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Digitisation of programme material in Audio Archives

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Digitisation of programme material in Audio Archives

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1. Scope

This recommendation specifies technical requirements for the transfer of analogue audio material into a digitised form, with particular reference to the digitisation of audio archives.

There are many issues involved in archive preservation. Questions of professional ethics, material selection and prioritisation, and long-term strategy are dealt with in the IASA document "The Safeguarding of the Audio Heritage: Ethics, Principles and Preservation Strategy"[1].

2. Background

The general trend of audio technology is from an analogue (continuous) to a digital (discrete and numerically coded) representation of audio material. There are many aspects of this change. For audio archives, the most significant aspect is preservation of the audio material.

Audio storage media (carries) do not last forever. Life expectancy is measured in decades, at best. All audio collections face a future of transfers, from old carriers to new, every few decades. The transfer from analogue to digital is the critical stage because future transfers to new digital media can be fully automated, with no loss of signal quality. The transfer from analogue to digital cannot be automated, and capture of the full quality of the original is not guaranteed.

These two aspects, manual handling and risk of quality loss, make the transfer from analogue to digital (A-to-D) the most expensive and highest risk transfer an archive will ever face. This document gives basic guidance for archives facing this demanding task.

3. Archives strategy

IT (information technologies) offers many interesting options for supporting the requirements of the digitized audio archive. The hardware associated with IT does not, in general, pose any particular problem when designing a new archive. More difficult, however, are the tasks of determining the right archive strategy, organisation and the need to allow for the inevitable future expansion of the proposed installation. Many different variables must be taken into consideration. Whilst the hardware can easily be expanded or modified at any time, to maintain flexibility in the functionality of the archive to meet changing demands, an array of special preconditions must be created as a good starting point for project planning.

The initial and prospective workflow of the audio archive and its intended linking to a technological environment must be defined before the start of the project work.

Accordingly, the system integrator will be forced to entrust the main functionality of the archive to a software environment running on appropriate hardware and he will need to identify and exactly

define any future steps leading to the expected system development. In this way the system can be optimally dimensioned for the user at any given stage in its development.

4. Storage capacity

IT storage technologies are subject to a continual progress of increasing capacities at reducing costs. The implication of this is the need to periodically replace costly storage components of IT systems with bigger and cheaper components. It is not, however, economic to upgrade unused long-term storage components (hard disks, data cassettes and so on).

This makes it especially important to identify the likely pace of archive digitisation in the planning stages of the archive and to dimension the storage capacity so as to be adequate for a few years only.

The essential condition of the above declaration is an easy scalability of all IT storage elements in the system.

In determining the pace at which the new archive will be filled, all data sources must be taken into consideration to correctly dimension the storage capacity. The following data sources are the most important:

- Digitisation of legacy archive
- Ingesting new programme
- Programme exchange (import of external sources)
- Repurposed programme (new final production)
- Production-related (rough cuts, broadcast logging, Metadata etc.)

Tasks that are generally considered as the main purpose of an archive, the storage of old programmes, in fact represent only one part of the function of a digital archive. Moreover, the other functions of the digital archive are even more onerous due to the relentless continuity of daily production.

The outputs of an archive can similarly be listed:

- Support of production and postproduction workflows
- Providing information about Content and its manipulation
- Making available programmes for broadcasting
- Making available programmes for programme exchange

The estimation of necessary storage capacity should always take into account that the accompanying database of Metadata needs sufficient space as well. Further multimedia components will also inevitably emerge as part of audio programmes in the near future.

5. Metadata

Description of newly digitised Essence by means of Metadata has somewhat deeper significance and importance than is usually realized. The highest attention should be paid to the processing of all relevant information indispensable for creating Metadata. The Dublin Core [14] Metadata specification is a favourite method of Essence description in the radio environment. This open and highly flexible system can easily be combined with other Metadata standards, moreover.

Metadata must be created or captured at the earliest opportunity. Any delay brings the risk of limited availability of archive-elements in the future.

Metadata must be generated at the same time as the new digital audio Essence is ingested.

This principle applies equally to the digitisation of older programme material. Whilst it is technically possible to add Metadata to material at any time, the memories and experience of the Content creators or production teams may not always be accessible. The golden rule is *do it now*.

Full description of newly digitised material is costly, lengthy and tedious, but it radically increases the utility and value of the archive forever.

Having decided to digitise the archive and therefore to use Metadata, the appropriate data model of this information system must be precisely defined. In case of databases the existing orientation can be accepted. The XML definition of Metadata supports a linking to other data systems.

The Metadata model should be prepared to exactly suit the needs of the archive.

The detailed information about the contents of items in the archive should primarily serve the purpose of enabling easy retrieval of any needed audio recording. Technical Metadata, on the other hand, describes the technical characteristics of an item, such as the file format, sample rate, sample size, position of the digitised object in the storage and so on. Some Metadata will be fixed, relating to the history and to the original form of an audio item; some Metadata will be modified or created at some time in the future as the Content is modified or used.

The most important sets of information carried by means of Metadata are:

- Data about the creation of recording or programme
- IPR information
- Data about manipulation with the item (versions, usage, modifications)
- Association with other archive items (used cues, series)
- Documentation (texts, photographs, awards)
- Programme exchange (history, conditions)
- Data about the process of digitisation (when, how, what)
- Technical parameters (quality, formats, accompanying data)

Despite the fact that all Metadata comprise a database entry firmly associated with a relevant archive item, storing key-data in "chunks" of the file carrying digitized audio is recommended (and is supported in the BWF and RF64 file formats).

6. Compression

The conversion of analogue audio into digitised form determines the available digital audio quality forever.

The use of digital compression at the time of conversion must be understood in terms of the compromises between saving expense in data storage, the sound quality that is made available and the possibly disastrous longer-term implications of some decoders not remaining available over time.

It is clear that the IT data storage cost presents a variable with descending tendency whilst the audio quality represents a constant value. In light of this simple consideration the following very important declaration can be made:

The audio archive should, whenever possible, avoid the use of audio compression and it should preferably be organised in PCM audio format

There is no possible reason why an audio archive should be at the mercy of the continuing availability of a decompression codec with which to access its contents.

7. Channel Formats

Despite a broad discussion about the future of audio formats and the fast progress of multichannel technologies, their impact on the structure of an archive should not be very visible. Any temptation to up-convert old audio clips or programmes in the archive to multichannel must be absolutely resisted. Such processes can be applied in postproduction or broadcasting, but not irreversibly (without leaving a footprint) in the source materials. The only exception to this rule is the duplication of a mono signal (file) into the Left and Right channels of a stereo signal (file) with an appropriate level correction.

All recent archive technologies are pretty much format-agnostic and all Metadata systems support the transfer of information about the native format of the audio.

The channel format of the audio Essence used in the archive should be identical with the format applied during its origination, the exception being a conversion from mono to stereo.

8. Restoration of audio

Many items in an analogue archive have extremely high historical value but low technical quality. In such cases, audio restoration should be applied, though with due caution. Some of the more recently developed restoration processes substantially benefit from having a certain level of redundancy in the source signal. Also, **due to the continual development of audio restoration methods, optimally digitised original material should in any event be retained in the archive**.

This is yet another reason why digital compression should not be used in archives.

9. Indexing

The possibility of perfect navigation through the items in the archive is a major advantage of the digitised solution. A higher level of Content control requires that navigation be possible inside the individual files. This is especially important in the case of music items, whose internal structure has to be described in detail. Indexing is the method that fulfils all these needs.

Indexing is a very important tool that radically increasing the efficiency of browsing and manipulation within items of the archive.

There is usually no problem with indexing during ingest of CDs or DVDs. On the other hand, indexing material from magnetic tapes and gramophone records during the digitising process demands some assistance and software support. Despite the fact that in these cases it is impossible to make this process fully machine-controlled, the automated detection of music components during continuously running ingest is a significant aid. The user can concentrate on dealing with Metadata only.

Fast access should be allowed to all different elements of the archive. For music, noises, jingles, complete programmes or rough-cut materials, a fine granularity in their Metadata description should be applied.

A high grade of granularity used in Metadata description radically increases the comfort of Metadata treatment.

Furthermore, indexing enables rough-compilation of items according to a cue list. The relevant files are accessed from the archive and they are aligned in a form that makes the compilation process more transparent, easy and fast.

10. How to accelerate the process of digitisation?

The best way to prioritise the order in which Content should be digitised for the archive is to consider the following criteria:

- Artistic and historical value of the Content.
- The frequency of actual use of a given piece of Content up until the present.
- The degree of signal deterioration caused by the recording medium

Using these criteria to dictate the order in which analogue material is digitised, it is observable that after the conversion of as little as about 20% of the whole analogue archive, the digital archive is capable of sustaining about 90% of the demands made upon it by users.

It seems appropriate to preferentially process new production material for the archive, as in most current production the format is already digital. In this case the archive serves in its role as a production support.

An increased level of staff costs during the process of digitisation is an inevitable consequence that must be taken into consideration in costing the archive.

11. The right choice of technical parameters

The key requirement in audio archival is to maintain the highest possible aural quality of Content.

As aforementioned, the quality of conversion into digitised form will determine the quality of the audio forever. In comparison to video or TV archives, where expectations are growing at a fast pace (HDTV, UHDTV, D-Cinema), the currently achievable quality of digital audio, both in recording and reproduction, seems to be sufficient to satisfy the most demanding needs of listeners, and:

The only relevant criterion of digitised audio material should be its suitability for up-conversion processes in the future.

12. The process of digitisation

Analogue stages before digitisation:

- Ascertain, if possible, the quality of the original production and the original recording process (bandwidth, signal/noise and drop-outs).
- Make sure that both the analogue replay equipment and the analogue signal chain is correctly aligned so that they will not degrade the recording. This must be re-checked periodically during batch digitisation projects.

12.1 Parameters for digital signals

12.1.1 Standard (studio and B2B) quality level

Sample frequency:	48 kHz or 96 kHz
Word length:	Up to 24 bit
Level:	According to EBU R89 [6] or R68 [7]

Any subsequent processing of the digitised material may benefit from more precise sampling (higher sampling frequency and/or longer word lengths; see EBU R84 [8], and therefore the use of sampling at up to 24 bit per sample is recommended wherever possible.

12.1.2 Lower (B2C) quality level

It is not recommended to use less than 16 bit word length and lower than 48 kHz sampling (or 44.1 kHz sampling in the case of the production of Red Book audio CDs). The savings in storage cost are not justified.

12.2 Format of digital files

12.2.1 EBU Broadcast Wave Format

The BWF [10] is an open file format widely used in the professional audio environment for production and programme exchange. Within the file header are Metadata chunks containing a unique identifier, key audio parameters and the coding history, including any IPR information.

12.2.2 EBU RF64 Wave Format

The RF64 [11] is a BWF-compatible multichannel-capable file format enabling the generation and use of files in excess of 4 Gbyte.

12.2.3 Associated information

Sleeve notes, album covers and any associated documentation should be digitised if possible and linked to each other and to the associated audio using a USID [12] or UMID [13] in Metadata.

13. Monitoring of quality

The sound quality of digitised files heavily depends on the quality of the original analogue material (often degraded by dirt on the head of the tape player, echoes caused by print-through of the signal on the tape, sticky tape and clicks and crackles caused by electrostatic charges), on the conversion into the digital domain (A/D distortion, incorrectly set levels) and on the diligence of operators.

It is important to discover and analyse quality problems as soon as possible, and particularly before the original analogue material is disposed of, so re-digitisation can be attempted if this process was at fault.

Decisions on whether to use an automated evaluation of final quality as opposed to human quality control procedures will be individual to each company. Nevertheless, the following important criterion should be strongly adhered to during the whole process of digitisation:

The (analogue) player used for digitisation must be maintained in a professional manner to comply with the manufacturer's performance specifications.

14. Bibliography

The latest available version of the following documents should be consulted.

[1]	IASA-TC 03 ver.3, Dec. 2005:	"International Association of Sound and Audiovisual Archives - The Safeguarding of the Audio Heritage: Ethics, Principles and Preservation Strategy"
[2]	IEC 60094: Magnetic tape sound recording and reproducing systems.	IEC 60094-1 (1981); am1 (1994): Part 1: General conditions and requirements IEC 60094-2 (1994); Corr.1 (1995): Part 2: Calibration tapes IEC 60094-3 (1979); am2 (1988); am3 (1996-02): Part 3: Methods of measuring the characteristics of recording and reproducing equipment for sound on magnetic tape IEC 60094-6 (1985): Part 6: Reel-to-reel systems
[3]	IEC 60098 (1987):	Analogue audio disk records and reproducing equipment
[4]	IEC 60268:	Sound system equipment IEC 60268-1 (1985); am1 (1988); am2 (1988-01): Part 1: General; IEC 60268-2 (1987); am1 (1991); Part 2: Explanation of general terms and calculation methods IEC 60268-3 (2000); Part 3: Amplifiers IEC 60268-10 (1991); Part 10: Peak programme level meters IEC 60268-17 (1990); Part 17: Standard volume indicators. IEC 60268-18 (1995); Part 18: Peak programme level meters – Digital audio peak level meter
[5]	IEC 60386 (1972):	am1 (1988) Method of measurement of speed fluctuations in sound recording and reproducing equipment ("Wow and flutter" measurement)
[6]	EBU R 89-1997:	Exchange of sound programmes on Recordable Compact Discs, CD-R
[7]	EBU R 68-2000:	Alignment level in digital audio production equipment and in digital audio recorders
[8]	EBU R84-1996:	Word length, sampling rates and auxiliary information in digital systems used for high-quality audio production
[9]	EN 60908-1999:	Audio recording - Compact disk digital audio system
[10]	EBU Tech 3285-2001:	Specification of the Broadcast Wave Format (BWF) - A format for audio data files in broadcasting
[11]	EBU Tech 3306-2007:	RF64 - An Extended File Format for Audio.
[12]	EBU R 99-1999:	'Unique' Source Identifier (USID) for use in the Originator Reference Field of the Broadcast Wave Format
[13]	SMPTE 330M:	Unique Material Identifier (UMID)
[14]	EBU Tech 3293-2001:	EBU Core Metadata Set for Radio Archives