Technical Report 003

Radio Archives: Conception & Practice

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1. Scope

Most modern audio production and processing technologies work in the digital domain and handle audio as files. This fact opens up many possibilities that could not have been contemplated in the analogue era. If an analogue audio archive can at best serve as a warehouse of magnetic tapes (hopefully, perfectly organized and documented), then the role of a digital archive will be considerably broader. The user will be in much more frequent contact with it, he will use it during preparation of his projects, during the production process and when making decisions about further usability of finished works.

The goal of this document is to provide germane information to those who plan to digitize their sound archives. The EBU (European Broadcasting Union) has many Members who have already trodden this path and whose experience is a very valuable commodity. The information provided here is not a set of universal instructions on how to proceed; the main idea is rather to point out the significant principles, learned from experiences and findings that should be observed in case of newly developing projects.

This material is the result of work done by the EBU's P/CRA (Conception of Radio Archives) Project Group and it draws on work previously performed by the P/DAW and P/NAP Project Groups, both of which focused on implementing information technologies (IT) in standard studio environments. It should be noted that another output of P/CRA, EBU Recommendation R105-2008, is conceived in the same way, but it only deals with the process of digitization and with the determination of appropriate parameters for this purpose.

2. Strategy of archives

Perhaps the most important advantage of digital audio signals is that they do not suffer from the process of technical aging. Even if users could expect nothing more than this, digitization would be an inevitable step for each archive. On the other hand, audio storage media (carriers) do have a finite lifetime, with life expectancies measured in decades, at best.

All digital audio archives face a future of transfers from old carriers to new, every few decades. The important point is that this transfer from carrier to carrier can be fully automated and it incurs no loss of audio quality.

The transfer of audio from the analogue domain to digital is the critical stage; it cannot be automated and it must be done carefully if the full quality of the analogue original is to be captured.

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

Preventing the process of signal aging is not the only benefit of digitization and a number of its other advantages must also be appreciated and must be properly exploited in the new archive.

Recent levels of IT capability are well able to support the digitized audio archive in a wide variety of different ways. The hardware needed does not pose much of a problem for project planning, as it is fairly well understood these days. A more difficult task is that of determining the right strategic and organizational structure of the new installation. Whilst hardware can easily be expanded or modified at any time, the functionality of the archive is not so easy to change and an array of special preconditions must be created to guarantee a degree of flexibility. Respecting the following condition can be a good starting point when commencing the project to design an archive.

The workflow of the audio archive and its integration into a surrounding technological environment must be defined before the start of the project work.

Accordingly, the system integrator must entrust the main functionality of the archive to its software functionality and he should define (as exactly as possible) any future development steps that can be foreseen. The system will thus obtain dynamic dimensions that are optimal for the user.

3. Project Preparation

Depending on the easy upgradeability of IT hardware is dangerous when it comes to planning a digital archive that corresponds to current needs but which will need extending when increasing demands are placed on it. Whilst such an approach seems logical and will largely spare the user from initial estimations of the anticipated needs for system development, it must be warned against for the following reasons:

- Rapid developments in the IT world usually mean that current infrastructure becomes redundant, which decreases its easy upgradeability in time.
- A mere increase in IT infrastructure does not guarantee scalability to achieve new functionality.
- Insufficient network throughput is usually the major limiting factor to increased system performance.
- The lack of an initial assessment of the anticipated development of the system can lead the user to a solution that lacks the prerequisites for continuous development.

A wrong decision about system dimensioning at an early stage can make the installation much more expensive in the longer term. The system architect who has a real idea about the necessary development of his system has the opportunity to sensitively and economically choose the extent of its proper over-dimensioning right at the beginning of the project.

It should always be possible to initially contractually secure a notion of system development within the Support and Maintenance process under clearly defined conditions. This is fundamentally preferable to a later effort to reach higher system capacity / functionality by negotiating a new contract.

The analysis of longer-term system developments and the provisioning of means of securing them must be the first steps made within the new archive-digitizing project.

The initial phase of project preparation must also fulfil many other tasks. It will be necessary to win the support and co-operation of the many professions working in the current (analogue) environment to embrace the workflows imposed by an efficient assimilation of IT-based production. Technical re-education should be offered during this phase. The users of the future system must learn about the new environment in a timely and easily assimilated manner. Articles, seminars and personal consultations are the best kind of preparation for further cooperation.

During the project preparation process it is necessary to "diplomatically" educate all workers to realize the necessity of the project that is being developed. Top management must be seen to be unanimously supportive of the project to stimulate the necessary cooperation.

Tactical project establishment within the organization is very important for further cooperation on setting new archive environment functionalities.

4. Project Team

Regardless of whether the broadcaster employs an external partner to take care of the new archive development, or whether it is managed internally, an internal Project Team that distils all the users' needs of the system is necessary.

The Project Team must be representative of all the users of the new archive; it must weigh the financial aspects of the various solutions on offer and ultimately identify the best compromise between the financial costs and technical features of these solutions. In case of tenders, the Project Team plays a key role in the preparation of all the formal and practical processes defined by law.

It is not possible for a group of technical specialists, alone, to suggest an optimal archive system for a given organization. Only close cooperation with the future users of the system may ensure a successful solution.

Due to the fact that this is an important conceptual decision that also involves a high investment, the Project Team must be sufficiently mandated by the management to act on its behalf in all necessary matters. Adequate powers should therefore be delegated to the key members of the Project Team.

The mandate of the Project Team will necessarily extend until the new archive becomes a standard and fully accepted part of the production environment of the company. It assumes long cooperation of people whose replacement will not be easy. Such circumstances must be taken into consideration when preparing the project.

5. Analytical Project Preparation

A clear idea about what the final archive system should provide is a necessary condition for commencing the Project.

It is recommended that a report be generated in which the required functionality of the new system, the format required for archiving, the anticipated source signals and the forms of output from the archive are identified. It is not wrong if at this stage the anticipated new workflow has not yet been fully described. The workflow, or at least an idea of it, can be formed only within the preparation of the conceptual project solution.

An analysis of present production processes, identifying their strengths and weaknesses, should be one of the first steps undertaken. Their functional mapping into the future workflow is essential.

Without a rigorous analysis of the present state of the archive it is not appropriate to start the design work on its digitized form. The results of this analysis will become an essential tool for the future workflow definition. That is the strength of this phase.

Analysis is not carried out to simply "mirror" the old processes into the functioning of the new archive. Such attitude must be prevented under all circumstances. Adoption of new IT-based technology means that new, typically digital workflows must also be adopted. Objective analysis of all previous experiences gained from the adoption of IT-based infrastructures confirms this.

6. Archive Solution Conception

The second phase of the project preparation, in which the functionality of the digital archive is defined, has an inherent difficulty that it is difficult to specify what you need if you have never practically experienced the capabilities of the new environment. It is obvious that only operational experience in the new environment will show what could be solved differently and more efficiently.

The IT-based archive is impossible to model in isolation. Digital audio workstations (DAWs) presented a much easier assessment, as it was enough to buy two or three examples and to test all their qualities, including their network transfer characteristics. With this information it was an easy matter to start the process of integrating them into the production environment.

The use of an IT-based archive, either audio or legacy, has a far-reaching impact on the workflow of the production infrastructure in which it forms part. It can be assessed only as a functional part of the entire production infrastructure.

There are only two ways in which the risks of investing in an unknown technology may be minimised, or at least better managed:

- To consult with those broadcasters within the EBU who have prior experience in the technology and who can point out possible pitfalls. This information exchange is a core function for the EBU.
- To plan for an intermediate, so-called customizing phase within the Project. This phase provides an opportunity for the implementation or modification of functionalities that have been shown necessary (or desirable) in a previous, interim operational phase of the new system. This step, having been planned from the outset of the Project, can be accommodated in the original financial and contractual aspects of the investment. The Project Team will have the availability of correcting or ameliorating the observed conceptual deficiencies, however it will not be blamed for poor quality preparation.

The customizing phase of the Project provides the opportunity to supplement the system with qualities that prove necessary or desirable in operation.

As well as considering the internal processes and functionalities of the new IT-based archive, its interfaces and methods of distributing the digital content must also be taken into account when designing the system. For instance, the archive may also be used as a repository for the off-air log that is mandated by law in most countries. This use may impose other requirements such as the quality in which the content is archived and the descriptive metadata that is required; all need specifying at the outset. All proposed archive functionalities must lead to a unification of processes used in an organization. Besides distribution it is also necessary to take into account the use of the archive for production purposes.

The role of software in an IT-based archive is immense. It is necessary from the outset to start

specifying the choice of Media Asset Management, operating systems, user software for each application (ingest, editing, automatic recording etc.), middleware, system and integration software, and auxiliary software tools that can aid data migration from the original databases.

7. Definition of the roles of users

The protection of archived items is paramount and proper attention must be paid to it when defining the archive. The issue has two levels. Firstly, archived content must be protected against loss or destruction due to system failure. This latter can include accidents, hardware malfunction and software errors. Such events must be avoided by robust IT backup solutions and well-debugged software components.

Proper robustness of the archive system is achieved through adequate content backup, and this is a basic requirement of the proposed solution.

Secondly, the archived content must be protected against loss or destruction by user-manipulation error. This is achieved by limiting what can be done to the content according to a hierarchical system of user rights. Different classes of users will have user rights that will variously give them access to browsing only or to browsing and copying and so on. A modern archive must offer a wide spectrum of such user rights whose use can make it possible to automatically control access to content while minimizing the associated risk.

With appropriate application of user rights it is possible to create an "absolutely safe" archive system, which will protect archive items against undesired manipulations, against errors leading to destructive operations and, last but not least, against intentional misuse of content.

8. Initial Project Specification

The proper specification of all the attributes of a new archive is not an easy matter and it is very costly to remedy errors. A time will nevertheless arrive in the Project when it will be necessary to hand over a system specification that must clearly express the system design and which is a binding basis for the delivery of a physical system.

If, as recommended here, the IT-based system concept takes into account the requirements and notions of the future users, then the preparation of the initial project specification must involve intense cooperation from IT specialists as well as system users.

Practice has shown that it is difficult to successfully run a team consisting of creative employees and (IT) technicians. The first group consists of non-specialists in the field of IT whilst the second, technician group very often finds it difficult to assimilate the seemingly non-rational requirements of production procedures and the needs of the creative employees. Only a very careful orchestration of dialogue between these groups yields the desired result.

9. Networking

Special attention must be paid in the Project to network connectivity. Whilst the data transfer requirements of audio are significantly lower than those of television, it is as well to appreciate that a digital audio archive will need to service a potentially large number of devices (DAWs and other clients) simultaneously and that this could load the network quite heavily.

Reliability of the network and sufficient throughput capacity relates not only to the security of data transfer, but also to the quality of the user's-experience in performance of their work.

When specifying an archive it is necessary to anticipate potential data bottlenecks in networks and to adjust their transfer capacity for later developments.

Developments in the IT world have brought several new advanced networking technologies that can be used to advantage for the transfer of digitized audio. Typically, the main advantages of networking are: easy and risk-free equipment installation, the ability to interconnect several studios using wide area networks (WANs), thus removing the limits of acceptable distance between devices, the undeniably high reliability of networks and their continuing increase of transfer capacity.

Whilst the main type of transfer associated with archives is file transfer, streaming is increasingly encountered. In streaming, audio material is organized and multiplexed in such a manner that playing is possible with minimum requirements on the local cache and with short delay. Streams, unlike files, it must be noted, do not have a clearly defined beginning and an end.

The most important network properties that define the network's fitness for purpose are high transfer capacity and short latency.

Before deciding upon the necessary parameters of the network that is needed, it is important to know what will be expected from the archive, both internally and towards other technologies. In particular the requirement to connect to on-line environments will lead to the need to support stream transfers.

10. Data centre

Installation of all the necessary technology within a single premises (data centre) brings many advantages. It must nevertheless be remembered that the administration and protection of archived data requires special care. The data centre must be able to effectively eliminate the dangers of fire, water leakage, overheating of equipment, power outage and also sabotage. The proper solution should be based on a definition of the level of service availability that is required, e.g. method of Tier Levels. The completion of the data centre is an important condition of commencing installation of a modern IT-based archive.

When defining parameters of the data centre it is necessary to take into consideration future expansion of the archive. The expansion has two components. Firstly it is normal capacity expansion of the storages and secondly it is the process of expanding the services offered.

11. Storage capacity

Storage technologies are developing rapidly. Disk capacities are increasing dramatically whilst their cost per gigabyte is decreasing dramatically, which is good news as far as archives are concerned. This has implications both on the amount of long-term storage capacity that it is economic to maintain in an archive and on the diminishing cost-benefit of compressing data in the archive.

The installed long-term storage capacity of the archive should be sufficient to accommodate only a very few years of content at the currently known real pace of ingest.

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

All data sources of the future archive have to be taken into consideration to correctly fulfil the abovementioned principles. The following five data sources are the most important:

- Ingesting new programme elements
- Input of newly compiled programmes (new final production)
- Documentation (rough materials, logging of broadcasting, metadata)
- Programme exchange (import of external sources)
- Digitization of the legacy archive

In other words, tasks generally considered as the main purpose of archives (storage of old programmes) represent in fact only one part of their whole complexity. Moreover, the other four jobs of archive are even more complicated due to the relentless continuity of daily production.

Similarly, we can compile a list of outputs:

- Support of production and postproduction
- Providing information about content and its manipulation
- Making programmes available for broadcasting
- Making programmes available 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. Also further multimedia components will emerge as part of audio programmes in the near future.

12. Metadata

Description of newly digitized essence by means of metadata has somewhat deeper significance and importance than we usually realize. That is why the highest attention should be paid to the processing of all relevant information indispensable for creating metadata. The Dublin Core metadata specification is the favourite method of essence description in the radio environment. This wide-open and highly flexible system can be easily combined with other metadata standards. The specification of the Dublin Core is provided in EBU Tech 3293.

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 description must be made at the same time as the new audio essence emerges.

In addition, the gathering of details related to old programme materials should be considered a key matter. It is possible to add and specify different metadata anytime, but the memories and experience of the authentic creators or former production people may soon be inaccessible.

Perfect description of newly digitized material is costly, lengthy and tedious, but it radically increases the value of the archive forever.

Having decided to digitize the archive and therefore to use metadata, we must precisely define the appropriate data model of this information system. 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 content of an archived item should serve the purpose of easily finding any needed audio recording. But it is not solely the content of programmes that is described by means of metadata. Besides cataloguing data, technical metadata describe the technical

characteristics of an item, such as the file format used, its sample rate, sample size, position of the digitized object in the storage and so on. Some of the metadata describes the history and the present form of an audio item; some metadata will be modified or created at some time in future to describe future processing and versioning of the content. The most important sets of information carried by means of metadata are:

- Data about the creation of the 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 digitization (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 essential metadata in "chunks" within the audio file format is recommended.

The gradual increase of multi-channel recording and their share of programme exchange will bring new requirements on the use of metadata, which can be used for influencing the behaviour of the decoders of the listeners.

13. Compression

It is important to always keep in mind that conversion of audio into digitized form determines the available audio-quality **forever**. The use of compression must be understood in terms of a compromise between the costs of data storage and the available sound quality. It is clear that in an environment of constantly falling prices of IT-based storage (hard disks) the case for compression is also diminishing. We can therefore make the following very important declaration:

The radio archive should generally avoid the use of audio compression and it should preferably be organised in PCM audio format.

There is another reason for shunning compression. It is the objectionable dependency of the archive on particular decoders in the longer term.

14. Formats

Despite a broad discussion about the future of audio formats and the fast progress of multichannel technologies, their impact on the structure of archives should not be significant. Any ideas about up-conversion of old audio cues or programmes in the archive must be resolutely refused. Such processes can be applied in postproduction or during their broadcast, but never irreversibly in the source materials.

All the recent archives are format-agnostic and all metadata systems support transfer of information about the native format of the audio. The only exception may be the duplication of a mono signal into the Left and Right channels of stereo signal with an appropriate level correction.

The format of the audio essence used in the archive should be identical with the format applied during its origination, but not lower than stereo.

Thanks to the rapid development of HDTV the audio associated with television broadcasting will rapidly become multichannel as a matter of course. Radio broadcasting must also react to the circumstance. It will be necessary to prepare radio archives for work with multichannel, because its production will experience fast volume growth in all the important genres. The area of programme exchange will require unified rules for documenting multichannel items. Only responsible preparation for this easy-to-predict development will prevent later requirements for changes in the conception of archives.

15. Loudness

Digitized items in the archive must be suitable for immediate playout for the purpose of broadcasting and programme exchange. It is therefore necessary to take into consideration that the correct level of audio signals in digital interpretation must be set. The latest surveys show that it is not suitable to define correct level of signal by measurement using a PPM or VU indicator type. It is better to use modern integration methods close to the ITU BS-1770-2006 standard.

Guarantee of steady loudness of records from the archive requires their storage in precisely defined form. A good starting position for the fulfilment of this requirement is the ITU-R loudness meter, or any other variant, based on the integration measurement at least of a Leq(A) type.

16. Stage of Implementation

Clarification of all questions brought by the project phase is a prerequisite for commencing the process of realization. It is often necessary to use tenders, which bring the risk of longer terms. Due to the complexity of this approach it is often the case that commencing of realization is delayed and this can be inconvenient with respect to the fast development of information technologies. Commencing realization also requires suitably conceived data centre and clear idea whether it is to be used for archiving only or whether it will concentrate all IT means of production. Equally important is precise specification of contractual conditions with the partner, who is carrying out the realization. Together with properly selected time schedule of deliveries it is also possible to put the system into operation in logical steps, which will create the conditions for installation of hardware, implementation of software, its customization and putting into testing operation.

Detailed definition of acceptation procedures and division of these before commencing realization will allow the broadcaster to have continuous and transparent supervision over the new system.

17. Stage of Testing

Practical verification of functionality of the new system is the last step of realization. If the project is divided into several parts it is suitable to verify operational performance and reliability of parts of the system, as well as of the entire system. The user must not be disappointed if practical operation reveals a number of problems. He must perceive them as the price of creating the best possible user environment for the future users. It is therefore necessary to involve the users in the testing operation as much as possible. Within the testing operation technicians and creative employees have the unique opportunity to get to know the system before sharp operation, but they also have the last opportunity to make small modifications, which will later make their lives easier.

A number of ideas, inspirational suggestions but also various errors appear during the installation. The stage of testing and defining new possibilities of the new system is the last possibility to

include such findings in the Project. It is therefore not important, whether modifications are carried out immediately or they are taken into consideration for the future development of the system. New requirements will be documented and thorough evaluation of their relevancy will be carried out. It is also suitable to evaluate the project from the financial point of view.

Besides standard tests of the basic functionalities of the system, or its parts, it is necessary to carry out also a heavy-load test and a test of security. It is proper to prepare in advance testing scenarios, which will guide this difficult process. A part of these materials must be clear specification of two key values: depth (range) of tests and their duration. In order to prevent later disputes participation of the investor, supplier and system integrator is required. It must be understood that testing is not cheap. It stops for certain time further realization; it cannot be used for training. Therefore the investor should find the extent, where testing brings sufficient control of parameters and performance of the system, but verification of reliability and functionality is left for the testing operation.

Testing operation must, at least in its final phase, simulate the operation of the real production environment as closely as possible. But it is not convenient to permanently integrate the tested part of the system in the production environment. On one hand it is not possible to guarantee perfect protection of "real" data and on the other hand removing possible defects requires very complicated removal of the tested part from the system.

18. Process of Initiation

It is often mistakenly thought that only the entire complete system can be put into operation. It is possible, but it is not convenient especially in case of larger installations. The user should base the terms for putting the system into operation on the parts of the system, which represent concrete functionality. Therefore there is nothing wrong on commencing digitalization of analogue tapes without putting into operation the subsequent distribution of new cues for external users of the archive. The process of putting the archive into operation can be in fact different from the original concept and plan. If there were significant problems connected to the acceptation of some parts and their removal required time, it would not be convenient to delay start of the entire system. Broadcaster can therefore operatively decide to use a different scenario for opening of the new archive.

Two important steps must precede the situation when the system gains new functionalities and is therefore prepared to be handed over to a new user. The first step is preparation of user manuals; the second is training of future administrators and users. It should be in deep interest of the system integrator of the project to pay due attention to this stage. He should realize that it is a key moment of the project, when relation between the new user and the archive is formed. His uncertainty and fears of failure to master completely new technologies are the worst initial feeling.

In the first years of operation of his new archive the user will need cooperation with its builder (system integrator). Their cooperation should not end after acceptation. This factor must be taken into consideration in the phase of contractual preparations.

19. Testing and development environment

Let us assume that the archive is successfully providing services. However, a problem will occur if there is a need to significantly change its properties. There could be many reasons for such need. New format, new additional services, improvement of parameters, expansion of capacities and increasing the number of users, choosing new workflows etc. In such cases the problem is how to install new or modified software and hardware directly into the production environment without endangering its operation. An even bigger threat is the risk of losing archived data. Therefore it is

suitable to create, for the purposes of future development of the system, a model-testing environment working independently of the main system. This will allow objective control over all prepared modifications under conditions very close to the real archive. For implementation of smaller installations it is possible to combine a testing environment with a development environment.

A testing environment for subsequent development of the system must be based on technology related to the production environment, or even better, on identical technology. Only then will the results be correct. Due to fast IT development it is desirable to take this condition into consideration in the preparation phase.

20. Restoration of audio

A lot of items in the archive will have extremely high historical value but low technical quality only. In such cases the process of audio restoration should be applied. The choice of an appropriate type of digitization plays a key role. The reason for this is the possibility of applying some of the recently developed restoration processes, for the use of which a certain level of redundancy in the source signal would be favourable. This is yet another reason why no compression should be used in archives. Generally speaking, the restoration processes should be treated with caution.

Due to the continual development of different restoration methods optimally digitized original material should be retained in the archive.

Restored treated material must not replace the original recording. It must become properly documented version and in the archive exist alongside with the original. There are a number of reasons for this, the most important one being the possibility of repeating the restoration process later, when more advanced processes are available. The source material for these processes must always be perfectly digitized original.

21. Indexing

The possibility of perfect orientation in the items of the archive is the main advantage of the digitized solution. A higher level of control of the content requests navigation inside the individual entries; this is especially important in case of music items, the internal structure of which has to be described in detail. Indexing is the method to fulfil all these needs.

There is usually no problem with indexing during the ingest of CDs or DVDs. On the other hand, the process of digitization from magnetic tapes and phono-records demands some assistance and software support. Despite the fact that in these cases it is not possible to make this process fully machine-controlled, the automated detection of music components during continuously running ingest offers a significant aid. The user can concentrate on dealing with metadata only.

The archive has to offer an easy orientation among its items. Indexing is a very important tool radically increasing the efficiency of browsing and manipulation with items of the archive.

Fast access should be allowed to all different elements of the archive. For music, noises, jingles, complete programmes or rough materials high grade of granularity in their metadata description should be applied.

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

Furthermore, indexing enables rough-compilation of items according to a cue list. The materials

are taken out of the archive and aligned in a form that makes the compilation process more transparent, easy and fast.

22. Technical parameters

The key requirement in audio archive is a highest possible quality of its content. We should keep in mind that the quality of conversion into digitized form will determine the quality of audio for next generations. In comparison to the video or TV archives, where expectations are growing at a fast pace (HDTV, D-Cinema), the achieved and used quality of audio seems to be sufficient, the recording and reproduction technology is able to satisfy the highest needs of listeners. That's why:

The only relevant criterion of audio materials should be their suitability for up-conversion processes in the future.

23. Process of digitization

The best way to determine the working sequence of digitization for the archive is to respect the following criteria:

- Artistic and historical value of content
- Frequency of actual exploitation of a given programme up to now
- The degree of signal deterioration caused by the recording medium

If we meet these criteria we are able to guarantee that after the conversion of as little as approximately 20% of the whole volume, the archive can be considered 90% digitized because on IT level we will be able to meet archive requirements of 90% of our clients.

It seems to be correct to digitize new production preferentially, because in many cases the output format of the programme material has already a data form. In this case the archive in principle presents a support of usual technological continuity.

An increasing level of staff costs during the process of digitization should be considered a typical related fact.

Analogue stages before digitization:

- Ascertain, if possible the quality of the original production and the original recording process (bandwidth, signal/noise and drop-outs)
- Make sure that the analogue replay equipment and signal chain are correctly aligned so that they will not degrade the existing recording and re-check this periodically during batch digitization projects.

Parameters for digital signals (according to EBU Recommendation R105-2008):

Standard (studio and B2B) quality level:

Sample frequency:	48 kHz or 96 kHz
Word length:	Up to 24 bit
Level:	R89 or R68

Any subsequent processing of the digitized material may benefit from more precise sampling

(higher sampling frequency and/or longer word lengths; see EBU R84, and therefore the use of sampling at up to 24 bit per sample is recommended wherever possible.

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 production of Red Book audio CDs). The savings in storage cost are not justified.

Format of digital files:

- **EBU Broadcast Wave Format**

  The BWF 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 the IPR information.

- **EBU RF64 Wave Format**

  The RF64 is a BWF compatible multichannel file format enabling file sizes to exceed 4 Gbyte.

Associated information

Sleeve notes; album covers; any associated documentation should also be digitised if possible, and linked to each other and to the audio using USID or UMID in metadata

24. Further System Development

Each IT installation has to take into account creating suitable conditions for the future system development. In case of the digitized archives the possible requirements can be divided into three parts. The development of capacities used for storing archive files, their preview formats and respective metadata will be quite natural. The second way will consist in increasing the system availability. It is related to the increase of the user number, the system popularity and the level of usage. This is a desired effect that shows evidence of a successful digitizing process, but it is usually connected to high costs. These are, however, necessary only in case when the increase of availability has not been taken into account at the very beginning, at the project preparation phase. If it has been taken into account, then the costs will not be high but planned and expected, reaching only the necessary amount. The last development group consists in the moral renovation of those installation aspects which are most affected by the rapid IT development. There seems to be no defence against this trend, however, appropriate definitions of system blocks and the usage of unified interfaces can help to stretch out the system's life span up to the point of its regular generation renovation.

Gradual archive system development must be considered a completely logical process. A system should not be developed into its final form en bloc, but it is right to gradually develop it at a pace that exactly copies the user's requirements. That way investments will be best protected and the development in the right direction guaranteed.

25. Monitoring of Quality

The sound quality of digitised files depends on the quality of original material (dirt on the head of the tape player, echo caused by print-through of the signal on the tape, sticky tape, click and

crackles caused by electrostatic), on the conversion into digital domain (A/D distortion, bad levels) and on the diligence of operators. It is important to discover and analyse these problems as soon as possible. Decision to use the automated evaluation of final quality or the human quality control procedure depends on decision of each company. The following important criterion should be strongly adhered to during the whole process of digitization:

The player used for digitization must be maintained in a professionally perfect manner.

26. Bibliography

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