george blood audio

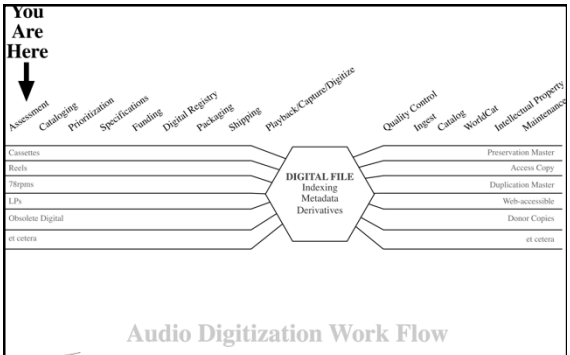
audio

. . . and video

Understanding Reformatting Options and Providing Access

Caring for Audiovisual Material Webinar Series
Heritage Preservation and CCAHA - October 30, 2013

Stephanie Renne
Audiovisual Archivist
George Blood Audio & Video



Audio Digitization Work Flow

Digital Archival Set

- Preservation Master
- Use and Access Copy
- Web-Accessible Copy

Preservation Master

- Key Traits
  - Rarely accessed (Dark Archive)
  - Most important to manage
  - Typically 96kHz/24bit or 44.1kHz/16bit
    - kHz of PCM = dpi of TIFF
    - bit resolution (in volume or amplitude) = bit of TIFF (range of colors)
  - .WAV or .BWF
    - "wave" or "broadcast wave"

Preservation Master

- Key Advantages of broadcast wave
  - Widely used
  - Higher resolution than 99+% of sources
  - Better than most playback chains
  - Derivatives easily created
  - EBU standard
  - Think of PCM like a sound TIFF

Preservation Master

- Key Difficulties of files
  - No standard storage medium
  - Data tapes expensive to maintain
  - Too big for CD-ROM
  - On-line storage requires ongoing maintenance
  - Internet delivery impractical
    - 5x play time for T1 .ftp

Preservation Master

- Typical Solution
  - 96/24 on hard drive to digital library
    - Enterprise-level storage
  - 96/24 on DVD-ROM
    - Can be migrated to HDD when available
  - Do something else
    - Gold CD-R
    - CD-ROM
    - LTO-3 data tape

Use & Access Copy

- Key Traits (and Advantages!)
  - Readily accessible
  - User-friendly format
  - Good enough to substitute if
  - Preservation Master is lost
  - Nearly always CD-Audio

Use & Access Copy

- Key Difficulties (CD-Audio vs. CD-ROM)
  - CD-DA (digital audio)
    - Pure serial-read (can't re-read to correct errors, even transient errors)
  - CD-ROM (digital audio as data)
    - Sector-based, so can re-read (more reliable)
    - Requires computers (software, OS, etc.) to retrieve
- Summary
  - CD-DA more widely playable
  - CD-ROM more reliably played

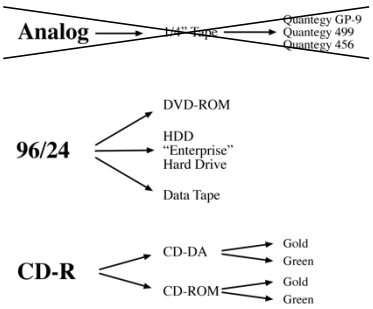
Use & Access Copy

- Typical Solutions (depend somewhat on Preservation Master)
  - CD-DA for near-universal playability
  - Multiple copies
    - CD-DA, one copy on "gold," one on "green"
    - CD-ROM (gold?) and CD-DA (green)
  - Gold CD-R for Preservation Master, Green for U&A

Web-Accessible Copy

- Depends on Rights
  - RA & AAC more secure than MP3 or WMA
- Depends on Needs
  - Too restricted to put on-line
  - Beyond institutional abilities or needs
- Perhaps as-needed only

Preservation Master



Digital is not forever.

Preservation for Access

- ALA PARS definition of Digital Preservation:
  "Digital preservation combines policies, strategies and actions to ensure access to reformatted and born digital content regardless of the challenges of media failure and technological change. The goal of digital preservation is the accurate rendering of authenticated content over time."
- Preservation of information / content over medium
- Audiovisual media deteriorates rapidly
- Digital is not forever but analog is dead

The "Catch"

"regardless of the challenges of media failure and technological change"

Digital makes migration a way of life!

Migration

- How frequent? (How long will it last?)
- What determines when?
  - Format obsolescence [WAV or BWAV]
    - Not such a big problem
  - Carrier obsolescence [LTO, HDD, CD]
    - Really big problem

What is Obsolescence?

- CD-R vs. LTO
- "Bunch of Drives on a Shelf" vs. IT support for "enterprise-level" storage

What can your institution support?

- LTO: cheap, reliable, high density, high resolution
- LTO: IT intensive, short life cycles, complex machine-dependency
- CDs: cheap(ish), widely available, mid-resolution
- CDs: lots of handling to migrate, no metadata (except label)
- "BODOAS": cheap, fast, familiar
- "BODOAS": cheap, fragile (die easily & easily erased)
- Enterprise-class HDD: fast, preferred solution
- Enterprise-class HDD: expensive; needs technical staff

Conclusion:

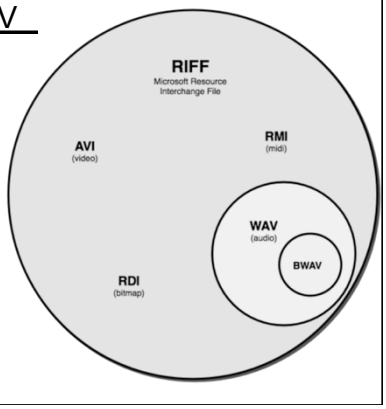
- IT gets ever cheaper, ever more quickly.
- IT gets obsolete ever more quickly.
- What is the life-cycle cost, over multiple migrations?
- What ability will your institution have at any given future time to support the migration of digital content? The decisions you make today are governed by that future ability.

Standards

- BWAV
- bext and INFO chunks
- ID3 tags
- AES-57
- PB Core
- Checksums

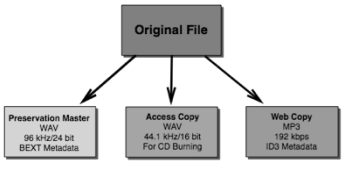
WAV / BWAV

- Part of the RIFF Standard (Resource Interchange File Format)
- Released in 1992 as a part of Windows 3.1



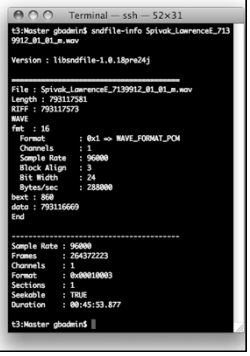
Standard : BWAV

- File automation at George Blood Audio & Video
  - All files created from single original capture file
  - Specific file info gathered from FileMaker Pro Database
  - LINUX command line audio utilities



Standard : BWAV

- SoX - Sound eXchange
  - "Swiss Army Knife of sound processing"
  - Sample rate and format conversion
  - http://sox.sourceforge.net/
- libsndfile
  - "C" library
  - Contains an example program that gives a lot of useful info about files "sndfile-info"
  - BEXT embedding
  - http://www.mega-nerd.com



Standard : BWAV

- Mandatory WAV Chunks
  - "FMT " - Describes the contents of the WAV file
    - Format
    - Number of Channels
    - Sample Rate
    - Bit Depth
    - Streaming Info
  - "DATA" - Audio data
    - WAV PCM - no compressions
    - WAV PCM EX - Extensible. Handles higher resolution audio files, multi-channel formats and 64 bit audio
    - Many others

Standard : BWAV

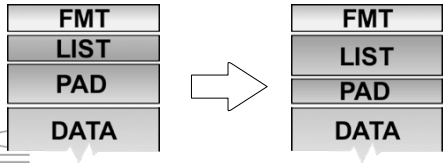
- Optional WAV Chunks
  - LIST (INFO) Chunk
    1. Stores Metadata in a WAV file
    2. Any new INFO field may be defined, but an application should ignore any chunk it doesn't understand
    3. common registered INFO fields
    4. artist
    5. comments
    6. copyright
    7. genre
    8. name

Standard : BWAV

- Optional WAV Chunks (continued)
  - SMPL Chunk
    - info useful when data is used in samplers
    - Rarely holds value in the preservation world
  - PEAK (all versions) inserts a SMPL chunk in every WAV file it saves!

Standard : BWAV

- Optional WAV Chunks (continued)
  - PAD or JUNK Chunks
    - Place holder chunks
    - Allows quick expansion of any header chunks
    - WavLab inserts pad chunks in all saved WAV files

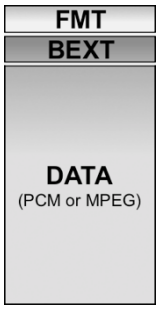


Standard : BWAV

- BWAV
  - Includes mandatory BEXT chunk
    - Defined Metadata Fields
    - Controlled and Suggested vocabulary for most fields

- Description
- Originator
- Originator Reference
- Origination Date
- Origination Time
- Time Reference
- Coding History

- Limits DATA chunk to PCM or MPEG formats



Standard : BWAV

- BEXT chunk:

```
Description      : Ross Lee Finney; String Quartet No. 6 in E: 2.
Allegro Scherzando
Originator       : George Blood Audio & Video
Origination ref  : New World Records CRI DRAM
Origination date : 2009-04-16
Origination time : 08-16-04
Time ref         : 0
BWF version      : 1
UMID             :
Coding history   :
A=ANALOG,M=stereo,T=Studer_A-80RC; 21569; Scotch_111A-24R
A=PCM,F=96000,W=24,M=stereo,T=PrismSound; ADA-8XR; A/D
A=PCM,F=96000,W=24,M=dual-mono,T=MetricHalo; ULN-2; DIO
A=PCM,F=96000,W=24,M=stereo,T=SoX14.1; DAE
A=PCM,F=96000,W=24,M=stereo,T=libsndfile-1.0.18pre24j
```

Standard : WAV

- Problems with WAVs
  - Proprietary Chunks
    - PEAK
      - No other app will read this
      - All info is redundant
    - Older apps don't always ignore superfluous chunks.
    - Efforts should be taken to write the most basic WAV file you can. The simpler it is, the more interoperable it will be.

Standard : WAV

Programs to strip extraneous chunks from your WAV files:

- WAVtrim – a windows app to remove superfluous chunks from wav files (www.mptrim.com)

SOX – command line application that does many audio utilities. Can clean superfluous chunks from WAV files.
Download from sourceforge.net

Standard : WAV

- Problems (continued)
  - Lack of WAVEFORMATEXTENSIBLE support
    - Windows 2000 update to the spec to support
      - higher sampling rates
      - greater bit depths
      - multiple channel (greater than stereo) audio
    - Best to avoid if you can

Standard : BWAV

- BWAV Problems
  - Implementation
    - Few/no commercial software titles read BEXT chunk info
    - Few pro audio apps embed metadata
    - **Yes**
      - Peak 6
      - Adobe Audition
      - WavLab
    - **No**
      - Peak 5
      - Audacity
      - iTunes
      - SoundForge

Standard : BWAV

- BWAV Problems (continued)
  - Application
    - Fields geared towards broadcast applications
    - Short field limits for info preservationists would want to convey

Standard : BWAV

- BWAV Review
  - Keep it simple
  - Avoid WAVPCMEX (Extensible)
  - Know your software

ID3 Tags

- Several different versions of tag implementation
- Metadata embedded into either the beginning or end of MP3 files, depending on version
- Not for WMA, AAC, Ogg Vorbis, etc. (they each have their own tagging format)
- id3.org - Website full of information on ID3 tag history and implementation

ID3 Tags

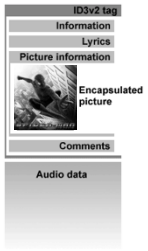
Version 1 - Most widely compatible, Least capable

Title - 30 characters
Artist - 30 characters
Album - 30 characters
Year - 4 characters
Comment - 30 characters
Genre - 1 byte

ID3 Tags

Version 2 - Most capable, but tricky to support

- Use of chunks give great power and flexibility
- Applications are not very responsible with this power, abuse for proprietary reasons



ID3 Tags

Extra flavors....

- 2.3 most popular (stores tag at beginning of file)
- 2.4 hasn't caught on as successor (stores tag at the end of file)

ID3 Tags

Princeton Story...

ID3 Tags

iTunes

Real Player

ID3 Tags

- Pick a version, use that version *only (either 1.1 or 2.3)*
- One tool to embed, another to check
- Beware of using multiple tools to embed!

ID3 Tags

- Winamp: Windows program which can be used to write and view version 1 and 2 tags.
- id3v2: Command-line tool for writing, extracting, and erasing version 1 and 2 tags.

AES57-2011

http://www.aes.org/publications/standards/search.cfm?docID=84

- Published in 2011
- Sets out to develop a vocabulary to describe both digital and analog audiovisual elements
- Uses extensible markup language (XML)
- Provides structured human readable document that is easily parsed and manipulated using different tools
- Concerns the technical documentation (metadata) for long-term storage and preservation
- Links document to physical object

PB Core (Public Broadcasting Metadata Dictionary Project)

http://pbcore.org/index.php

http://pbcore.org/news/introducing-pbcore-2-0/

•Organized as a set of specified fields that can be used in database applications, PBCore is utilized as a data model for media cataloging and asset management systems. As a schema, it enables data exchange between media collections, systems and organizations.

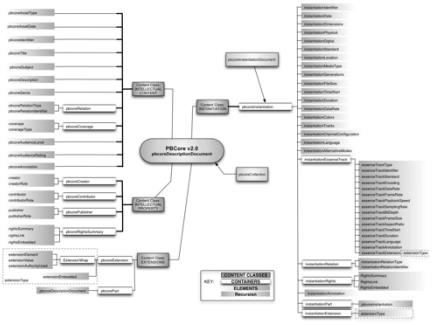
•Developed by Corporation for Public Broadcasting and based on Dublin Core

•Version 2.0 released in 2011

•A format for "semantic web applications involving media"

•Free with Creative Commons licensing

PB Core Elements



Checksum Formula

```
/* Process each 16-word block. */
For i = 0 to N/16-1 do
/* Copy block i into X. */
For j = 0 to 15 do
Set X[j] to M[i*16+j].
end /* of loop on j */
/* Save A as AA, B as BB, C as CC, and D as DD. */
AA = A    BB = B
RFC 1321    MD5 Message-Digest Algorithm    April 1992
CC = C
DD = D
/* Round 1. */
/* Let [abcd k s i] denote the operation
 a = b + ((a + F(b,c,d) + X[k] + T[i]) <<< s). */
 /* Do the following 16 operations. */    [ABCD  0  7  1]  [DABC  1 12  2]  [CDAB  2
      17  3]  [BCDA  3 22  4]    [ABCD  4  7  5]  [DABC  5 12  6]  [CDAB  6 17  7]  [BCDA  7
      22  8]    [ABCD  8  7  9]  [DABC  9 12 10]  [CDAB 10 17 11]  [BCDA 11 22
      12]    [ABCD 12  7 13]  [DABC 13 12 14]  [CDAB 14 17 15]  [BCDA 15 22 16]    /*
      Round 2. */    /* Let [abcd k s i] denote the operation         a = b + ((a + G(b,c,d) + X
      [k] + T[i]) <<< s). */    /* Do the following 16 operations. */    [ABCD  1  5
      17]  [DABC  6  9 18]  [CDAB 11 14 19]  [BCDA  0 20 20]    [ABCD  5  5 21]  [DABC
      10  9 22]  [CDAB 15 14 23]  [BCDA  4 20 24]    [ABCD  9  5 25]  [DABC 14  9
      26]  [CDAB  3 14 27]  [BCDA  8 20 28]    [ABCD 13  5 29]  [DABC  2  9 30]  [CDAB  7
      14 31]  [BCDA 12 20 32]    /* Round 3. */    /* Let [abcd k s t] denote the
      operation         a = b + ((a + H(b,c,d) + X[k] + T[i]) <<< s). */    /* Do the following 16
```

x^6+y^3+z+1

X = 09, Y = 06, Z = 11
$9^6 + 6^3 + 11 + 1 =$
531,441 + 216 + 11 + 1 = 531,669

X = 08, Y = 06, Z = 11
$8^6 + 6^3 + 11 + 1 =$
262,144 + 216 + 11 + 1 = 262,372

Change +1 in one value

x^6+y^3+z+1

X = **09**, Y = 06, Z = 11
$9^6 + 6^3 + 11 + 1 =$
531,441 + 216 + 11 + 1 = **531,669**

X = **08**, Y = 06, Z = 11
$8^6 + 6^3 + 11 + 1 =$
262,144 + 216 + 11 + 1 = **262,372**

Checksum: Does unique matter?

No!

Does the stored value match the calculated value?

Change of a single bit gives very different value
change isn't subtle

3.4×10^{38} possible values

Probability

- Chance of drawing 1 pair in poker
  1:1.36
- Chance of drawing 2 pair in poker
  1:20
- Chance a book will circulate
  1:50
- Chance of dying in a plane crash
  1:1,000,000
- Chance of winning the MegaMillions Lottery
  1:175,000,000
- Chance of 2 files having the same checksum
  1:34,000,000,000,000,000,000,000,000,000,000,000,000

Probability

- Chance of 2 files having the same checksum value
  1: 3.4×10^{38}
- Chance of having any given combination on a chess board
  $1:10^{52}$
- Number of atoms in the known universe
  10^{78}
- Chance of 2 bits changing and yielding the same checksum
  depends on number of bits in the file

Checksum family

- MD5 (message digest #5)
- SHA-1
- SHA-256

- 128bit value
  - That's a lot of ones and zeros
  - Converted to hex to make it easier for humans to read
  - 32 place values, base16 (16 values in each column)

Example:
be6af004116d5378064b411177c12940

Checksum

Binary:
10111110011010101111000000001000001000101101
10101010000000000000000000000000000000000000
00000000000000000000000000000000000000

Hex:
be6af004116d5378064b411177c12940

Checksum

Binary:
10111110011010101111000000001000001000101101
10101010000000000000000000000000000000000000
00000000000000000100000000000000000000

Hex:
be6af004116d50000000000000000000

Checksum

Binary:
10111110011010101111000000001000001000101101
10101010000000000000000000000000000000000000
00000000000000000000000000000000000000
10111110011010101111000000001000001000101101
10101010000000000000000000000000000000000000
00000000000000000100000000000000000000

Hex:
be6af004116d5378064b411177c12940
be6af004116d50000000000000000000

Conclusions...

- No magic solutions - expect a catch
- Test Again!
- Use established tools
- Upgrade cautiously
- *Every* solution is temporary

Questions?

Stephanie Renne
Audiovisual Archivist
stephanie.renne@georgeblood.com

George Blood Audio & Video
21 West Highland Avenue
Philadelphia, PA 19118
PH # 215-248-2100

Special thanks to George Blood for his contribution to course content.

Resources

Principles of Digital Audio by Ken C. Pohlmann

Preservation and Reformatting Section – American Library Association:
www.ala.org/alcts/mgrps/pars
www.ala.org/alcts/resources/preserv/defdigpres0408

ID3 Tags: http://id3lib.sourceforge.net/id3/id3v2.4.0-structure.txt

PB Core: http://pbcore.org/index.php
http://pbcore.org/news/introducing-pbcore-2-0/

AES57:
http://www.aes.org/publications/standards/search.cfm?docID=84

Software programs available for download:
www.mptrim.com
http://sox.sourceforge.net
http://www.mega-nerd.com