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Federal Agencies Audio Visual Digitization Working Group

Assess Audio-system Evaluation Tools and
Plan the Audio System Evaluation Tool Project

Assessment Report and Initial Recommendations

Prepared
By

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1. Introduction

a. Background

The Federal Agencies Digitization Guidelines Initiative is a governmental interagency activity that draws participants from the Library of Congress, the National Archives and Records Administration, the Smithsonian Institution, the National Libraries of Medicine and Agriculture, Voice of America, and several other interested agencies. The initiative is divided into two parts: the Still Image Working Group and the Audio-Visual Working Group.

The performance of the systems used to digitize content has been of interest to both Working Groups. Over the past several years the Still Image Working Group has been involved in activities developing standards, guidelines, and resources for evaluating systems used for scanning still images. The two most important contributions to this effort are a framework for measurement--defining the parameters of interest--and the determination of specific pass-fail points for each parameter. The framework document has been published while the enumeration of pass-fail points, which differ according to content category, is an emergent part of the drafting of an extended guidelines document.[1] The Still Image Working Group also developed scanning targets and a software tool to measure the values for the key parameters.[2]

During this same period, digitizing system performance was also discussed in the Audio-Visual Working Group (hereafter *Working Group*). In early 2009 the Working Group convened a meeting of Federal Agencies involved in audio digitization projects at both administrative and technical levels to more clearly evaluate and quantify similar needs in the audio domain. The attendees concluded that there was a need to develop similar resources based on the collective experience of the participants. This meeting also resulted in the formulation of a few concepts related to the evaluation of audio digitization activities, described in further detail below.

The overarching finding was that there is a definite need for audio-digitizing-system performance measurement within organizations holding recorded sound collections and

[1] For an overview of this topic, see the presentations on this page http://www.digitizationguidelines.gov/stillimages/presentations.html. The slide show http://www.digitizationguidelines.gov/stillimages/documents/Evaluating_Digital_Imaging-2010.pdf provides an introduction, with slides 18-21 outlining the concepts of categories and objectives, while slides 25 and 26 offer a short description of how levels of achievement come into play. The detailed, published framework for measurement may be found at http://www.digitizationguidelines.gov/stillimages/documents/DIFfinal.pdf. The current draft for the extended guideline document is at http://www.digitizationguidelines.gov/stillimages/documents/FADGI_Still_Image-Tech_Guidelines_2010-08-24.pdf.

[2] The targets and associated software have not been widely disseminated by the Working Group at this writing. A short description is featured on slides 21-29 in this presentation: http://www.digitizationguidelines.gov/stillimages/documents/IS&T_MS_CF.pdf.

who are involved either internally or externally (outsourced) in reformatting of content from legacy audio media to file-based formats. Although the project's origin is from a group of Federal Agencies, the needs are relevant across the field of sound preservation and archiving.

Audio-Visual Preservation Solutions (AVPS) serves as an expert consultant to the Working Group, and it was assigned the task of following up on the discussion, and to assess what is currently available and what might be feasible to develop. This report is the result of AVPS's investigation.

This project is concerned with the all-important analog-to-digital (A/D) converter, the signal path from the converter to the digital audio workstation (DAW; or some other device used for file-making), and aspects of file-making and file-storage within the DAW. The Working Group identified two related aspects that, albeit important, were deemed to be out of scope due to considerations of focus and efficiency. One of these concerns born-digital audio, and issues that may arise as it is transcoded or receives other treatments for the sake of preservation. The second out-of-scope element concerned the performance of the "playback" portions of a reformatting system, "upstream" of analog-to-digital convertors and related equipment and software. This analysis is not concerned with the signal path prior to the input of the A/D converter. This is not to say that the Working Group does not feel that the analog playback problem is not important, but rather they felt it appropriate to constrain the scope of this investigation.

The specifications and methods that are the focus of this effort are ones that can be used to measure the performance of an organization's own internal sound-transfer laboratory and/or as requirements to reformatting labs that serve as contracted service bureaus. For instance, if a federal agency contracts with an audio preservation lab to reformat a collection, the agency could require the audio lab to run the specified tests to qualify their systems at project startup and again at periodic, predetermined points during the period or performance. The results of the tests might consist of reports and/or audio files that could be tested and validated by the agency to confirm that the vendor's system is performing to specification. For internal work, the Working Group envisions that the organization's own audio labs will use these tests as routine and periodic quality assurance measures for ensuring system integrity and complying with best practices and standards.

b. Goal: an affordable, user-friendly tool

The Working Group wishes to serve a wide range of organizations with varying levels of engineering expertise and, for this reason, it sketched out a set of desirable features for the set of tools that might be developed for testing.

- **Simple interface**: The system must be easy to use and navigate by a non-technical person.
- **Non-expert target user**: The system will be used by expert and non-expert people in the performance of quality control and assurance. Therefore, someone that is not trained as an audio engineer must be able to easily use this system.
- **Low cost**: Although the Working Group did not identify a particular cost threshold, they felt that wide possible adoption of a toolset would depend upon keeping costs as low as possible. Many small archives--even in the federal sector--are budget challenged and too high of a cost will significantly impede the use of the toolset.
- **Performance of analysis with simple pass/fail response**: The system should provide clear and simple pass/fail reports.
- **Basic and detailed reporting of analysis and results**: Accompanying and underlying the simple pass/fail report there should be additional granular details made available for expert users.
- **Storage and transmittal of test audio files for verification and potential re-analysis**: The system should allow for the storage and transmittal of the reports as well as the resulting test files. This will allow for full transparency and verification by the client.

c. Three aspects of digitization for testing

The Working Group's discussion and early input from this consultant highlighted three aspects of digitization tools and workflow where measurement and testing could be seen as important. Each of the three aspects -- explored in more detail in the sections that follow--has its own character and requires its own testing procedure and measurement tools.

- **Measuring the performance of the audio-digital converter**: The A/D converter is the single most critical tool employed by a digitization operation. In effect, the relevant test is a "bench test," evaluating the A/D converter in isolation from other devices. In this test, a set of test signals serve as an input to the A/D and the digital output is measured.
- **Monitoring digital-data management and file-writing integrity**: This aspect entails the successful handoff of digital data from the A/D converter, its acquisition by the DAW, and the DAW's successful writing of the file to a storage medium.
- **Monitoring clock stability during transfer**: This concerns the assessment of a facet of the system during the course of actual digitization. The samples which make up digital audio data are recorded and played back in reference to a master “clock” which is critical to the integrity and quality of the resulting signal. This test entails tracking the stability of the clock throughout the digitization process and on an ongoing basis.

Test 1. Measuring the performance of the audio-digital converter

The test is intended to evaluate the performance of the A/D converter. As described in the findings below, the test would employ a test signal generator to provide the converter with an analog signal (e.g. tones). These signals would then be received and converted to digital form by the A/D converter just as, in normal operation, it would receive and digitize the output from a playback device, e.g., an analog audiotape player. The output from the A/D convertor would then be evaluated by a digital audio analyzer according to established metrics and performance criteria.

The question often arises, *How good does an A/D converter have to be?* Audio specialists often discuss the sufficiency of converters at varying price points. The Working Group proposes to embrace the pass-fail specifications set out by the International Association of Sound and AudioVisual Archives (IASA) Technical Committee Publication, TC-04.[3] As indicated in the sidebar that follows, the Working Group recognizes that these pass-fail points represent a very high level of achievement and that not all archives will be in position to meet this level based on the corollary price point.

The IASA specifications (expressed in British English) are as follows:

Total Harmonic Distortion + Noise (THD+N)
With signal 997 Hz at -1 dB FS, the A/D converter THD+N will be less than -105 dB unweighted, -107 dB A-weighted, 20 Hz to 20 kHz bandwidth limited. With signal 997 Hz at -20 dB FS, the A/D converter THD+N will be less than -95 dB unweighted, -97 dB A-weighted, 20 Hz to 20 kHz bandwidth limited.

Dynamic Range (Signal to Noise)
The A/D converter will have a dynamic range of not less than 115 dB unweighted, 117 dB A-weighted. (Measured as THD+N relative to 0 dB FS, bandwidth limited 20 Hz to 20 kHz, stimulus signal 997 Hz at -60 dB FS).

Frequency Response
For an A/D sampling frequency of 48 kHz, the measured frequency response will be better than ± 0.1 dB for the range 20 Hz to 20 kHz. For an A/D sampling frequency of 96 kHz, the measured frequency response will be better than ± 0.1 dB for the range 20Hz to 20 kHz, and ± 0.3 dB for the range 20 kHz to 40 kHz. For an A/D sampling frequency of 192 kHz, the frequency response will be better than ± 0.1 dB for the range 20Hz to 20 kHz, and ± 0.3 dB from 20 kHz to 50 kHz (reference audio signal = 997 Hz, amplitude -20 dB FS).

Intermodulation Distortion IMD (SMPTE/DIN/AES17)
The A/D converter IMD will not exceed -90 dB. (AES17/SMPTE/DIN twin-tone test sequences, combined tones equivalent to a single sine wave at full scale amplitude).

Amplitude Linearity
The A/D converter will exhibit amplitude gain linearity of ± 0.5 dB within the range -120 dB FS to 0 dB FS. (997 Hz sinusoidal stimuli).

[3] See http://www.iasa-web.org/audio-preservation-tc04.

Spurious Aharmonic Signals
Better than -130 dB FS with stimulus signal 997 Hz at -1 dBFS

Internal Sample Clock Accuracy
For an A/D converter synchronised to its internal sample clock, frequency accuracy of the clock measured at the digital stream output will be better than ±25 ppm.

Jitter
Interface jitter measured at A/D output <5ns.

External Synchronisation
Where the A/D converter sample clock will be synchronised to an external reference signal, the A/D converter must react transparently to incoming sample rate variations ± 0.2% of the nominal sample rate. The external synchronistation circuit must reject incoming jitter so that the synchronised sample rate clock is free from artefacts and disturbances.

d. Sidebar: levels of achievement

The consultant and the Working Group's agree that there are many different archival organizations (even in the federal sector) and that there are different categories of material to be reformatted. Either or both of these variables may occasion variation in the quality of the preservation copies that are produced. In many archives, curators will indicate which classes of content warrant expert, high end treatment and which may be reformatted using moderate means. In addition, practical matters will influence production planning: limitations on budgets and human resources and the availability or unavailability of high quality studio workrooms. All of these factors will lead to the reasonable outcome that some projects produce the highest quality copies while others produce copies at moderate quality levels.

The concept of varying performance levels may be compared to the four performance levels being developed in the testing regime in the Still Image Working Group.[4] The four levels for still imaging performance all point to the same set of target specifications but allow for graduated levels of variation or tolerances. The result is that the highest performance level allows very little variation from the target, while the lowest performance level allows for a much greater level of variation. The applicability of a given performance level and it's alignment with the goals and objectives of the organization, including preservation, is left up to the archivist or collection manager to decide.

[4] See http://www.digitizationguidelines.gov/stillimages/documents/FADGI_Still_Image-Tech_Guidelines_2010-08-24.pdf pages 15 - 33 for text speaking to performance levels.

How might this concept be applied to the performance measurement of digitizing systems for audio? Readers will note that each of the relatively stringent IASA TC-04 specifications listed above could be restated in relaxed form, at least at one additional level and perhaps more. The Working Group has not yet studied the matter in order to identify alternate values and thus the following example is purely illustrative.

Highest level (as specified by IASA): With signal 997 Hz at -1 dB FS, the A/D converter THD+N will be less than -105 dB unweighted, -107 dB A-weighted, 20 Hz to 20 kHz bandwidth limited.

Relaxed level (illustrative): With signal 997 Hz at -1 dB FS, the A/D converter THD+N will be less than -100 dB unweighted, -102 dB A-weighted, 20 Hz to 20 kHz bandwidth limited.

What is the impact of this concept on the project at hand? The Working Group seeks to develop tests and tools that can be widely used, including use by archives that wish to digitize at the highest levels. The presumption is that any tools that are developed will also be capable of providing measurement data at relaxed levels, for use by archives that choose to work at those levels for a given job. The development of a set of relaxed pass-fail levels is further outlined in *Next Steps Activity B*, below.

Test 2. Monitoring digital-data management and file-writing integrity

Test 2 pertains to issues experienced by a number of Working Group members. They have identified glitches in files that do not exist in the original recordings. The needed test is one that would ensure that the A/D converter or DAW are not introducing any artifacts into the digital bit-stream or file. These glitches, also known as *interstitial errors* may be caused by computer system interrupts and processor allocation issues, e.g., from a processor intensive video card or local/network applications that perform periodic probes to perform system checks, such as anti-virus programs.

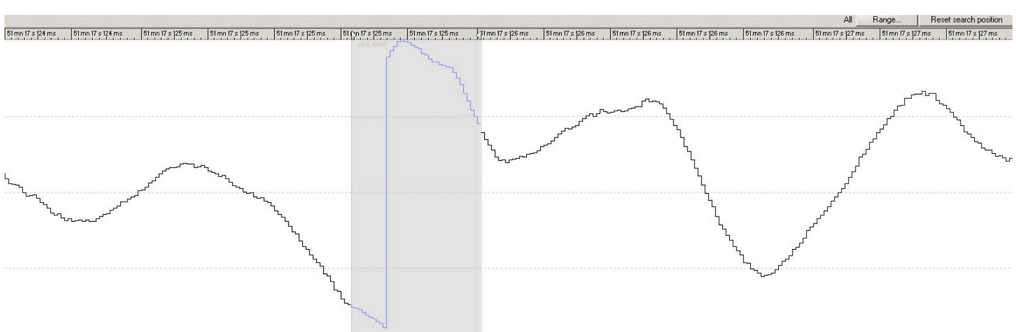

Figure 1: Audio Waveform Demonstrating Interstitial Error Discussed Above

Test 3. Monitoring clock stability during transfer

Test 3 would take a systemic approach to integrity testing by analyzing and documenting clock stability of the A/D converter over time and throughout each recording. This concept is akin to monitoring the RF output of a video playback deck during reformatting. Theoretically this data could be represented on a timeline next to an audio track to aid in quality assurance and could be an indicator of quality issues.

e. Objectives for this report

The preceding sections report the Working Group's consensus about the need for specifications and tools for performance testing as well as reporting additional analysis provided by AVPS. In this context, the Working Group asked the consultants to explore the topic further, looking at the following objectives and activities:

- Assessment of benchmark specifications
- Assessment of available tools and systems
- Definition of next steps and phases for the Audio System Evaluation Tool Development Project

This report is the result of AVPS's investigation.

2. *Findings*

A number of audio test and measurement companies were consulted to discuss the range of issues and potential concepts for testing. Companies consulted with included:

- Audio Precision Instruments
- Prism
- NTI
- Metric Halo
- Bluecat Audio
- VB-Audio
- Cube-Tec

In addition to this, the consultants met with members of the Audio Engineering Society Technical Committee on Archiving, Restoration and Digital Libraries and the Standards Committee on Digital Audio Measurement Techniques during conference proceedings of the 127th AES Convention. The following is a summary of findings regarding each test concept:

a. Overview

As suggested in the introductory discussion above, there is a need for different tools tailored to the needs of each test. The desired tools are unlikely to be encompassed within a single device. The methods, domains, metrics and requirements are different enough for each test that coupling them into one device seemed unnecessarily burdensome.

As we investigated this matter, we were surprised to find that audio test and measurement standards have not yet caught up with the transitions in technology of the past couple of decades. Many test procedures and devices are rooted in the analog domain. With the transition into the digital domain a different set of metrics must be used for test and measurement. In addition, there is still debate about the parameters: which metrics are the most important ones; are there yet-to-be identified metrics that will reveal additional insights into evaluating the quality of systems? In short, the question is not entirely settled that we are measuring with the right "yardstick," or that "yards" is even the right unit of measure. On the positive side, some tests that are possible today offer more information than tests available ten years ago, but there are no formalized standards or test methods which utilize this newly obtainable information. We believe that the audio engineering community is still waiting for the written standards and best practices to catch up to the technological changes.

Nevertheless, although metrics and methods are somewhat emergent, the findings and recommendations that follow build upon two strong foundational documents: IASA TC-04 (cited earlier) and the Audio Engineering Society standard *AES-17: Standard for measurement of digital audio equipment*,[5] a well established family of test methods. Meanwhile, we encourage the Working Group to monitor the field for new ideas and developments, and to be confident that the group's articulation of needs in this area will promote additional development by the audio engineering community at large.

b. Findings for test 1: Measuring the performance of the A/D converter

Overall, test 1 is both viable and relatively simple, although the equipment in the marketplace to perform the test is costly. In essence, our measurement tests require (a) a signal generator and (b) the means to measure the digital file that is created in the DAW, a file that represents the reference signals. The metrics of this output file would be checked against the IASA TC-04 pass-fail recommendations, using the methodological provisions of the Audio Engineering Society standard *AES-17: Standard for measurement of digital audio equipment.*

Our review of offerings on the market today--which carry designators like *Audio Analyzer* or *Audio Test Instrument*--revealed that the products that might be appropriate to our needs are relatively expensive. The most optimistic reading indicates that a device in the $15 - $20,000 range would be required, a steep cost for many small archives. A safer, less optimistic reading suggests that an archive might have to spend roughly twice as much for equipment to perform the test.

What accounts for the high cost? The first reason relates to the relatively stringent demands of the IASA specifications, which require equipment capable of working at high levels of precision and accuracy. The second reason is related to the typical market for

[5] Available from the AES: http://www.aes.org/publications/standards/search.cfm?docID=21.

analyzers and test instruments: professional recording studio engineers. These specialists require sophisticated, multi-function equipment that include capabilities beyond those required for our test. The combination of IASA's stringent specifications and the studio engineer's need for multi-purpose gear has led manufacturers to produce hardware-intensive professional equipment that sells at high prices. It is also the case that this sophisticated equipment requires an expert user.

This consultant believes that the Working Group's needs could be met at a far lower cost. A signal generator is required to produce the input signals but this could be a relatively simple, single-purpose device. Then, in order to read and evaluate the output of the A/D converter, it should be possible to develop software that could be installed in the DAW. The DAW would use the A/D converter output to create a file which, in turn, would be read by the measurement software.

The development of a single-purpose signal generator and signal-analysis software could dramatically reduce costs. However, there are no such products on the market today. In order to attract a for-profit company to develop such devices, the preservation community would have to present a big enough market to make a solid business case for investment. Alternatively, grant funding or other sponsorship could support this development.

c. Findings for test 2: Monitoring digital-data management and file-writing integrity

Overall, test 2 is also viable and relatively simple, but comes with some caveats. The viability of this type of test is supported by the existence of similar tests that examine the integrity of a bit stream that is passed through digital hardware and software. In this document, we'll call this the "traditional" bit stream integrity test. It is a kind of bench test that is commonly performed by everyone from console manufacturers to editing-software application developers. One typical version of the traditional test is to run a known reference signal consisting of a pseudo-random bit sequence through the system under test and validate it on output. A properly functioning system should not alter the bit sequence at all. Although these types of analyses are incorporated into test-and-measurement tools there are no standardized test methods, particularly for use by end users.

As we studied this topic, however, the value of applying the traditional test to audio digital-data movement and file writing was not clear. The issues reported within the Working Group tend to be associated with system resource allocation issues within the DAW and are by definition erratic and intermittent. Periodic bench testing of a device or system with a reference signal does not replicate the environmental conditions which create this error. Thus this type of test does not meet the intent behind test 2. This is not to say that traditional bit stream integrity test should not be a part of a suite of tests, only that they will not identify the main issue discussed within the Working Group.

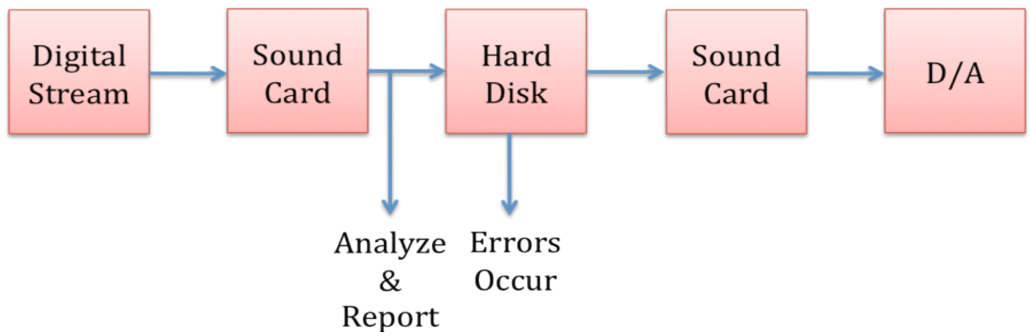

Figure 2: An Illustration Demonstrating the Possible Reason Why Some Real Time Analysis Systems Do Not Identify Interstitial Errors

In order to reveal the problems discussed, we need a test that monitors aspects of the actual digitization process, i.e., the testing must take place during digitization and on an ongoing basis. There are existing real-time analysis systems, associated with analog-to-digital transfer systems being marketed to archived today. These valuable existing systems monitor a variety of important issues and they work well for identifying many problems, including certain types of digital errors. Systems such as these do not, however, catch the glitches discussed within the Working Group. We believe that this is due to the fact that the errors discussed by the group typically happen *during* the writing of the bit stream to disk, while real-time systems monitor the bit stream *prior* to being written to disk. The block diagram in Figure 2 illustrates the issue in a simple way and may be compared to the alternate arrangement illustrated in figure 3.

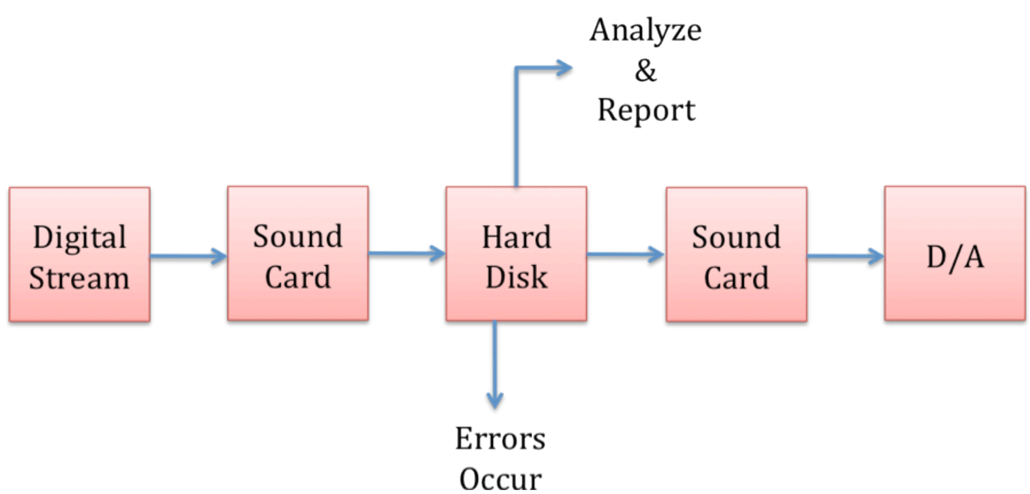

Figure 3: An Illustration of Analysis and Reporting Performed in Non-Real Time as a Post-Transfer Process. This Performs Analysis after the File is Written to Disk, but Existing Detection Algorithms Have Proven Challenged by Interstitial Errors.

In addition, real-time and non-real-time analysis systems use algorithms analyzing amplitude variation over a number of samples to identify "glitches." This results in dramatic over and under reporting, requiring labor intensive intervention to produce meaningful information through manual review of each flagged error.

The need for awareness regarding this issue and the lack of available test and measurement systems to identify this type of error led to the publication of a paper in January, 2010 titled *Digital Audio Interstitial Errors: Raising Awareness and Developing New Methodologies for Detection*[6]. This paper proposes a real-time comparative analysis tool that is expected to effectively detect these types of errors.

> *The basic idea is fairly simple. The approach is to record as usual to the DAW while inserting a digital distribution amplifier (DA) at the digital output of the A/D converter (some A/D converters already provide multiple digital outputs, alleviating any need for a DA). This would yield two identical digital outputs from the A/D converter. One digital output of the DA would go to the DAW digital input. The other digital output would go to a standalone file-based recording device. Comparative analysis of the two resulting files would determine whether there are any significant differences, which in turn would reveal points in the file where digital interstitial errors have occurred. (page 10)*

Similar to the toolset needed to perform test 1, the test 2 tool does not currently exist. It is, however clear that development would be straightforward. As in the case of the test 1 tool , a manufacturer or developer will require a clear business case to develop this tool. We also believe, however, that a grant-funded project could likely produce an open source and off-the-shelf solution in the absence of solution provided by a manufacturer. For demonstration purposes, figures 4 and 5 on the next page illustrate two possible ways to implement the concept described in the above excerpt.

[6] See http://www.avpreserve.com/wp-content/uploads/2010/01/Digital_Audio_Interstitial_Errors.pdf.

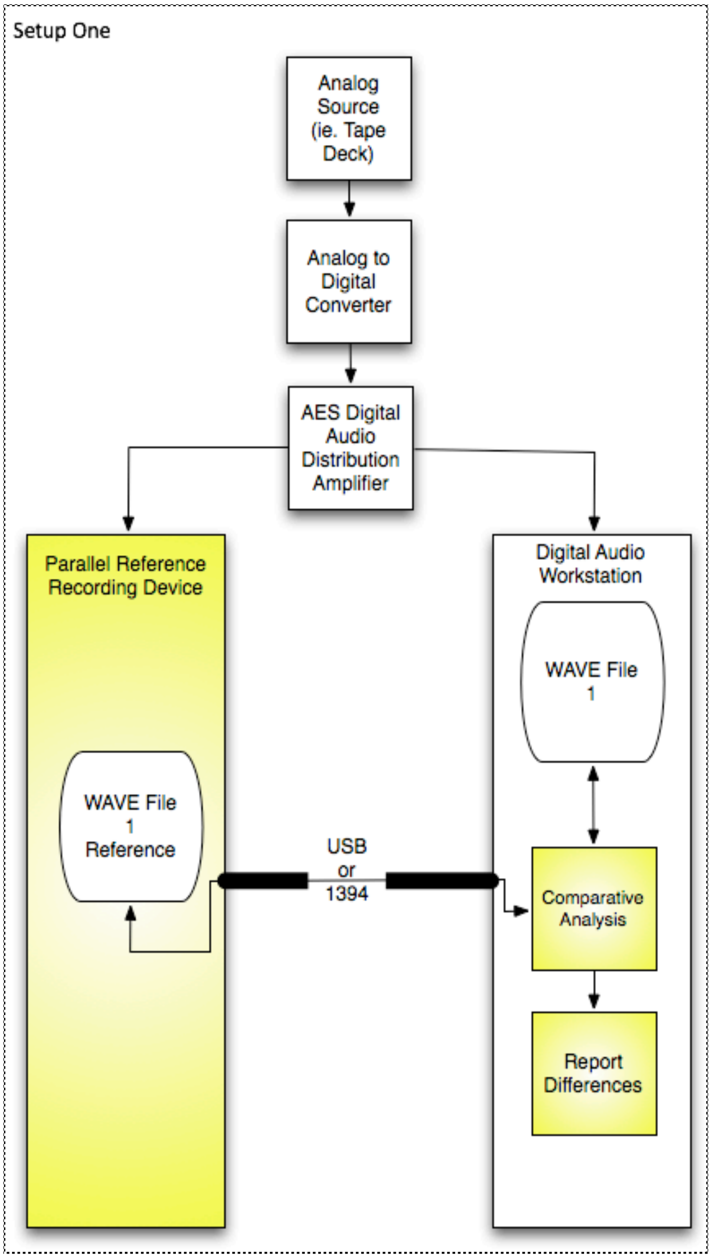

Figure 4: Basic Diagram Illustrating Possible Implementation of Test Concept for Test 2

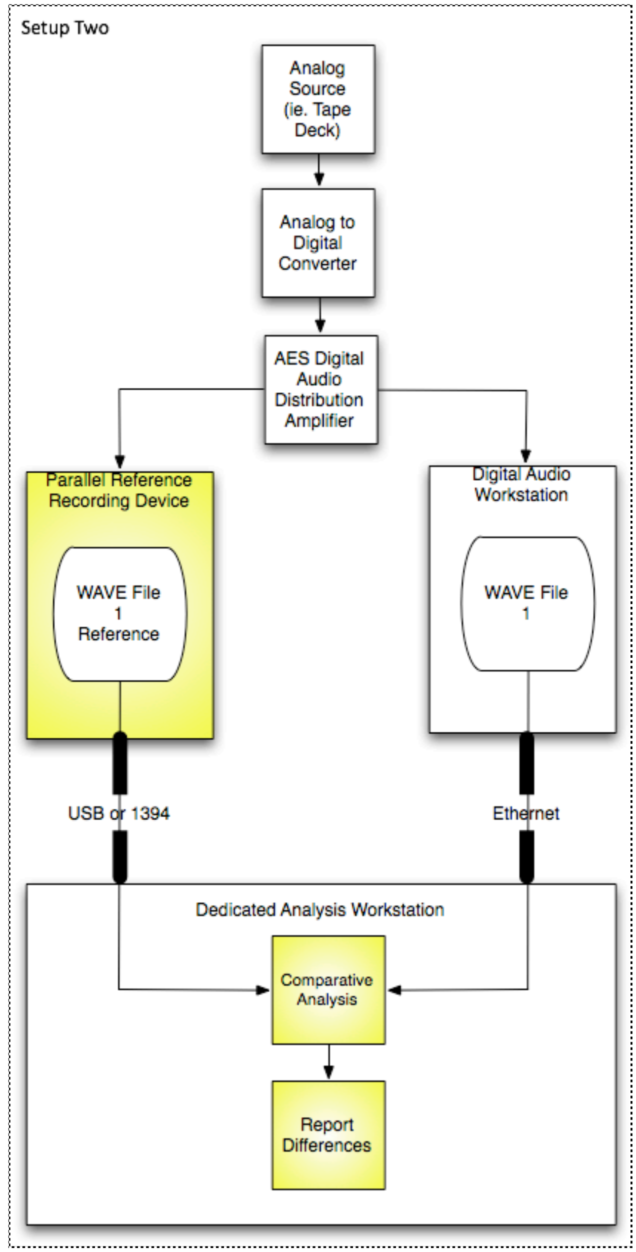

Figure 5: Basic Diagram Illustrating Possible Implementation of Test Concept for Test 2

d. Findings for test 3: Monitoring clock stability during transfer

Test 3 is the most novel and experimental concept in the set. Our investigation indicated that there is no existing system to perform this test. The precision required to monitor a clock on an ongoing basis calls for highly specialized and expensive equipment. In addition to this, our conversations with experts in the field indicate that clock stability is not something that is expected to be erratic. There may be gradual shifts corresponding to variation in room temperature, but other than this, erratic clock stability only occurs in extreme situations where there are major issues that would result in the manifestation of evident errors. Ultimately the clock stability tracking described in test 3 is of questionable value, particularly when weighed against the development and likely equipment costs.

We encourage the Working Group to join us in being attentive to reports that might indicate that some systems have "clock problems." Based on our findings to date, however, we recommend that the Working Group set aside this test for the time being. All parties will be grateful for any additional expert input on this matter.

3. Next Steps

We recommend that the Working Group consider a number of activities that would address the findings in this report. Activity A (proof of concept system for testing A/D converters) is the most important and, ideally, ought to be carried out in parallel with activity B (establishment of pass-fail levels based on the IASA guideline). Activity C (monitoring digital-data management and file-writing integrity) is independent from the work associated with Activity A.

a. Activity A. Build a proof-of-concept system to demonstrate how to measure the performance of the A/D converter (test 1), with a follow-up assessment activity

Description:
This activity would assemble existing devices, e.g., an audio analyzer, into a proof-of-concept demonstration system for testing the relevant parameters in test 1. The proof-of-concept demonstration system is intended to demonstrate the functions that will be desired in a future purpose-built system. The use of existing devices in the proof-of-concept system offers the most efficient way to assemble a demonstration system, although this means that an expensive multi-function device will be employed even though use of available functions will be limited.

The proof of concept system will use the IASA TC-04 specifications and the AES17 standard as the primary references. The documentation produced by the project should outline an explicit step-by-step test method for each IASA performance specification element. If there are areas that are not covered by AES-17, other relevant test and measurement standards should be referenced. In the absence of any reference the author should confer with experts to discern a suitable proposal.

Once the tool is in working shape, activity A will conclude with a *demonstration* for Working Group members and, with the Working Group's approval, for other interested archives. The demonstrations should be followed with an *assessment or survey* of the level of community interest in such tools, in order to inform prospective actors in the next phase, whether in the private or public sector, including funding organizations. The survey should be complex enough to identify an organization's ability or interest in purchasing these systems, the parameters under which they expect they may use them, and the level of expertise of the anticipated implementers and operators. It would also be valuable to ascertain the price threshold that would influence purchasing decisions, at least at a rough and ready level.

Deliverables:

- Detailed plan and budget for creation of the demonstration-project toolset, to be approved by the Working Group before proceeding.
- A working proof of concept device assembled from components available in the marketplace today.
- Documentation that includes an explicit step-by-step tutorial documenting the test method and associated performance specification for each specification in IASA TC-04. The document should identify the origin for each test method. This document must include a detailed description of the reference signals to be used.
- The documentation should also provide a certain amount of context similar to that found on pages 34 through 38 of *Technical Guidelines for Digitizing Cultural Heritage Materials: Creation of Raster Image Master Files*[7] for providing context and guidance.
- A descriptive report of the testing and its results, including lessons learned that may apply to Activity B.
- A demonstration of the proof of concept system for Working Group members and for other interested archives.
- A report from an end-of-activity "level-of-interest" assessment survey with supporting numbers.

b. Activity B. (i) Draft a design concept and requirements statement for an A/D test device and software (test 1) and (ii) adjust the IASA pass-fail specifications and determine relaxed levels for moderate quality jobs.

Description:
This activity features two elements. The first element will draft a design concept and requirements statement for an A/D test system that builds upon the experiences and lessons learned in Activity A. The deliverables from this element should provide

[7] http://www.digitizationguidelines.gov/stillimages/documents/FADGI_Still_Image-Tech_Guidelines_2010-08-24.pdf

sufficient information to permit (a) a prospective manufacturer or (b) a grant funded organization to develop a prototype (or better) of the hardware and software

The second element revisits the IASA pass-fail specifications, also building upon the experiences and lessons from Activity A and additionally conferring with experts in the field. The experience and/or the expert commentary will permit the Working Group to do two things. One of these is to adjust the IASA specifications, if this is needed. The second is to develop a range of performance levels for a variety of common content classes and types, similar to the levels for image-system performance developed by the Still Image Working Group. (See the *Sidebar: levels of achievement*, above.) The consultant foresees that the existing IASA specification will serve as the most stringent level with wider tolerances being defined for lower performance levels.

Deliverables:

- Document that presents a design concept and requirements for the test signal generator and associated software with sufficient detail to permit the drafting of detailed design for actual construction (which would probably be a fully realized prototype).
- The description of the associated software should cover such topics as:
    - Requirements for performance, functionality, reporting and behaviors
    - Mock layouts and designs of the interface
    - Information and formatting of the reports
- Document that provides information similar to pages 4 through 34 of *Technical Guidelines for Digitizing Cultural Heritage Materials: Creation of Raster Image Master Files*[8]. This report must include each specification and the tolerances associated with each identified performance level.

c. Activity C. Draft a design concept and requirements statement for a demonstration system to monitor digital-data management and file-writing integrity (test 2)

Description:
This is a planning-and-design activity that will produce the information necessary to develop a prototype system for performing test 2, i.e., the detection of interstitial errors. The materials delivered at the end of this activity should also include documentation for standardization and guidance on implementation.

This activity is not dependent on prior activities and may be performed in parallel with activities A and B, or after they have been completed. The deliverables from this activity must provide sufficient information to permit (a) a prospective manufacturer or (b) a grant funded organization to develop a prototype (or better) of the hardware and software.

[8] http://digitizationguidelines.gov/stillimages/documents/FADGI_Still_Image-Tech_Guidelines_2010-08-24.pdf

As the planning proceeds, the activity should include an *assessment or survey* of the level of community interest in such tools, in order to inform prospective actors in the next phase, whether in the private or public sector, including funding organizations. The survey should be complex enough to identify an organization's ability or interest in purchasing these systems, the parameters under which they expect they may use them, and the level of expertise of the anticipated implementers and operators. It would also be valuable to ascertain the price threshold that would influence purchasing decisions, at least at a rough and ready level.

Deliverables:

- A test method providing detailed step-by-step instructions
- A detailed description of the hardware requirements sufficient for building a prototype or identifying an existing product
- A detailed description of the software sufficient for developing a prototype. To include, but not limited to:
    - Requirements for performance, functionality, reporting and behaviors
    - Mock layouts and designs of the interface
    - Information and formatting of the reports
- A detailed work plan for developing a prototype (or better) system using open source and off-the-shelf components. This must include activities, deliverables and costs.
- A report from an end-of-activity "level-of-interest" assessment survey.

d. Activity D. Report on Audio Engineering Society Standards Committee work

Description:

The Audio Engineering Society (AES) maintains standards and technical committees which focus on test and measurement issues. The key AES standards committee related to the work described in this document is AES SC-02-01. Standards committees within AES are responsible for taking on proposed projects which are relevant to the field. The consultant and author of this paper is a participant-member in AES SC-02-01 and has had preliminary conversations with the committee regarding these projects. These conversations indicate interest and enthusiasm for taking this work on as formal projects which would lead to the development of AES standards.

In order to make this happen, the likely near- and medium-term actions are as follows:

- Drafting and submission of a formal standards project proposal to the committee
- Drafting and editing of language in the standard within the committee
- Review, comments, and discussion regarding these standards on the SC-02-01 reflector (listserv) and in committee meetings held at AES Conventions

It is recommended that a consultant be hired to perform these actions and to report back to the Audio-Visual Working Group with observations, and to carry to the AES groups any recommendations and preferences from the Working Group. In effect, the hired consultant would provide the time and effort needed to draft written notes for the Working Group that summarize AES activities and, from time to time as requested, travel to Washington to make in-person presentations at one or more Working Group meetings.

This activity should be independent from the previous activities. The standards-drafting process can take years and the Working Group should not wait to move forward on activities A, B, and C above. Any variation resulting from the two activities being independent from each other can be resolved at a later date. Another factor for consideration is that the standards process often requires a champion to drive the drafting and progress of a particular standard. The Working Group is not in the position to make this long-term commitment, but should participate and support the work of the AES standards committee in this effort to the degree possible.

Deliverables:
Working Group deliverables would include:

- Periodic transmission of notes from AES meetings, estimated to require 12 hours of effort per year
- Participation by phone in Working Group meetings, estimated to require 8 hours per year
- Travel to Washington for one Working Group meeting per year