

RECOMMENDATION ITU-R BR.1351

**REQUIREMENTS FOR THE APPLICATION OF DIGITAL TECHNOLOGY
TO AUDIO ARCHIVING SYSTEMS FOR RADIO BROADCASTING**

(Questions ITU-R 215/10 and ITU-R 216/10)

(1998)

The ITU Radiocommunication Assembly,

considering

that many broadcasting companies possess vast audio archives, whose exploitation is expected to play a key role in audio production in the near future;

that most of the materials, being stored in analogue formats, are in danger due to the ageing of the media;

that digital storage formats, allowing for lossless copy operations, are expected to bring substantial benefits to the asset management;

that the technology allows for the design of automated digital archives;

that the new multimedia technology permits the handling of the audio materials and the relative documentative information (metadata) as composite objects;

that low cost information technology equipment is able to manage real time CD quality audio,

recommends

that the design of digital audio archives for radio broadcasting should be based on the user requirements given in Annex 1.

ANNEX 1

**Requirements for the application of digital technology
to audio archiving systems for radio broadcasting****Archive functional architecture****Types of information**

The types of information that an audio broadcasting archive must contain can be categorized as:

- 1) audio programmes;
- 2) metadata.

The audio programmes can be considered as made of the following types of objects:

- 1) sound material;
- 2) ancillary data:
 - a) synchronous;
 - b) asynchronous.

The sound materials can comprise assembled programmes, single contributions or purchased records (CD or vinyl). Ancillary data, comprising objects of various types like still pictures, text or animations, can optionally complement the sound materials. The ancillary data can require synchronization with the main programme, as in case of subtitles, or be asynchronous, as in the case of teletext.

The metadata is composed of multimedia information which is useful to better qualify and retrieve the audio content. It can be divided into:

- textual documents;
- images;
- graphics;
- EDL;
- cue points;
- hyperlinks;
- attributes.

The type and organization of metadata varies according to the programme genre and state of development of the item, e.g., contributions not yet included in a programme will probably have a lower level of documentation than a programme which has already been transmitted.

Archive architecture

In a broadcast archive two main modules can be distinguished: the content library and the index library.

Content library

The content library is the part of the archive that contains and manages the media on which copies of the audio programmes are stored and is thus responsible for the storage and preservation of the materials.

It is responsible for performing the following functions:

Archiving: All of the operations required to introduce new materials into the content library, including verification of the signal quality, generation of backup copies, etc.

Preservation: All of the maintenance operations that must be performed to ensure proper preservation of the materials, like periodic checking of the state of deterioration of the media and regeneration of the content on new media when needed.

Delivery: The procedures and means employed to provide a user with the required material for reuse in production. Several ways of delivery can be implemented depending on the technology available:

- file transfer;
- synchronous transfer (streaming) on various types of links (analogue, digital, IT), generally in real time;
- medium delivery.

Index library

The index library contains all the metadata needed to retrieve and browse the content of the archive.

Information contained:

- audio programmes (browsing quality);
- textual documents;
- images;
- EDL;
- cue points;
- attributes.

At least the following functions must be provided:

Documentation: All of the procedures required to gather, link and compile the information that will permit the retrieval of the programme content. Part of the information can be imported from the production, part can be generated by the system automatically and part must be input manually.

Retrieval: Various methods provided to query the index library. The most common consists of specifying the value of pre-formatted fields, like Title, Author, Production date, etc. More sophisticated methods can be implemented based on content search, provided that suitable algorithms are included for comparing objects of various nature such as audio, still pictures, video and free text.

Browsing: Through the browsing operation, the users can listen to a preview of the material selected during retrieval, by accessing a low-quality copy of the audio contained in the index library. Even if the quality of this signal is generally too low to be used in production, it serves various important functions, like precisely locating the audio excerpt that must be downloaded from the content library or remote editing.

Users

Different kinds of user can be identified that have different needs and priorities for access to the archive:

a) Production technicians

They must have high priority access to the content library, while less sophisticated indexing functions are generally required. This is especially so in news and sports environments, where production is often working on an extremely tight schedule, system reliability and fast transfer rates are mandatory requirements.

b) Programme makers and journalists

They use the system for documentation purposes only. Thus, access to the content library is not needed, provided that pre-viewing is available from the index library. On the other hand, sophisticated search functions are required.

c) Documentators

Their task is to assemble the documentation of the new items introduced into the archive. This job can generally be accomplished by browsing low quality versions of the materials, so that access to the content library can be avoided. The user interface for this category must be designed very carefully, as they need to be able to screen automatically generated information, like audio indexes, to link in external multimedia objects and to input textual information and audio indexes.

d) External users

External users can have access to selected parts of the archive. Both the documentation and the content can be required, but, in most cases, the materials are delivered in an intermediate quality format to preserve copyright. Special attention must be paid to security and accounting issues when this category of users is enabled.

User requirements

Content library

Archiving

Audio quality

As the materials stored in the archive can be reused in production, no quality loss must be implied by the archiving process. The content library must be able to support all the audio formats used in production so that any item can be stored in its original format without any possible loss of information. Materials received in compressed formats, e.g. coming from contribution links or news gathering systems, should be stored in compressed form rather than decoded into PCM, so that during future retransmission appropriate transcoding algorithms, if available, can be applied, therefore avoiding the need for cascaded codecs.

Automatic certification of new materials

If an audio item, while entering the archive, needs to be copied to a medium different to that of the original one, the fidelity of the copy against that of the original must be verified. It is desirable that automatic systems be developed to perform this task without need of human assistance. If this goal cannot be achieved, a human assisted operation based on automatic pre-analysis would already represent a step forward with respect to the present situation.

Preservation

Durability of the media

It is well known that any storage medium is subject to deterioration due to usage, ageing and atmospheric conditions. Thus, periodic regeneration of the material on new media must be performed. Due to the dimensions of the archives, this operation is very time and resource consuming and should be performed as seldom as possible. Even if automatic detection of endangered material with subsequent automatic regeneration is available, the average lifetime of the media should be in the order of several years to reduce the time critical nature of the monitoring process.

Automatic verification of the state of conservation of the media

It is desirable that, when using automated digital libraries, the state of preservation of the media is automatically and constantly monitored. This feature can be implemented by adopting recording formats having robust error detection and correction mechanisms that are widely used in the information technology world. In addition, it is desirable to be able to communicate, to the system, parameters to determine how often the correction mechanism is employed. By monitoring these parameters, it can be statistically determined when the regeneration of the content of a given medium is required.

Lossless copy operations

As periodic regeneration of the materials cannot be avoided, the low loss of copy operations must be guaranteed. Thus, recording systems with verification after copy capability should be employed in preference to recording systems only able to work in stream mode with error concealment.

Management of different media formats

Mass storage technology is rapidly evolving, delivering media with higher and higher recording densities and transfer speeds. The automation system of the content library should therefore be able to handle heterogeneous media formats, so that various formats can coexist within the library, allowing for a seamless migration to newer formats in the course of time.

Delivery

Automation capability

Automated media handling is an essential step in reducing the management costs of the archives and to substantially increase the performance of the whole system as well as to implement new features like automatic monitoring of the media ageing. Thus, the choice of the media formats supported by the content library must take account of the availability on the market of suitable robotized libraries. For cost and efficiency reasons, higher packing density formats should be preferred.

Near on-line availability

Any items selected from the index library should be ready for delivery to the user within a few minutes from the initial request. The actual delivery time will also depend upon the connection available from the library to the user location.

Delivery methods

Several delivery methods can be implemented according to the storage technology and the distance between the library and the users. If information technology (IT) storage systems are used, the delivery is best implemented through computer network protocols, as the maximum flexibility in network topology can be obtained. In this case the transfer can occur as a normal file transfer, asynchronously from real time playback, at a speed independent of the load and type of the network. If digital audio technology is used for storage, the transfer must be done at real time. It can still be implemented via computer networks, provided that enough bandwidth can be guaranteed by the system at any time, otherwise a dedicated audio connection or contribution link must be available. A further method, useful when no transmission link is available between the archive and the receiving site or the material is not urgent, consists of the delivery of a medium containing a copy of the wanted items via traditional mail.

Partial downloading

To minimize the bandwidth requirements, it must be possible to specify the transfer of selected parts of an item, identified via the browsing function in the index library. Pre-editing capabilities are also desirable.

Integration with production standards

To avoid inefficiencies and the possible loss of quality due to transcoding, the archiving storage formats should be compatible with those used in production. This implies that both the signal format and the file format (if applicable) must be compatible. The use of IT could increase the possibility of exchanging programme related multimedia information between production facility and archive.

Fast access from production

For some kinds of material, like news and sport, it is very important to have materials from the archive available at production facilities almost in real time. Thus, it must be possible to implement privileged connections between the archive and production.

Fault tolerance

As production staff will rely more and more on the archive facility, access to the content library to production must be guaranteed without service interruption. The system must be protected from staff hardware and software faults and from improper access.

Copyright management

Methods must be provided to verify copyright violations on the delivered materials.

Index library**Documentation****Multimedia data**

As the description of an audio item can be formed by formatted alphanumeric records (e.g., Title, Author, Date), other multimedia objects (text documents, still pictures or graphics) or pointer meta-data, (EDL and cue lists), the index library should be able to manage multimedia information. A simple storage and downloading of bulk data without any capability of interpretation is not satisfactory, as it shifts the burden of managing multimedia objects onto the user application and onto the network. The archive manager must be able to make new types of data known to the system when needed. The system must be flexible enough to allow for different types of aggregation of information, depending on the specific programme content.

Multi-layer indexing

A programme can be documented at various levels. For example, a news report can have an entry in the data base as a whole, but, in certain situations, an entry for any news contained can provide a more convenient access. Thus the same piece of audio material can have more than one entry in the data base, and all of them must be properly linked together, for example in a hierarchical tree. Further studies are required to define which levels of indexing are useful and how they should be organized.

Automatic audio indexing

The indexing of audio programmes, if done manually, is a very time consuming operation, so it is desirable that tools be provided to segment the material automatically into units with a logical meaning. If this goal cannot be achieved by today's technology, human assisted tools could provide a useful aid.

Automatic gathering of currently available information

Part of the documentation of a programme is often available at the production facility. As an example, the list and timing of the news contained in a news report is certainly available during production, as well as the script of the news (with the possible exception of field interviews). If common standards are adopted both at the production and facilities archiving, and proper links are set, the documentation efforts could be minimized by importing all the currently available information.

Efficient documentation interface

The interface for the documentation workstation must be carefully designed, as the task of selecting and linking all the various pieces of programme information, as well as extracting all the required index points, can be very complex.

Exchange of information with the external world

Standard file formats must be defined to wrap the metadata that constitute the information of an audio item, so that archives belonging to different organizations can seamlessly exchange programmes and related documentation.

Retrieval**Service availability**

The index library must be accessible from both in-house and remote user terminals via standard networks and protocols, preferably using low-cost platforms (personal computers) and without the need for special hardware. Provision for a high number of simultaneous accesses may be required.

Network requirements

The retrieval operation must be guaranteed for heterogeneous network connections, with different bandwidth capabilities. In the case of particularly slow connections, and depending on the network load, the system should still be able to deliver a useful service by dropping unessential multimedia information in favour to more concise textual descriptions.

Platform independent interface

It is desirable that platform independent protocols, like those employed in Internet services, be used to develop the user interface to the index library. This will ensure that the greatest variety of personal computers and workstations can be utilized with the minimum effort devoted to porting and maintenance of the user software.

Conditional access

Conditional access methods should be implemented to restrict and prioritize the availability of services and data to authorized users when needed.

Relational search

Relational search is the basic search method implemented in any database, and is the minimum requirement.

Advanced text search

Advanced text search methods should be provided to allow for keyword searches in free text fields and documents. The provision of auxiliary tools like dictionary, synonyms and related words lists is also desirable.

Content based search

Content based search methods are probably the new frontier of multimedia data base systems. Applied to audio databases these methods can include tools like voice and music recognition.

Browsing

Network requirements

The audio signal should be coded at a very low bit rate, compatible with the audio quality requirement, to provide an acceptable service even on limited bandwidth networks like the Internet. Three operational modes can be envisaged: constant bit rate (CBR), where the bit rate remains fixed during the transmission, variable bit rate (VBR), where the bit rate is dependent on the demand for bits to maintain a constant quality and available bit rate (ABR), where the bit rate changes according to the network availability.

Audio quality

Audio quality is not the main issue in browsing applications. As the audio must be on-line from the index library, the storage space must be minimized to allow the use of fast access media, like hard disks. Audio quality of grade 3 on the ITU-R 5-grade impairment scale for most of the materials is probably appropriate for browsing operations.

Software decoding and rendering

The decoding and rendering of any coded multimedia object, particularly audio, should be performed on the user terminal exclusively through software tools, preferably implemented using platform independent programming languages and running in real time.

Excerpts selection

During browsing, it should be possible to enter cue points so that high quality material delivery will occur only for the selected excerpts.

Remote editing

It is desirable that EDLs can be produced by simulating editing of the low-quality audio. These EDLs, applied to the high quality material stored in the content library, will produce a new assembled programme.