Wrappers and Metadata

O. Morgan
Avid Technology

The Wrappers and Metadata subgroup of the Task Force set out to find a single comprehensive solution which would cover the requirements for classifying Metadata, and the requirements for wrapping programme Content into suitable containers which would ensure complete interoperability in a future networked production environment.

As described in brief here, this work has led among other things to the creation of a Metadata "encyclopaedia", which is maintained by a registry mechanism, the specification of a Unique Material Identifier for the Content contained in a Wrapper, as well as the specification of various Wrapper formats for the streaming and storage of Content.

1. Metadata

Metadata is broadly defined as "data about data" and the number of distinct varieties of Metadata is potentially limitless. It can, for example, be process-oriented, business-oriented or data-format-oriented.

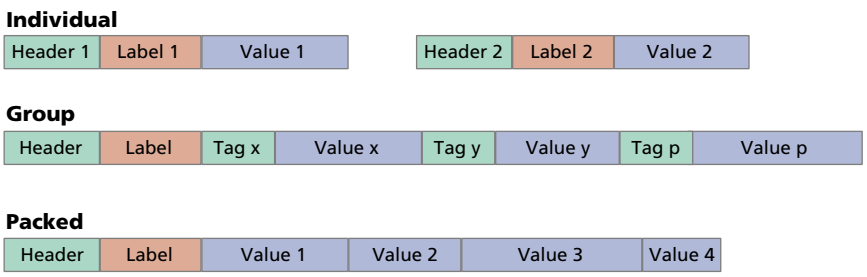

Figure
Some examples of the proposed packet formats for Metadata.

The SMPTE is working on the definition of standardized packet formats to encapsule Metadata such that it can be stored within and transferred throughout digital television systems, without the need for it to be translated or re-keyed every time it is interconnected. *Fig. 1* shows some of the proposed packet formats that are being worked upon and brought together into a single unified architecture. There are individual items of Metadata, groups of Metadata and packs of Metadata – which are familiar concepts in the world of data-processing.

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Each item of Metadata incorporates an SMPTE *Universal Label* which, at this point in time, is in a standardized ANSI format. These labels are all entered into an SMPTE registry which can be thought of as a "table of contents" to some huge "encyclopaedia". This encyclopaedia contains, for example, all the relevant specifications in the world, all the standards that relate to our industry, and all the things that describe and tell you what is the meaning of a particular piece of Metadata, or a piece of Data Essence, or a piece of Video / Audio Essence.

The SMPTE registry has a couple of interesting features: one is that you can keep adding new labels to it, and the other is that it does not necessarily provide a full description of the items which it is linked to in the encyclopaedia – it keeps these items all separate so that, for example, you can find out where to look in order to pull out one or more required specifications and use them. The registry also enables the stored specifications to be placed within the public domain so that, for example, if "manufacturer A" makes a specification public by means of the registry, then "manufacturer B" or "system C" can openly use that specification.

The SMPTE has established the SMPTE *Registration Authority* which is an electronic global library, index and table of contents for all the relevant specifications which now exist and for the ones which may be added in the future. It uses ISO standard rules for the operation of registration authorities, providing a global dictionary of Metadata items. Because it is extensible, it allows a "fast-track" approach to extending the existing standards. This is something which is very important because the standards process has had a reputation for moving much too slowly for the rapid advances that take place in technology.

2. Wrappers

When you combine together all these bits of Metadata with all the bits of Essence (data, audio and video), the result is *Content*. This Content must then be put inside *Wrappers* (i.e. containers or file formats) so that it can readily be moved and stored throughout the system.

It swiftly became clear to the Task Force that there is not just one magic container format. There are a lot of them, each one optimized for a different purpose – perhaps optimized for streaming, maybe optimized for storage, or perhaps optimized for databases and so on. However, there is a generic data model which can be put into any of those containers.

Abbreviations

AES	Audio Engineering Society	**ISO**	International Organization for Standardization
ANSI	Americal National Standards Institute	**MPEG**	(ISO/IEC) Moving Picture Experts Group
AV	Audio-video	**NCITS**	(US) National Committee for Information Technology Standards
DAVIC	Digital Audio-Visual Council	**SDTI**	Serial data transport interface
FC	Fibre Channel	**SMPTE**	(US) Society of Motion Picture and Television Engineers
IEC	International Electrotechnical Commission	**UMID**	Unique material identifier
IP	Internet protocol	**UPID**	Unique programme identifier
ISAN	International standard audio-visual number		

The type of things you put into those containers are: Metadata, Essence formats, relationships between bits of Metadata, and the relationships between Metadata and Essence. Consequently, you end up with many physical representations (many container formats). But the outcome is the all-important interoperability made possible by the Metadata and the Registry, as well as by the templates which determine how items are used in specific applications.

2.1. Generic Wrapper formats

Fig. 2 gives an overview of generic Wrapper formats, with specific varieties targeted towards *streaming* purposes or *storage* purposes by means of streaming mechanisms (interconnects) or storage mechanisms. The diagram shows specific examples of target applications:

- ⇨ IP-based;
- ⇨ Fibre Channel AV-based;
- ⇨ SDTI-based;
- ⇨ raw content, such as recorded on tape;
- ⇨ specialized storage systems for advanced access methods in computer systems;
- ⇨ normal file systems such as can be found currently in server systems and computer systems.

This list is by no means complete. Standardization projects aimed at container formats are under way both within the SMPTE and elsewhere, e.g. within NCITS, ANSI, X3, ISO, MPEG and the AES. What we are attempting to achieve through the work of the Task Force is to have all of these formats basically able to contain elements of the common data model.

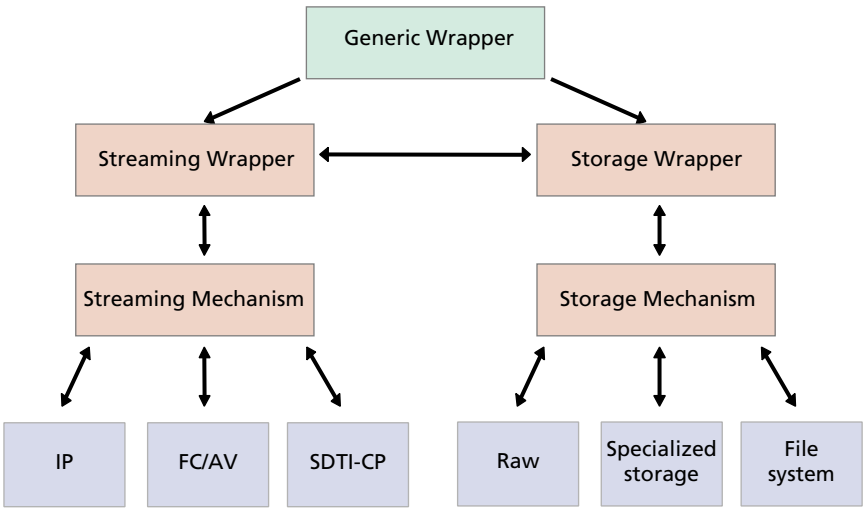

Figure 2
Example of a generic Wrapper format.

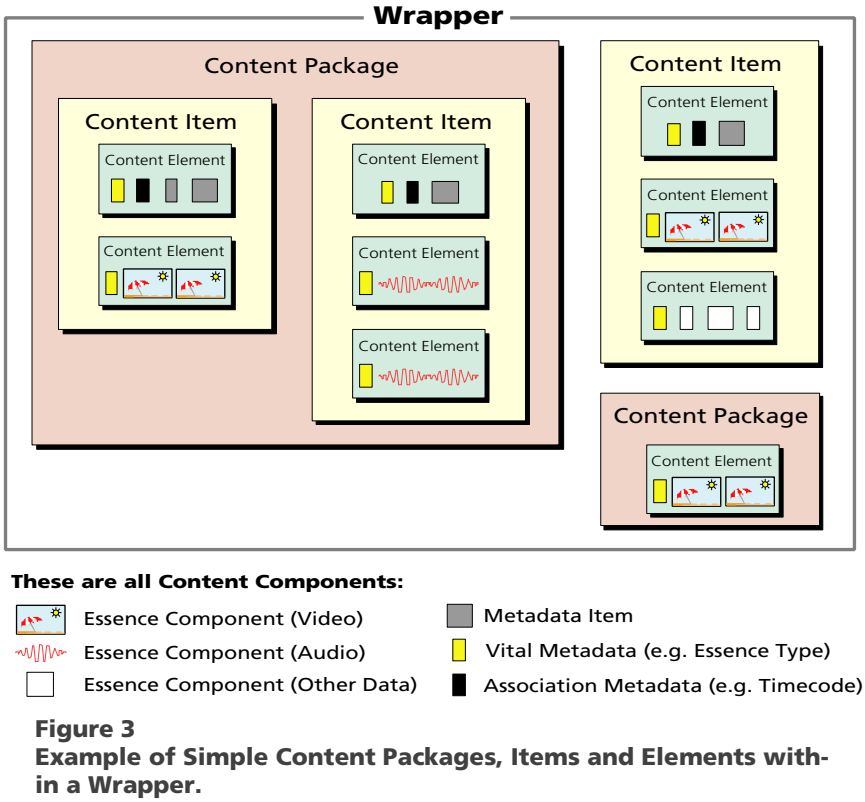

Figure 3
Example of Simple Content Packages, Items and Elements within a Wrapper.

2.2. Simple content packages

Fig.3 shows the simple content model that has been derived by the Task Force, starting from the work of DAVIC. What we have here is content which is organized into *content packages* which are made up of *content items* which, in turn, are made up of *content elements*. There are different types of content elements including Video Essence, Audio Essence, Data Essence, Vital Metadata and Association Metadata.

Familiar items of Content – such as video, audio, captioning, virtual studios, scripts and time-code – can be described very easily by *Template* mechanisms which are available publicly via the SMPTE registry. Thus the right template for a specific application can readily be found.

These simple content packages represent a very good way of organizing programme contributions and delivery.

2.3. Complex content packages

Complex content packages are somewhat different to the simple packages described above. In this case, what we are trying to put into the container is all the data, all the choices, all the possible revisions, all the undo history and all the 3D models that go to make up elements of a programme. So we end up needing a very comprehensive index of everything we have inside the package; the content itself and the composition Metadata. We then find that we have got all kinds of hierarchical and recursive rules about what we can put inside these packages.

Fig. 4 shows a basic example of a complex content package which consists of some simple content, some composition Metadata (which looks a little bit like an edit list) and an Index. Such a package may contain edit decision lists, news items, news stories and even complete shows. However, while this kind of content package would be good for production, content creation and editing, it is not really intended for delivery.

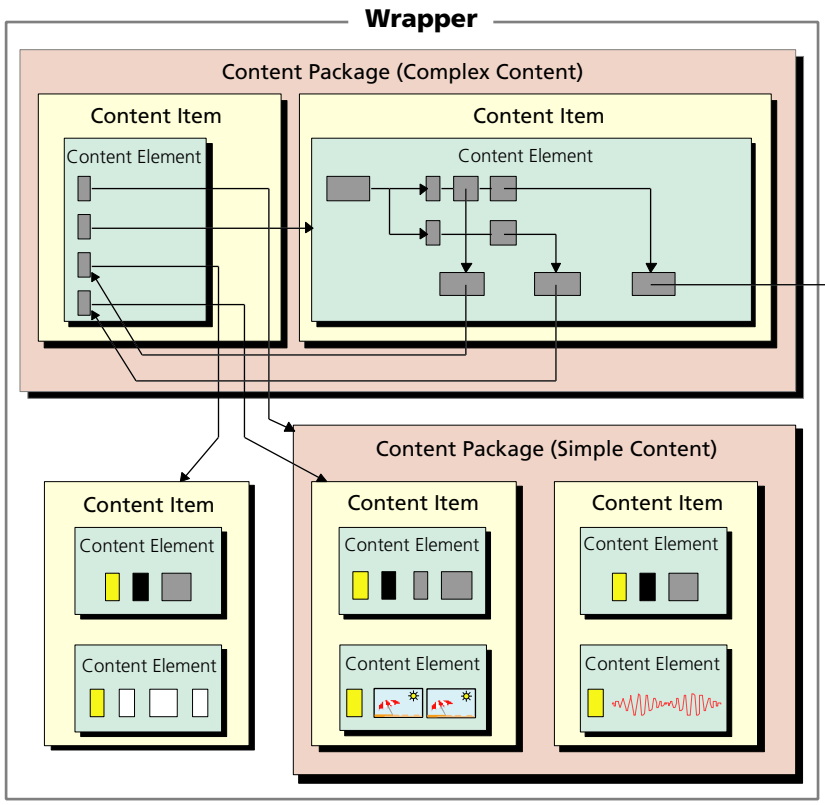

Figure 4
Example of a Complex Content Package.

2.4. Unique content identifiers

Unique content identifiers basically come in two types. One is an identifier for finished programmes, the other is an identifier for the content objects which go to make up those programmes. The essential point

about a unique content identifier is that it identifies the piece of content independent of its location. This allows, for example, multiple copies of the content to be referred to by an asset management system, and it also enables hierarchical storage, content browsing, online tape libraries, archives and many other such applications.

There are different types of content identifiers for different uses. *Fig. 5* shows some of the diverse examples (e.g. Unique Material Identifiers, Unique Programme Identifiers) which are being brought together into a single standard framework for unique content identifiers. Because a unique content identifier starts off with the SMPTE Universal Label, which is a registered entity, each identifier can be used by a system whose natural content identifier is different – the Task Force's unique content identifier is an interoperable, interchangeable entity.

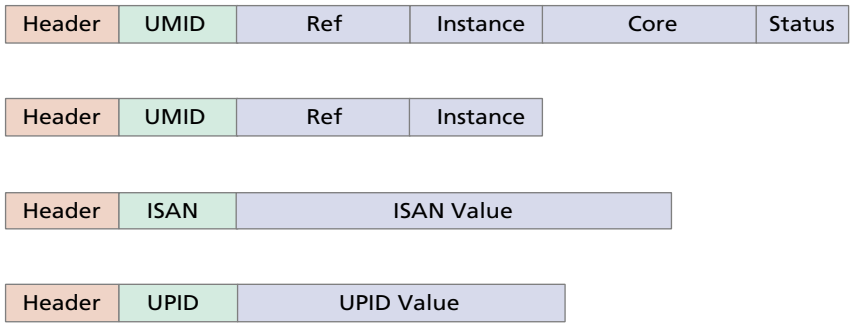

Figure 5
Examples of Unique Content Identifiers.

Fig. 6 shows some of the areas that these standards and specifications touch upon, even if the diagram presents a rather simplified view of a networked studio of the future. At the bottom left of the diagram, content is entering the system by the traditional method, i.e. via a video tape and a data storage device. It has a wrapper around it – we can think of this wrapper as a rubber band which joins together the video cassette and the floppy disk (or a piece of paper) which contains the Metadata. The incoming material is carried via an SMPTE standardized streaming wrapper into the near-line storage area which uses file-system storage wrappers containing the Essence and the Metadata (i.e. the Content).

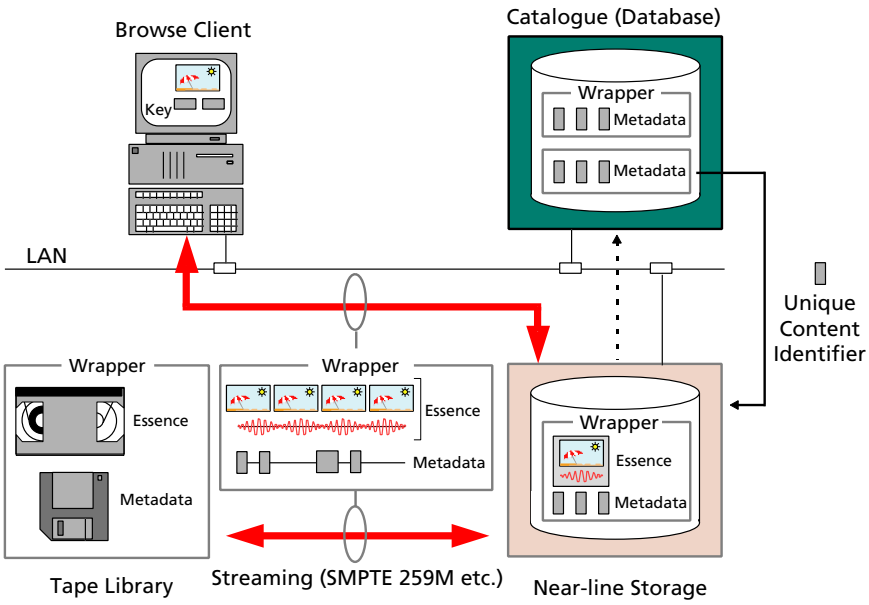

Figure 6
Example of a future network-based production facility.

The upper right part of the diagram shows the catalogue, or database, where some of the incoming Metadata is stored and organized in a database format, for ready access and use by the exploitation part of the system. The separate database and server aspects of this area are tied together using either unique material identifiers or unique content identifiers.

And finally, in the upper left part of the diagram is the browsing client. It uses other forms of streaming wrappers and other forms of APIs to access the material held within the system.

3. Standardization

In conclusion, there is at least one SMPTE project to write a standard for each aspect and for each element of the Wrappers and Metadata issues that were studied by the Task Force. We are also aware of similar projects in other standards bodies, and we are closely liaising with these bodies in order to keep everyone within the same interoperability framework.

Oliver Morgan *studied Physics at Oxford University. In 1978, he entered the TV industry in the UK and ever since has worked primarily on software development for post-production. He was Director of Engineering at Convergence Systems until 1990 and Manager of Technology at the Sony Advanced Development Center in San José, California, until 1997. Since then, he has been a Senior Consulting Engineer at Avid Technology in Massachusetts.*

Mr Morgan, a holder of eight patents in TV production and related technologies, was previously Chairman of the SMPTE Working Group on Editing Procedures, and Chairman of the SMPTE Committee on Wrappers and Metadata Technology. He has been a regular contributor to SMPTE conferences and is a Fellow of the SMPTE.

More recently, Oliver Morgan chaired the Wrappers & Metadata subgroup of the EBU/SMPTE Task Force.