



Metadata in TV Production: Associating the TV Production Process with Relevant Technologies

By D. J. Rayers

At each step in the production process the metadata to be collected and used has different characteristics. Possible metadata processing is listed for the major steps in TV production with an indication of the benefits and overheads at each point. Some of the metadata formats that are suitable and optimized for broadcasting are briefly described, with the key technologies of XML, MXF, and AAF being identified. A table of the production process is used to show how we can store and use the metadata at each stage.

In the television production process, information is collected, processed, presented, and disseminated by both television and information systems. This information, now known as metadata, requires efficient management to become an important contributor for saving time, cost, and effort where productions now have to re-author and output material to more distribution channels than in the past. Metadata can cover a wide range of uses, so it is helpful to divide it into categories depending on its application:

Technical or Essential metadata describes the technical characteristics of the essence itself (e.g., picture width and video sampling rate). This information is usually embedded directly in the essence (video and audio) and has been processed like that for decades. It is not the main subject of this paper, as we are experienced in processing this in files, like MPEG, and streams like SDI.

Compositional metadata describes how various parts of a program come together to form a completed output. The best example is the Edit Decision List (EDL).

Production or Descriptive metadata is business information about the program and describes the artists, scripts, staffing, and rights, etc. This metadata is currently collected informally by most broadcasters. In the future, an efficient "joined up" process has the biggest potential for cost savings.

Stepping Through the Program Making Process

At each step in the production process metadata can be collected and possibly re-used. Each collection point can be treated as an overhead, and this must be imple-

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mented as painlessly as possible for production staff. Each re-use point is a saving, as we have removed a data reentry, probably reduced errors, and given producers more information to help their task.

Commissioning

A commission results when the producer persuades the TV company to finance the conversion of an idea into a real program. The commission is very important for production metadata collection as it gathers some key information like the “working” title, producer’s identity, possibly contributor’s names, genre, and initial scripts. It could also have financial and rights descriptions, which subsequently apply to the rest of the program making process.

In a production department, recording and development of such ideas rarely uses a single technology and often pen and paper is effective. However, some parts of program ideas could conceivably be presented to commissioners for a decision in a standard format. If this is the case the best format for metadata handling is standard IT techniques like web technologies or proprietary word-processing packages. In our quest for metadata capture we need to import the metadata from these techniques and store it in a processable form.

The metadata collection goal is to clearly and unambiguously put together a document reflecting the commission. Ultimately, as a long-term goal, this can have the status of a legal document so the metadata coding techniques must have the characteristics required, like security and signing.

Planning

When a commission has been accepted, a plan is put together before shooting. Proprietary software is often already available to help with this. The plan encompasses the staffing, resources, and creation of the artistic description in the form of a storyboard and script.

The metadata collection goal is to take this planning data, probably from a number of sources and software packages, and encapsulate it into a single database or document folder. We do not require all the software to interoperate fully, but it must export the collected data in a defined and standard form that can be re-used.

The metadata use goal is to make the full commissioning information available to the production team for their reference.

Capture

The obvious capture device is the camera, but equally, sound effects, graphics, stills, captions, and music may be added. At all points in capture there is an opportunity for metadata collection, and as we have physical devices to collect the material we can program them to collect metadata automatically. An example is the GPS (Global Positioning System), which can be used to identify shots by location. Other metadata, like a producer’s comments and annotation, can only be captured by direct entry at the time of shooting. We should allow producers to add metadata afterwards, if desired.

The metadata collection goal is to automate as much metadata as possible in the capture device. Secondly, there should be facilities to add metadata from other sources, like PCs, mobile phones, PDAs, and other devices. This metadata is expected to be either embedded directly on the tapes or referenced from tape to another data structure, held alongside in a computer of some sort. Metadata at this point in the chain should be viewed as portable, carried along with the essence as a link directly to a central database is not regarded as practical during a shoot.

The metadata use goal can be very important here as it could help considerably with a shoot. We already have the commission document and planning document folder and so we need a way of taking these documents to the shoot for reference. As before, it is important that this data is in a standard format so that it can be read by a third-party application and possibly embedded in the essence delivered from the camera.

Ingest

During ingest, all the tapes and other content collected during a shoot, as well as new metadata, are transferred into the editing environment; assuming that the planning and commissioning metadata is already in the system. More metadata can be generated and directly entered by an operator marking technically poor sections, or regions for special processing, or be extracted automatically. One of the most useful metadata items to extract at this stage is the shot change, which can be very useful later in organization and editing. The potential for the future here in automated metadata capture is enormous, as we can apply the full power of computer recognition to mark up and label the content.

The metadata collection goal is to capture metadata describing ingest, like the tape labels and contents, from the operator and automatically from the ingested material. All metadata captured on and already embedded or associated with the material should be captured here as well. At or just after ingest, metadata can be captured directly by analyzing the material using computer pattern recognition algorithms.

The metadata use goal is to view the tape labels so that an operator knows exactly and unambiguously what is being ingested. The software can also check the tape contents automatically for consistency and completeness. The program planning metadata can be used to automatically organize the material ready for post-production.

Logging

Logging is where the producers review what they have, and record its possible use. It is expected that all metadata capture that has taken place up to this stage will greatly reduce this overhead. Our long-term goal is to remove the need for a separate logging process altogether.

The metadata capture goal is to allow producers to review and add metadata about what has already been shot.

The metadata use goal is to provide enough previously captured metadata, so that the logging process is significantly quicker, simpler, and more informative.

Edit

There is little capture of production metadata during edit, as the entire editing process concentrates on capturing the composition metadata. We hope that all metadata associated with the shot and with individual clips is preserved transparently during the editing process. In some cases this is not possible to do unambiguously when cutting and inserting. There is a debate about how metadata in this circumstance can be usefully preserved.

The metadata capture goal is to produce enough composition metadata (an Edit Decision List) to accurately

represent the artistic composition of the program from its constituents.

The metadata use goal is to present any information, derived from previously captured metadata, to producers that can help with the creative editing process.

Archive

Archiving is a prime candidate for metadata re-use, as the metadata is the basis for a comprehensive search. The capture of metadata not only enhances the search, but also removes some of the overhead and uncertainty that archivists can have in cataloging the material.

The metadata use goal is to make searching and re-use of archive material simple and effective.

Playout

Metadata is already used a lot in playout as all productions are

required to produce paperwork describing their transmission details, rights, and payment information. While this is already automated, the collection of the data is not, and so the ability to feed the vast majority of the data from earlier stages in the production will save effort and errors.

The metadata collection goal is to build a record of when and where the material has been used.

The metadata use goal is to take existing business metadata to populate the required documents for administration of playout. Future distribution formats could make use of the metadata directly. For example, synopsis, scripts, and actor details form the basis of a website. Parts of the metadata describing the production can be broadcast for TV Anytime transmissions.

Metadata Format Possibilities

Good computer systems are built using a layered structure, so in this discussion we do not need to consider lower levels like networks and transport, which are expected to be standard. There are a number of techniques used to represent metadata; the ones of most interest are XML (eXtensible Markup Language), UMID

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(Unique Material Identifier), MXF (Material Exchange Format), and AAF (Advanced Authoring Format).

The UMID, MXF, and AAF are designed for, and by, the broadcast industry and are optimized for our application. XML is a general purpose IT technique for representing data, and has been further exploited in the MPEG-7 and MPEG-21 standards to describe media, but not presently in a way that is optimized or suitable for broadcast metadata. In theory it would be possible to use MPEG-7 and MPEG-21 to convey data through the broadcast chain, but additional work is required if we are to fully represent the broadcast metadata sets that describe our business.

XML

XML is a standard that allows us to represent data in a form that is easily exchanged in files or through the web. The parties to the exchange still have to agree what the data is and a data model so XML only solves the coding and formatting, not the design and agreement problem. A number of XML tools that can perform the coding and processing are available to software writers and web developers. The advantages of XML are that it is relatively simple, open, and well supported. The disadvantage is that it is verbose and inefficient in bandwidth and storage space. XML documents can be converted to a binary format called BiM, which can solve some of the efficiency problems.

The UMID

The UMID, or Unique Material Identifier is a standardized label for the essence. The idea is that rather than interleaving the metadata directly with the essence, the UMID acts as a lookup ID number (essentially a pointer via a database) for the metadata. The advantage is that there is no need, and there may not be space, to hold the metadata directly on a tape or in a data stream. The disadvantage is that relatively sophisticated database software is required to be operational at many points in

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the broadcast chain if UMIDs are used. It is not clear yet if this type of sophisticated database is a practical possibility in a real complete broadcast chain, and the UMID may be better exploited initially within smaller subsystems like “capture to ingest.”

The MXF File and Stream Format

MXF is Material eXchange Format and is a way of combining metadata with essence directly in a simple file. It is also designed to be streamed. The big advantage is that the completed work, metadata with essence, can be conveyed as a whole through and between systems as either files of streams. It can also be transferred with FTP (File Transfer Protocol); in fact any existing known file-handling technique can carry MXF. It is proba-

ble that this format will become a key technology in our business.

The AAF File Format

AAF is Advanced Authoring Format. It describes work in progress as a composition and can link many different intermediate essence tracks together with a rich description of metadata. Its main use is to convey a full, possibly uncompleted, composition between editors and other devices.

The Data Model

This function of the data model is to fully describe the sets and entities that make up the metadata, as well as any relationships and processing rules. It is abstract in that it describes the data, but does not specify how this description is implemented. A dictionary that defines the individual attributes and labels for the values, like XML tags, often accompanies the data model for a particular implementation.

Do We Store Values or References?

The values of the metadata can be put directly into a file or document. Alternatively, a reference (e.g., the

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Table 1—Metadata Representation at Each Production Step

Production Step	Metadata to be Captured	Metadata Set Described By	Can be Coded or Stored Using
Commissioning	Commission Document	Commission data model	XML
Planning	Plan of the program composition, with associated metadata like actors, locations, and staffing	Program plan data model of a composition (based on the AAF or MXF models)	Either AAF or XML
	Plan of the resources used	Resources data model	Document storage system or XML
	Scripts	Text, but marked up with instructions according to a script data model	Document storage system or XML
Capture	Label for the essence	UMID specification	Basic UMID
	Camera metadata generated automatically	UMID specification	Extended UMID
	Other metadata that can be captured with a camera or imported to the camera	Metadata dictionary	MXF
	Other metadata that can be captured with a camera and exported to a PDA, but associated at the time of capture	Camera capture data model	XML
	Metadata that can be associated at the time of capture. The essence is captured in the camera and the metadata captured to a PDA, but associated at the time of capture.	Program plan and program shooting metadata	XML, linked to the camera UMID
Ingest	Metadata generated at ingest like shot changes and other automated capture	Data model of essence with events on a timeline	XML or directly into a database
	Metadata generated by an ingest operator	Logging data model	XML or directly to database
Logging	Metadata generated by a producer doing a review after ingest	Logging data model	XML or directly to database
Edit	Metadata describing the edits to the composition	Models of edit decision lists (EDLs) based on AAF or MXF	AAF, MXF, XML (proprietary EDL formats are also likely)
Archive	Metadata describing reuse of material	Metadata exported to search engine	MXF and copies of metadata items to be searched in a database
Playout	Metadata describing playout information	Playout data model	XML or MXF

“...if someone’s name and address were included in a file as metadata, and they subsequently moved house, then the reference would keep it up to date, whereas the value would not. It is important when designing a system to be clear that this behavior is correct for the application under consideration.”

UMID) can be inserted so that the decoder has to decode the reference and lookup the result using another database system. The advantage of the value is that it is complete and direct, as no other database is required to find the result.

The advantage of a reference is that it allows the value to be administered, checked, and corrected at one central point. For example, if someone’s name and address were included in a file as metadata, and they subsequently moved house, then the reference would keep it up to date, whereas the value would not. It is important when designing a system to be clear that this behavior is correct for the application under consideration.

Complexity and Islands of Metadata

As described earlier, metadata becomes very effective when used to pass information between production steps. It is sometimes suggested that all broadcast processes communicate through a common network and a common database to achieve this. In many cases this is not practical, as an all-encompassing database would be very complex and hard to manage. This is particularly so where the metadata collection is remote from a studio center such as a shoot, but also in a large broadcast organization with many premises that should be designed to work in an autonomous self-contained manner. This is why, in many cases, we suggest that

the metadata is wrapped into a package like MXF and transported directly with the essence to the next step in the process. Such simplicity of concept is important to introduce complex data handling into a complex organization. Table 1 shows how metadata can be described at each step in the production process.

Conclusion

We have listed what types of metadata can be collected at each point in the production chain, and given an example of how this can be coded in a standard and open system.

At some places metadata is stored directly (by value) and at others there is a reference, or pointer that has to be looked up in a table or database. The main metadata formats for the broadcast application have been identified as XML, MXF, and AAF.

THE AUTHOR

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Rayers earned B.Sc. and Ph.D. degrees in the computer control of physics experiments from the University of Kent at Canterbury, where he used the emerging personal computer to automate and greatly enhance the data capture rate for nuclear magnetic resonance spectrometers. After graduation he joined the BBC and worked mainly on teletext, telesoftware, data broadcast, and computer graphics, and developed an in-depth appreciation of how computers can be used in broadcasting.