

Evolution of File-Based Image Archiving System

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Abstract

The purpose of the traditional image archiving system was to store the records of broadcasts. Since the standardization of the Material eXchange Format (MXF), the management basis of image material has been shifting from tapes to files and the purpose of image archiving has been changing from storage to distribution. Nowadays, the archiving systems of NEC Corporation are capable not only of managing image material but also of constructing new business flow systems for the distribution of image material between broadcasters or between broadcasters and associated commercial interests.

Keywords

image, file-based, asset management, archive, Material eXchange Format (MXF)
metadata, content distribution

1. Introduction

An archive is a location for storing records. Broadcasting stations have also used this term traditionally to mean the storage of records of broadcasting (video/audio materials). Although the recording medium has later on shifted from videotapes to computer storage, this shift is not the objective of file-based storage in the real meaning of the term. The purpose of file-based storage is that the possibility of integrated management of metadata and the uniqueness of materials resulting from the shift to file-based storage can activate a secondary use of materials and thereby become an incentive for the production of new values.

2. Image Archives of Broadcasting Stations

2.1 Integrated Metadata Management

With the previous tape medium, the metadata was managed using a ledger that manages the tape labels and tape storage shelves (or a system that manages the shelves). In this system, a person needing a specific material searches the storage location in the ledger, takes the tape out of the shelf, checks the images using a video device, enters the rental application in the ledger if the material is the required one, and brings the

tape medium out of the archive upon receiving the required permission.

When integrated management of metadata is enabled by the file-based storage of video/audio, the metadata search from a business PC connected to an in-house network is also enabled. In addition, the use of preview files of reduced resolution for use in searches (low-resolution image files) and/or thumbnail material for each image enables identification of the content of the material without actually handling it.

2.2 Uniqueness of MXF Standards and Materials

The MXF (Material eXchange Format) is an image file format standardized by the SMPTE (Society of Motion Picture and Television Engineers). When an image is turned into a file, the attribute information (metadata) of the material is wrapped in a single file together with the video and audio. From the viewpoint of operation, since the metadata is transferred at the same time as the file is copied or transmitted, human-error such as entry errors and label attachment mistakes can be effectively eliminated compared with operations using the tape medium and labels. When the person responsible for each item of information in the metadata is known, the metadata information can be guaranteed.

Assigning a unique ID (material code) in the metadata makes it possible to identify each material file uniquely. In addition, when the range of ID management is expanded from inside the broadcaster's office to include the associated businesses in-

volved in the distribution of the material, the material can be identified uniquely as a target even if the file is distributed within the ID management range.

2.3 Management of Target Materials

In assuming distribution of contents, an archive manages material to be used for an expanded range of applications. The management targets of traditional archives for storage purposes are in-house materials archived for storage (which are basically the completed program materials). The targets of an archive therefore assume the distribution of contents, including the materials that are temporarily stored in-house, such as externally produced program materials, news materials and commercials. As the archiving systems are often constructed section by section or step by step, they are generally classified as follows in order to clarify the purpose and scope of examination.

(1) Classification by application

- **Program materials:**

These are the main contents of programs. Include purchased programs such as movies.

- **News materials:**

Materials of news programs. Though news also belongs to broadcast programs, it is classified apart from the program materials because the news department is independent of the program production department.

- **Sport materials:**

Material of sports programs. These are classified separately from the program materials for the same reason as the news materials.

- **Advertising:**

Materials for commercials, program advertising and promotions.

(2) Classification by production process

- **Completed materials:**

Main materials that have completed production.

- **Original materials:**

Raw materials before editing.

- **Other materials:**

video clips, CGs, audio, subtitles, etc. that are produced during the process of program production.

(3) Classification by management lifecycle

- **Permanent management materials:**

Materials that are assumed to be managed continuously.

- **Temporary management materials:**

Materials that are managed for limited periods.

3. Configuration of the Archiving System

3.1 Architecture

The management-target contents of archiving systems consist of two elements; the metadata and the video/audio. The metadata grows continually by daily updating, and it is utilized in operations across various departments from both inside and outside the broadcasting enterprise. On the other hand, once a video/audio material is produced, the modifications thereafter are managed as revisions. The archiving system builds separate subsystems for these elements considering differences in properties, and combines their management by letting them share IDs that uniquely identify the materials. As a result, an archiving system is categorized into the following three architectures (Fig. 1).

(1) Metadata management

Integrated metadata management.

(2) File management

Combined management of video/audio and metadata link information between metadata information and library information.

(3) Library management

Management of audio/video locations.

3.2 Physical Configuration

Although the equipment configuration of actual installations varies depending on the management target materials, operational methods, output/input formats and management formats, the physical configuration of the archiving system can be conceptually distinguishable as follows (Fig. 2).

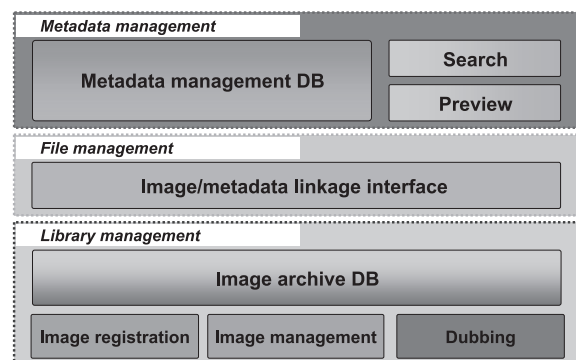


Fig. 1 Archiving system architecture.

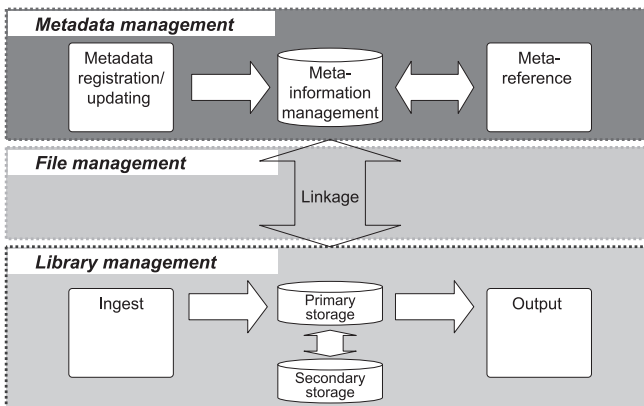


Fig. 2 Physical configuration of archiving system.

(1) Metadata management

Functions for the management of metadata material and for material input include thumbnail data for use in searches and low-resolution image files.

(2) Primary storage

Area in which frequently used materials are stored.

(3) Secondary storage

An area for which the main purpose is to store materials, and as this area does not require as high an access speed as a primary storage area it is built for a lower cost per capacity.

(4) Ingest/output

Function for the registration and output of materials. A codec and/or MXF wrapping system is introduced according to the input/output and management formats. Input equipment such as tape decks is also included in this area.

4. Design Points

4.1 Arrangement of Job Flow and Study of Metadata Management Flow

In order to create a system that can produce new values, it is essential to arrange the related job flow to enable efficient operation of the system, e.g., when building a system that converts video and audio materials into files in the in-house production process. Persons affected can thereby freely use the materials to subsequently perform a search. Operations are not possible by simply converting the materials into files or by arranging metadata and integrating it. It is also necessary to compile and systematize the operational regulations for per-

mission to reuse materials, such as the rules or test standards. Furthermore, if the range of operations is expanded to include distribution outside, it is also necessary to prepare operations related to agreements and rights and to build and systematize the cross-industrial metadata management standards.

Systematization of metadata management consists of definitions for input, updating, reference authorities and restrictions as well as for the preparation of the attribute information of the managed materials. These definitions relate to the job flow, defining “who registers which information and at which timing.”

The metadata management techniques should be clarified according to the properties of the metadata. The management techniques can be divided into cases in which metadata is packaged into the MXF files of the video/audio files and for cases in which the metadata is managed in the database (metadata management). Managing metadata in MXF files can ensure linkages with video/audio files but it is not suitable for a fast search. In general, metadata on the material codes and material structures (file formats, file creation dates, etc.) is saved in MXF files and metadata usage in job operations is managed by the database. Local information used in in-house jobs is managed by the database and when it is distributed outside the house, any required information is packaged in the MXF files that are sent outside.

4.2 Linkages with Associated Systems

Preparing linkages with associated job systems in parallel to the arrangement of job flow can promote improved efficiency and job accuracy (Fig. 3). The two key issues of linkage are as described below.

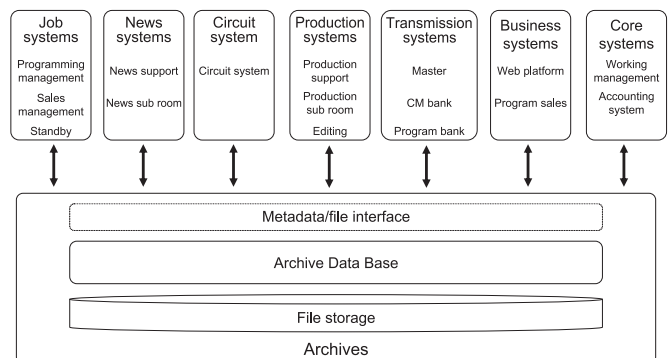


Fig. 3 Linkages with associated systems.

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(1) Integrated metadata management

Linkage between the job systems handling program information and the metadata can promote improvements in the efficiency and accuracy of jobs. In a broadcasting station, effective operations can be implemented by linking information such as program information and broadcasting achievement information obtained from job systems. This includes the business broadcasting system that manages the program organization and broadcasting schedules, and the news support system that manages the news production, as well as the accounting system in cases for which the management of the balance of payments per program is required.

(2) Video/audio location management

For example, in the process of news production, original materials registered by the coverage and circuit systems are edited and transferred to the transmission server and the news support system then edits the transmission schedule. In the systematization of this process, integrated management of the video/audio location and the transmission schedule can achieve effective system operations.

5. System Construction Issues

5.1 Step-by-step Construction

An archiving system can be constructed by linking various video/audio materials in-house with their associated systems and by applying integrated management.

Nevertheless, it is hard to introduce all of the functions at once from the viewpoints of both operation and cost. This makes it necessary to construct the system step by step. An example of the requisite steps is shown below.

- (1) Introduction of metadata management system.
- (2) Linkage with transmission server.
- (3) Introduction of materials servers and the implementation of unified management

5.2 Archiving Media

Since a huge amount of video/audio data is filed in the archive, the selection of the storage medium is very important. At present, suitable candidates include the SSD (Solid-State Drive), HDD (Hard Disk Drive), LTO (Linear Tape-Open) and optical discs. In general, media that excels in access speed or usability (SSD, HDD) is used for primary storage while that

excelling in cost and maintainability (LTOs, optical discs) is used for secondary storage. The secondary storage usually has a configuration capable of auto retrieving via a cart, etc., but a configuration utilizing external storage (virtual storage) is also possible. This architecture is expected to enable sharing by several enterprises in the future (implementation of shared archiving center).

5.3 Metadata

The material attribute information is managed in the form of text data. The archiving system is also capable of managing thumbnail data that is used to manage video scenes as still images for use in image searches and checks. It is also used to manage the low-resolution image files that are used to check the material contents. Construction of a system capable of handling low-resolution image files necessitates more consideration because these files contain more information than text data. Usually, the compression rate and format are decided assuming a search from a PC connected to a business network.

5.4 HSM (Hierarchical Storage Management)

HSM stands for hierarchical storage management. Use of an HSM in an archive allows users to employ the archive without being aware of the locations of the video/audio files. Since image files have large capacities, it is not efficient to store them in a single storage. Frequently used materials are managed in the primary storage such as an HDD, while less-used materials are managed in the secondary storage such as an LTO. Storing low-resolution files for search/check in the primary storage and storing actual material files in the secondary storage enable fast searches. As it is not effective to perform file transfers manually, the use of an HSM is essential for archiving systems above a certain size.

5.5 Video/Audio Analysis

Video/audio analysis technologies can make the operations more effective. The image identification technology announced in the paper on page XX of this issue enables searches of program materials that use certain image materials, even when encoding methods or compression rates are different. On the other hand, the audio analysis technology can generate text data automatically from video/audio and enable searches of image materials/scenes from lines of words in a program.

6. Conclusion

The ultimate objective of a file-based image archiving system does not lie in turning image based material into files but in the integrated management of the metadata of all jobs in the lifecycle of such material and in the implementation of effective workflows.

At NEC, we support not only the construction of systems but also the implementation of effective workflow in an integrated manner. Our strategy is based on our past achievements in introducing a wide range of broadcasting equipment both in-house and outside, and also on our experience in the construction of job broadcasting systems. In this way it is intended to assist the development of image material in becoming assets that are capable of generating new values.

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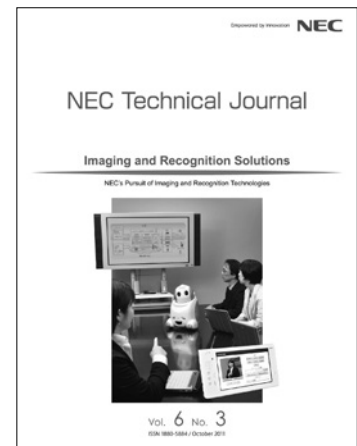
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