and audio intact, but also all relevant metadata, and/or links to it.

It was decided the best way of achieving the interoperability required within a networked based system using content coded as data files, was to establish a universal file format that can wrap video, audio and metadata and pass it through the IT network as a data package between different systems

MXF and AAF

Two file formats were initiated, to meet first the requirements of program exchange, and secondly the deeper material manipulation requirements of program production and post production.

These are respectively, the Material Exchange Format (MXF) and the Advanced Authoring Format (AAF), which are now generally recognized by broadcasters as the key formats required for the coming revolution of networked production using IT systems.

They are in fact linked. MXF is essentially a subset of AAF, specifically designed for program interchange and has almost completed the process of standardization within SMPTE, which will give it the seal of approval for use worldwide in the new digital environment.

AAF is a more dynamic file format, best described as an 'interchange toolkit' for post production. It will become essential in moving segments of moving images, sound and metadata between different systems, right down to frame level. AAF has to cope with the most demanding requirements of complex post production in both TV and digital cinema production, where many processes often need to be performed on the smallest pieces of content.

Unique Identifiers

Both MXF and AAF use metadata, and can make use of a variety of metadata schemes, built into their designs, to suit the particular purposes that users will want to put them to.

The environment in which these formats will be working is one of servers – basically high capacity, fast computers that store video and audio.

In this environment metadata becomes very important because it is the first link to identifying what the material in the servers is, and how it can be used.

Since this will be a world where labeled videotapes are no longer the basic building blocks of production, accurate metadata identifying all video and audio will become essential. 'Lost' video in a server is no more useful than a lost master tape.

An important fact to remember about metadata is that not all of the information about a particular piece of video or audio has to be physically present with that content i.e. actually embedded in the same data package. In fact, it's expected that most metadata will actually be stored elsewhere, in dedicated databases and metadata servers.

MXF (<http://www.mxf.tv>)

MXF is a SMPTE standard. It is the result of several years hard work from a vast number of contributors. Snell & Wilcox has been heavily involved from the start. We are on the board of the Pro-MPEG association which started the work. We have been a leading player in the design of MXF by leading projects such as G-FORS and working within Pro-MPEG and the AAF association to get agreement amongst manufacturers, broadcasters and users.

Snell & Wilcox engineers also hold the posts of Chairman of the File Interchange working group, Chairman of the MXF Implementers group and Editor of the 13 MXF documents. As MXF rolls out into the industry, you will see MXF appear in existing and new Snell & Wilcox products, not only for direct sale, but also for 3rd party OEM developers.

If you want to read the MXF standards, you can obtain them from the SMPTE (<http://www.smpte.org>).

The documents are:

SMPTE 377M	Format
SMPTE 378M	OP1a
SMPTE 379M	Generic Container
SMPTE 380M	DMS-1
SMPTE 381M	mapping MPEG
SMPTE 382M	mapping Audio
SMPTE 383M	mapping DV
SMPTE 384M	mapping Uncompressed
SMPTE 385M	mapping SDTI-CP
SMPTE 386M	mapping D10
SMPTE 387M	mapping D11
SMPTE 389M	reverse play
SMPTE 390M	OP-Atom
SMPTE 391M	OP1b
SMPTE 392M	OP2a
SMPTE 393M	OP2b
EG41	Engineering Guideline
EG42	DMS Engineering Guideline
RP224	Labels registry
RP210	dictionary

We strongly recommend you read EG41, the Engineering Guideline. Not only was it written by Snell & Wilcox, it's a lot easier than the other documents!

But clearly what does have to be embedded with each piece of content are pointers and links to where the metadata is stored.

To make this part of the process easier and more reliable, a form of universal tag or label for content in the IT environment was initiated. This is the unique material identifier or UMID, which has been standardized by SMPTE and will form a key part in metadata and asset management systems. The UMID can link the material and metadata in the file itself with any metadata stored elsewhere.

Along with other identifiers for content – for instance a GPS identifier that can tell you precisely where in the world an item of video was shot – the systems are in place to ensure any piece of content can be securely and reliably located.

Once the UMID was agreed and standardized, it became important to generate the metadata schemes for the new file formats, that could also be agreed and standardized, so equipment suppliers and broadcasters using these specific metadata schemes could rely on accurate interchange of video and audio elements.

The Importance of Standards

MXF was initiated by the Professional MPEG Forum, set-up to improve the interoperability of equipment in the MPEG2 domain, and the work on MXF was progressed with the co-operation of the AAF Association, which is the lead body developing AAF.

Both these organizations count leading equipment manufacturers and broadcasters amongst their members, so MXF and AAF can truly claim to represent the best that the whole industry can offer, after a period of unprecedented collaboration between companies and broadcasters.

Descriptive metadata schemes were agreed for both MXF and AAF, with the input of not just the trade associations mentioned above but also important industry organizations such as the EBU and SMPTE. In fact, SMPTE formulated a metadata dictionary and metadata registry for use by the TV, radio and cinema industries, to simplify the route to agreed and exchangeable metadata schemes.

It should be mentioned here that work on devising additions for these file formats is not finished. They are open standards, and are open in particular to new metadata elements and standards.

Both MXF and AAF have been designed to allow different metadata schemes to be included via a plug-in mechanism – so the way is open for improvements as they emerge.

These formats have only developed at all because of the cross-industry efforts by many manufacturers and broadcasters. There is continuing scope for more companies and broadcasters to become involved in the trade associations and industry bodies that evaluate suggested improvements to the existing standards. Both MXF and AAF are dynamic standards and the range of things they can be used for is expected to develop into other image communication business areas.

Metadata can be instructive as well as descriptive. In the higher operational patterns of MXF, different versions of the same content can be carried in the same file – for instance different language versions of the same program. So there would be metadata to tell you which bits of the file you need to output the program in a particular language.

In AAF, the descriptive and instructive metadata can go much deeper, containing not just the timeline of all the processes performed on the content, but also giving instructions on which of these processes to blend for a specific outcome – for example the cross fading of specific audio tracks, or wiping between different video sources. AAF can contain as metadata the information required to accomplish certain effects and transitions.

Capabilities such as this can create huge benefits in the post production environment, since they allow for the seamless transfer between different creation systems.

The same piece of content travels from one to another, containing not only descriptive metadata of what's happened to it, but also instructive metadata describing what needs to be done to it, so that when it arrives at the system that's capable of accomplishing that specific function, that instruction can be carried out.

Metavision

Advanced metadata handling can modify the way in which essence is handled. The Snell & Wilcox led Metavision project is researching into advanced workflows based on the principle of "shoot properly once, repurpose many". The project seeks to demonstrate the principles of metadata tracking and exploitation using the power of the MXF format. Content is shot using high frame rate, High Definition with 3D assistance. Subsequent processing steps track different versions, compression processes, 3D metadata processing, annotation and repurposing using the MXF file format for metadata tracking. Open standard wrapping of the metadata and association with the timeline of the captured material brings several benefits. Existing applications with no knowledge of the special metadata can still make use of the captured source files, even though some of the information to is dark to them. The final conforming applications consolidate all the metadata and create the final version(s) of the program

The Metavision project comes from a long line of successful European Projects involving Snell & Wilcox, the BBC and others. Projects such as Cougar, Atlantic, G-FORS, Presto, Brava and Nuggets have paved the way for Metavision. More information can be found at <http://www.ist-metavision.com>. More information on Nuggets can be found at <http://www.ist-nuggets.tv>.

New Metadata Schemes

Given the wide variety of information that can be stored as metadata and linked to specific pieces of content, it becomes very important to agree the descriptions of each element of metadata, so reliable exchanges of metadata between systems becomes possible.

Both MXF and AAF have agreed metadata schemes to facilitate this process, and these are determined by agreements on the data modeling and representation required.

First it's necessary to model the data you want to represent, then determine the relationships between the different bits of data you have, and how you relate those to any databases you want to use. Agreeing data models in the TV industry has not been a simple task, but harmonization of different data models is taking place. This should enable the interchange of essential metadata between different metadata schemes – another step towards the industry-wide interoperability that is the goal of most broadcasters.

There are already many asset management systems in the market, and metadata is the key element in their efficient use. Both MXF and AAF allow extensions to the metadata schemes they use, to allow the deployment of specific asset management tools.

The intention is that, as with 601 video, there will be well-defined interface points for the exchange of the new signals, now exchanged as files, along with a clean metadata workflow, complete with the pointers to embedded and separately held metadata.

Once the ability is there to track every piece of video in a networked system, it becomes much easier to organize that content efficiently, as the information necessary for any action to be taken with it is only a few mouse clicks away.

That essentially is what the revolution in digital workflow is about – the ability to know exactly what content you have in your system, know who's working on it, know what stage it's at in the production process, and also know where it's going to go next.

Although the technology behind this revolution in workflow is complex, the intention has always been to make the user experience as straightforward as possible – to use the underlying technology to remove the technical barriers to more creative and business efficient use of content. Then, broadcasters and program makers can concentrate on the activities that add value to the content they produce.

Points to Remember

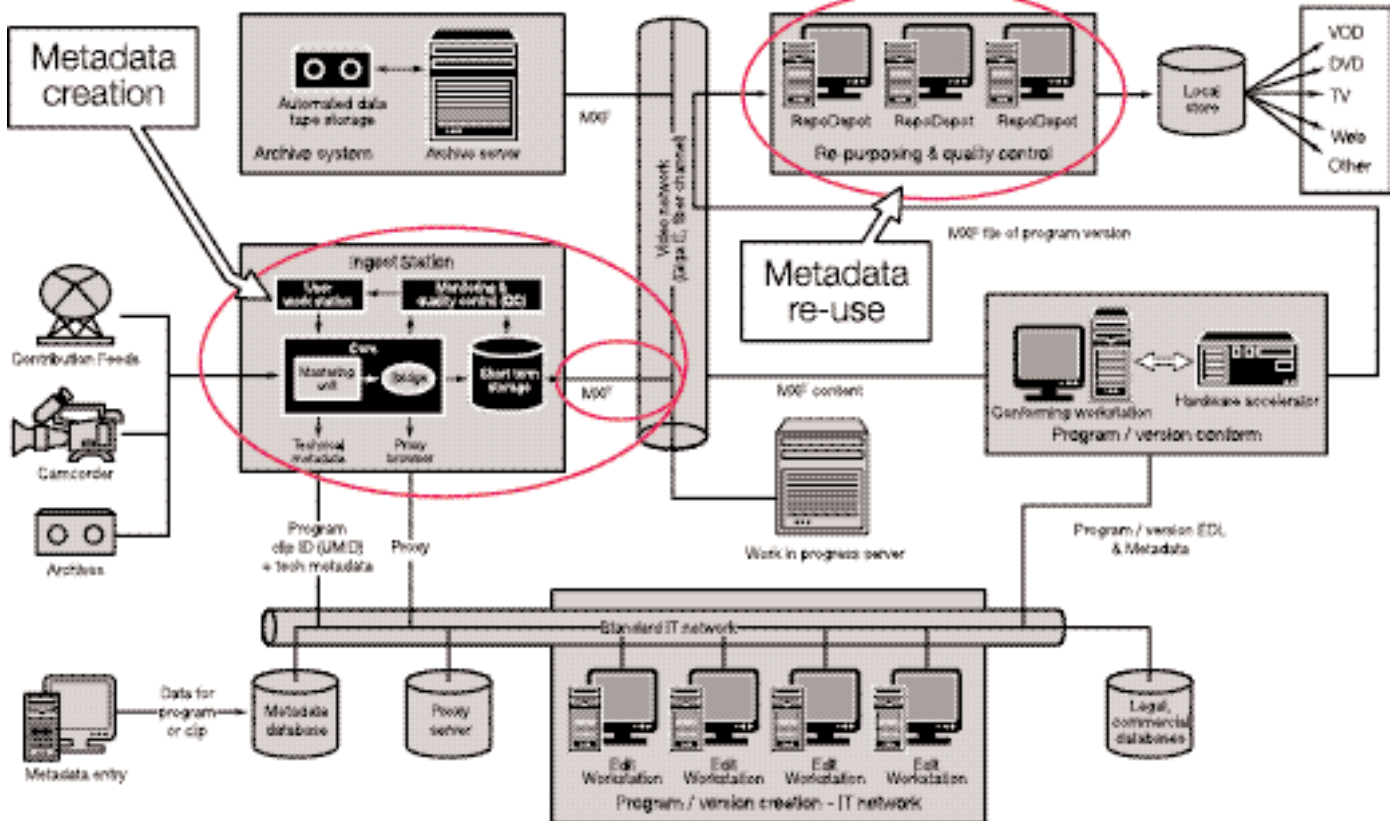
The efficient and effective use of metadata in a networked production system requires the transfer of traditional descriptions of content – what was previously kept on paper and floppy disks – to an IT based description, with those descriptions converted to well modeled metadata.

The production operation itself needs to be carefully analyzed to prepare the way for an efficient move to a workflow based on networked production techniques. The metadata involved needs to be physically represented in a way that's recognizable to different systems, accomplished by using standardized descriptive languages.

The use of UMIDs to mark content, and the MXF and AAF file formats that can wrap essential metadata as well as video and audio content, can ensure a sound foundation for the implementation of a more efficient and cost effective broadcasting operation.

Networked Broadcast Operation

MXF workflow



Company policy is one of continuous product improvement. Specifications are therefore subject to change without notice.

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