

2 Wrappers and Metadata

The Joint EBU / SMPTE Task Force has been considering the formatting of collections of audio-visual program material and related information for exchange within and between studios and other centers which process or store that information. The goal was to establish a maximum degree of interoperability independent of the encoding format for the audio-visual signal.

Collections of information include both streams of program material (to be transported by means under discussion elsewhere within the TFHS), and files of program material and related information, to be held in storage systems and manipulated by computer-based equipment.

The particular role of the TFHS Sub-Group on Wrappers is to determine the user requirements for the access to and manipulation of these collections of information. These requirements may influence the characteristics of the Wrappers used to group and label the information.

The particular role of the TFHS Sub-Group on Metadata is to determine the user requirements for the related information within these collections, including the types of information appropriate for each application, its formatting, its relation to the program material, and the relative importance of each type of information. These requirements may further influence the characteristics of the Wrappers used to group and label the information.

The results of these discussions are contained in this Chapter, and consist of:

- some Terminology
- a set of Requirements, grouped into topics

Background information and additional discussion of topics is contained in Annexes D1 through D5.

2.1 Purpose of Wrappers

The fundamental purposes of a Wrapper are to gather program material and related information together (both by inclusion and by reference to material stored elsewhere), identify the pieces of information and thus facilitate the placing of information into the wrapper, the retrieval of information from the wrapper, and the management of transactions involving the information.

2.2 Terminology – What's in a Wrapper

Program material and related information of any variety is called Content. The parts of Content which directly represent program material (such as signal samples) are called Essence (see section 0 below); the parts which describe the Essence and other aspects of the material are called Metadata (see section 0 below).

Wrappers are intended to be used to link physical media together, for streaming of Content across interconnects, and to store Content in file systems and on servers.

This and other terminology is discussed in this section.

2.2.1 Content Structure

A Wrapper does more than just contain Content; it also defines and describes the structure of the Content. The microscopic structure of Content is inherent in the Essence itself; the macroscopic structure is built using Metadata and Overhead (see below), and is classified as described here.

Each individual item, either Essence or Metadata, is called a **Content Component** – for example, a block of audio samples, or a timecode word. A Wrapper contains some number of Content Components, built into a logical structure.

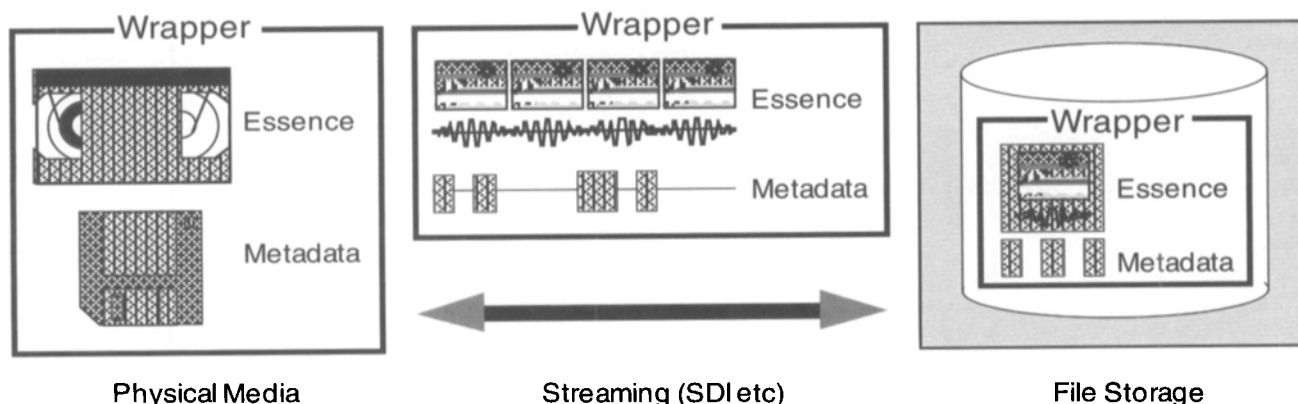


Figure 1: Schematic View of Wrappers in Use

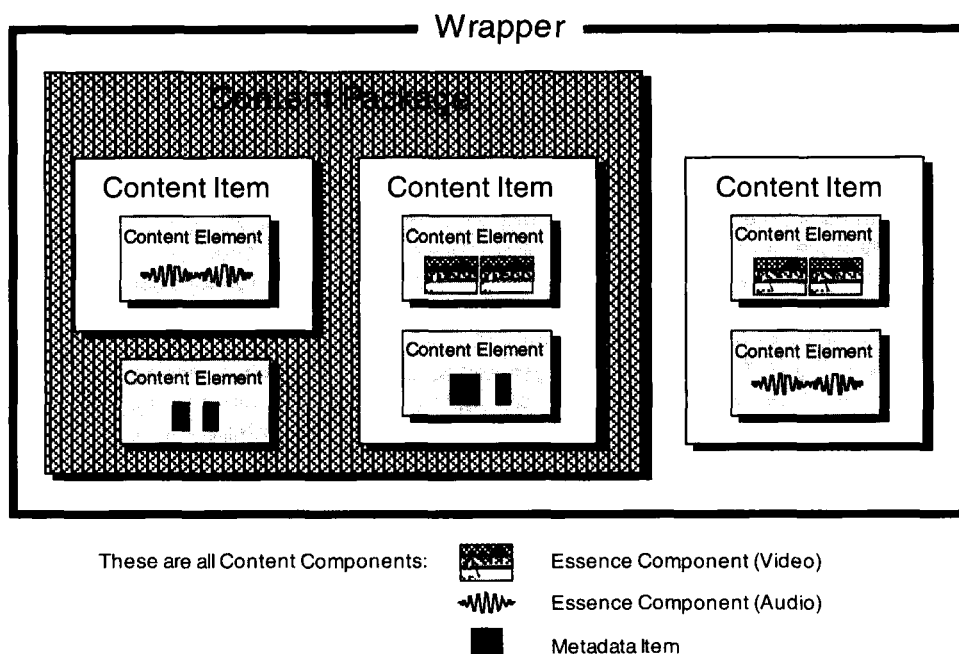


Figure 2: Content Structure and Content Components

A **Content Element** (CE) consists only of Essence of a single type, plus any Metadata directly related only to that Essence – for example, the blocks of samples of a video signal plus the Format Metadata describing the sample structure plus the Descriptive Metadata identifying the origin of the signal.

An exception to this definition is when a Content Element can be generated entirely from Metadata, without the need for Essence – for example, an encoded subtitle.

Types of Essence include Video, Audio, Graphics, Still Images, Text, and other sensor data as needed by each application.

A **Content Item** (CI) consists of a collection of one or more Content Elements, plus any Metadata directly related to the Content Item itself or required to associate the component parts (Content Elements) together – for example, a video clip.

A **Content Package** (CP) consists of a collection of one or more Content Items or Content Elements, plus any Metadata directly related to the Content Package itself or required to associate the component parts (Content Items and Content Elements) together – for example, a program composed of video plus audio plus subtitles plus description.

Although these terms describe larger and larger structures of Content, the smaller structures do not have to be fully contained within bigger ones. For example, a single Wrapper could contain Content Elements equal to a full hour of program source material, and Content Packages describing only a couple of five minute segments within the material.

Thus, a Wrapper is not restricted to contain any specific

quantity or portion of any of these constructs – it may contain only a few Content Components, or as much as several Content Packages.

Besides using a single Wrapper, two or more Wrappers may be used to transport components of a single Content Item or Content Package where separate transport mechanisms are used. In this case each of the Wrappers will contain a partial common set of Metadata to allow the wrappers to be cross referenced. This is the mechanism used where not all of the Metadata can be accommodated in the transport used for the Essence.

2.2.2 Essence

Program material itself is referred to as **Essence**. Essence includes all data that represents pictures, sound and text; types of Essence include Video, Audio, Graphics, Still Images, Text, and other sensor data as needed by each application. Essence may be encoded or compressed in whatever way is appropriate, and is typically structured in packets, blocks, frames or other groups, which are collectively called **Essence Components**. The microscopic structure of **Essence Components** depends on the particular encoding scheme used, which in turn is identified by Format Metadata (see below).

Essence typically has the characteristic of a stream, with sequential access whether stored on a file device or streaming device. Stream data will normally be presented in a sequential time dependent manner. Essence stored on a file storage device can be randomly accessible. Essence not having the characteristic of a stream (e.g. graphics, captions, text) may still be presented in a sequential time dependent manner.

2.2.3 Metadata

Other information is referred to as **Metadata**. Metadata is broadly defined as “data about data”.

The number of distinct varieties of Metadata is potentially limitless. To assist with describing requirements and behavior, Metadata is divided into several categories, depending upon its purpose, including at least the following:

- **Format** - any information necessary to decode the Essence. Examples: video formats, audio formats, numbers of audio channels, aspect ratio, pan & scan etc.
- **Descriptive** – all information used in the cataloguing, search & retrieval, and administration of Content. Examples: unique material identifiers (UIDs), labels, author, location, date & time, geospatial (information related to the position of the source), copyright information, access rights information, modification time stamps, version information, transaction records, etc.
- **Association** – any information necessary to achieve synchronization between different Content Components, and to achieve appropriate interleaving of the components.
- **Composition** – information required on how to combine a number of other components (e.g. video clips) into a sequence or structure (Content Element, Content Item, or Content Package) This may equally be regarded as information recording the derivation of the Content.

Examples: edit decision list, titling information, zoom lens positioning (for virtual studio use), color correction parameters, etc.

- **Other** – anything not included above.

Examples: Scripts. Definitions of the names and formats of other Metadata.

Within each category, Metadata may be further divided into sub-categories.

2.2.4 Metadata Characteristics

Metadata which is related to the whole of a subsection of the Content (for example a Content Item or Content Package) is referred to as **Static Metadata**.

Metadata which is related to a subsection of the Content (e.g. a single Content Component, a Content Element, or a frame or scene) is referred to as **Variation Metadata**. The variation will frequently be connected to the timing of the Content, but may also be associated with other indexing of the Content. Most categories of Metadata may be Variant.

Other such characteristics of items of Metadata may be identified.

2.2.5 Overhead

In addition, the construction of the Wrappers themselves

will require some additional items of data. This data is referred to as **Overhead**. Overhead includes such things as Flags, Headers, Separators, Byte Counts, Checksums, and so on.

2.3 General Requirements

Wrappers must be capable of including Essence, Metadata and Overhead in differing proportions and amounts, depending upon the exact Usage Profile of each Wrapper. For example, a program replayed from videotape might include Video, Audio, and Ancillary data streams, with almost no Metadata; an Edit Decision List might include Descriptive and Composition Metadata, but little or no Essence. Each particular variety of Wrapper will contain a minimum defined level of Essence, Metadata and Overhead.

Wrappers must be capable of including various structures which are combinations of Essence and Metadata, such as Content Elements, Content Items, or Content Packages defined above.

Metadata may be contained in a video or audio data stream (e.g., MPEG or SDI streams), but for ease of access could be replicated in a separate Metadata area. Real-time live transfer by streams may require repeating of Metadata and interleaving of structures.

As well as directly including Essence and Metadata, Wrappers may contain indirect references to either. This is discussed further below and also in D2 – Wrapper Referencing, which also includes a list of some different varieties of Wrapper.

2.4 Breadth of Application and Wrapper Profiles

Users would strongly prefer one solution to cover the widest range of applications.

Because of the limitations of technology and the concerns listed below, it is unlikely that a single Wrapper format will fit all applications. However, if multiple formats are to be developed, they must be created with a view to maximum commonality, understanding that program material may appear in and be converted between any or all of the formats during its lifetime.

The range of applications can be encapsulated into Wrapper Profiles, each calling for one or more of the possible Wrapper formats.

A wide range of potential activities were listed (see D4 – Notes), which were then grouped into the following categories:

- Pre Production
- Production and Acquisition
- Post Production

- Distribution and Storage
- Emission and Transmission
- Archive

Every application involves one or more of these processes, and each process makes use of Content in each of three forms:

- Unwrapped (for example, a Videotape).
- Streaming (for example, on an SDI channel or as an MPEG stream)
- Rich (for example, a database together with signal storage, or an Edit Decision List)

As well as being used within each process, these three forms are all used as interfaces between processes. There is therefore a requirement for at least two Wrapper formats (Streaming and Rich) in addition to the continued use of unwrapped Content.

2.5 Metadata Requirements and Metadata Sets

Recognizing the breadth of varieties of Metadata, the naming scheme used for varieties of Metadata should be hierarchical. The hierarchy of varieties (categories, sub-categories and so on), the actual names and the definitions should be registered by a single independent registration authority such as SMPTE. The names must have a plain text representation.

Each application will employ different combinations and varieties of Metadata. There is therefore a requirement for Metadata Sets to provide a guideline as to what combination to employ in a particular application. The Metadata Sets should be developed as part of the recommended Metadata standardization process. A preliminary list of the required Metadata Sets is contained in D4 – Notes.

To maximize compatibility, there is a strong preference for Metadata to have a defined representation in plain text form, using an international character set such as ISO 646.

It is recognized that some varieties of Metadata are inherently not representable as plain text. Other varieties carry information in local language, and must be represented using a regionalized character set. Metadata which names, defines and describes other Metadata must be represented in the international character set.

Within each Metadata Usage Profile, a core set of **Mandatory** Metadata items must be provided with each Content structure (Content Component, Content Element, Content Item, or Content Package). This small core set provides for the basic management of the Content structure.

A further set of **Essential** Metadata items must either be

provided, or else a sensible default value can be automatically inferred. These items are typically within the class of Descriptive Metadata.

Within certain Profiles, an additional arbitrary assortment of **Optional** Metadata items may be required to be carried.

2.6 Wrapper Size

In some Usage Profiles, the size of some Wrappers will undoubtedly exceed the capacity of a single storage volume. Wrappers must therefore contain a mechanism to allow for dividing them into smaller parts if they become too big.

This may require that some Metadata is repeated in each of the parts; alternatively, Metadata needed by each part may be held in a Wrapper of its own, whence the data will be obtained by Referencing

In this situation, Composition Metadata will be required, to describe the relationship between the parts.

2.7 Platform Neutrality

Wrapper formats must be designed to be “Platform Neutral”, so that Wrappers may be read by any machine with equal facility (although perhaps with different performance), no matter what machine was used to originally create the wrapper.

Typical considerations are byte ordering, and the organization of sample structures in customized word formats. The need for platform neutrality does not preclude creating a Wrapper in an optimal format for a particular machine.

Annex D1 - Platform Neutrality gives more information on this topic.

2.8 Interleaving

It is likely that information in Wrappers, particularly Essence Components, must be interleaved in various ways for optimization of storage, retrieval, presentation, and transmission.

Existing transport layers such as SDI or MPEG-2 Transport Stream may dictate the interleaving scheme. Wrapper formats must therefore permit conversion between interleaving schemes.

The Wrapper formats should insulate the user from the specific interleaving scheme which is used, so that both Essence and Metadata may be manipulated with equal simplicity (although perhaps with different performance) no matter how they are interleaved.

2.9 Unique Identifiers

Content must be identified by some species of Unique Identifier. Unique Identifiers are classified as Mandatory Descriptive Metadata.

Unique Identifiers serve to identify the Content, irrespective of the physical location of the content, and independent of whether the Content is the original or a copy. This is different from the function of the Filename (discussed by the Sub-Group on File Transfer Methods in Chapter 3).

When Content is duplicated, it must retain the same Unique Identifier; however, whenever processing is performed on the copy, or when a copy is made of only a subsection of the Content, a new Unique Identifier must be assigned. In some Usage Profiles, traceability to the original Unique Identifier is required (see also “History” below).

In some other cases, identification of each specific instance or copy of the Content is required in addition to the Unique Identifier. This will probably involve linkage between Unique Identifiers and Filenames.

2.10 Immutability and Generation Numbering

In most cases, it is not known how many References have been made to Content from other Wrappers.

In these cases, it is important to provide identification of the specific generation number (or version number) of the Content, to avoid one user of the Content affecting another user of the same Content.

2.11 References

The Wrapper formats must allow Metadata to refer to points and regions within other wrappers, or within the same wrapper, or within external material by means of indexing. Indexing is discussed in the next section.

This basic capability is required for many purposes, including:

- Creation of associations between Essence and Metadata
- Inclusion of external material (for example, from videotape or camera) within programmes
- Description of editing operations within Composition Metadata

Annex D2 – Wrapper Referencing gives more information on this topic.

Although the use of References can improve the efficiency of systems by decreasing the use of copy operations, this may be offset by increases in the complexity of systems to manage the proliferation of separate Wrappers.

It is expected that both techniques will be required to accommodate different operational requirements; but Wrapper Profiles may indicate a preference for one or the other method.

2.12 Indexing

For the purpose of implementing References, Wrapper formats must allow indexing of points and regions within a Wrapper in either of the following ways:

- Systematic indexing (for example, timecode, subframe or sample index)
- Specific indexing (for example, named cue points, key frames)

Note that there are many issues of consistency of indexing when dealing with the diverse sample rates and synchronization methods in present televisions systems – such as the relationship between audio samples and video frames, and the relationship between film frames and video frames. These relationships must be accommodated by the Indexing method, in combination with Association Metadata.

Annex D2 – Wrapper Referencing gives more information on this topic.

2.13 History

Two types of historical information may be included in the Metadata

- Derivation history information, which may include any Content used to create the current version of the Content, this type of historical information allows the production process to be reversed or reproduced with or without modification. This includes any editing history or signal transformation data.
- Transaction logging, allowing the steps taken to produce the current version of the Content from its source material to be traced but not necessarily reversed. This includes version and source information.

2.14 Access Control

Features for operational security may be included in a Wrapper format to prevent unauthorized access to Content. Operational security requires the use of a log-in procedure (or decryption key) and supports the user as an individual or a member of a group. Files may be protected by their location and by time limits. Access rights may be provided at several levels. Encryption is the only feasible mechanism of protecting components within a Wrapper.

Annex D3 - Access Control and Copyright gives more information on this topic. This subject is also discussed in the section on File Transfer Methods.

2.15 Support of Transactions

Wrappers will be subject to many transactions both for commercial purposes and in the operation of production systems. These transactions will include copying, moving, and modification of Wrappers.

Metadata in support of these transactions may be included within Wrappers.

Other aspects of the operation of transaction systems are outside the scope of this section, and are discussed in the section on File Transfer Methods.

2.16 Property Rights

Metadata recording the ownership of Content and the history of ownership may be stored in the wrapper in order to facilitate the establishment and preservation of copyright.

Annex D3 - Access Control and Copyright gives more information on this topic. This subject is also discussed in the section on File Transfer Methods.

2.17 Asset Management

Wrapper formats must support indirect references to content – that is, references to objects which are themselves references to Content. This is a basic requirement used to support all manner of different material management systems.

Effective asset management is required by the users. This may be provided by either manual or automatic methods as appropriate. Wrapper referencing of Content can work most effectively where automation tools are provided for storage administration tasks and to ensure cohesive referencing when files are moved or copied.

Specification of material management systems is outside the scope of this section, and this is discussed in the section on File Transfer Methods.

2.18 Application Programming Interface (API)

Specific Wrapper Profiles, particularly those emphasizing richness of data description may require a standard application programming interface (API) to simplify the process of reading and writing the Wrapper format.

2.19 Compatibility and Conversion

Wrappers must be compatible with existing formats, including formats for Essence (however stored or transported), and formats for Metadata. In addition, the use of Wrappers must be compatible with established working practices.

It is recognized, however, that when existing Essence and Metadata formats are included within program material, some of the benefits to be obtained from new Wrapper formats may not be available.

- A format is Compatible with a Wrapper format when Metadata or Essence can be directly placed in a Wrapper from the source format or directly exported from a Wrapper.
- Lossless Conversion is possible when Metadata or Essence cannot be directly used but can be translated to or from the Wrapper with some processing, and the conversion can be fully reversed.
- Lossy Conversion is possible when Metadata or Essence cannot be directly used but can be translated to or from the Wrapper with some processing, and some loss of meaning or quality, and the conversion cannot be fully reversed.

Users require Lossless Conversion or better in all cases, except where Content from outside a Wrapper is involved; in which case, users require Lossy Conversion or better.

2.20 Extensibility

Any new Wrapper format to be developed is required to be standardized and to have reasonable longevity, of decades or more. It is certain that new Metadata types and Essence formats will be required within the life of any standards document. Therefore, every Wrapper format is required to be extensible in the following ways:

- By addition of new Essence and Metadata types,
- By extension or alteration of data syntax and semantics.

To achieve maximum backwards compatibility, the addition of new Essence and Metadata types must be achieved without change to the underlying Wrapper data syntax with an efficient but complete documentation process, to ensure that any extensions are equally accessible to all implementations. This will depend upon maintenance of a proper Registry of data identifiers.

When unknown identifiers are encountered in the processing of a Wrapper, they (and any attendant data) should be ignored gracefully.

Other issues related to Version management are discussed in D4 – Notes.

2.21 Wrappers and Metadata – Recommendations

The specific recommendations on Wrappers and Metadata are as follows:

- The development of an extensible hierarchical classification of Metadata varieties, including the notion of Metadata Sets appropriate to particular uses.
- The establishment of a single registry of Metadata identifiers and definitions.
- The standardization of a single generic Wrapper format for streaming of Metadata, which can be mapped onto existing and emerging signal transport layers.
- The standardization of a single generic Wrapper format for applications requiring arbitrary richness of Content of all types, including Metadata and Essence. This must be highly compatible with the streaming format described above.
- The standardization of a single format for a “unique identifier” would also be of assistance; however it is recognized that multiple formats are already in use. As a minimum therefore, it should be possible to register existing and new unique identifier formats within the Metadata registry referred to above.