# Digital Archives, Digital Forensics, and Open Source Search: Developing Together

Mark A. Matienzo, Yale University Library

Open Source Search Conference

Chantilly, VA

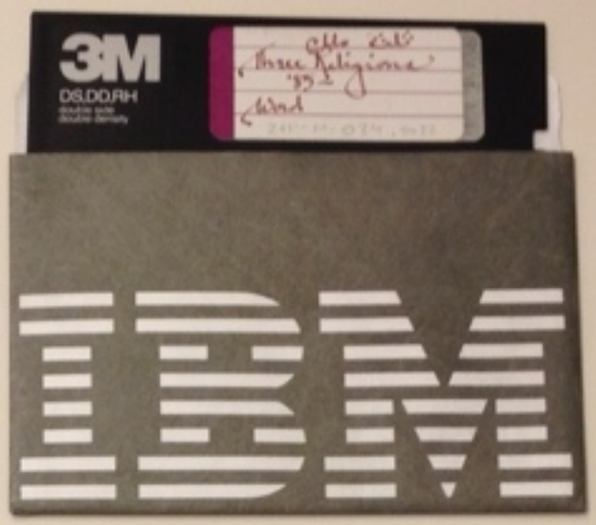
October 2, 2012

# About Me

- I am an archivist
- Occasionally I develop software
- I am not a digital forensics "expert"

# Digital Archives at Yale


IBM
P/N - 21F3036
RIGHTS RESERVED.
PYRIGHT IBM CORP. 1990, 1993
ZO MODEL UNIQUE LIC - PROPERTY OF IBM
D FOR USE ON INDICATED SPECIFIC
NUMBERED SYSTEM. NOT LICENSED
OTHER USE, REPRODUCTION,
TION OR DISTRIBUTION.
/93
BIN 0219


3M
DS.DD.RH
IBM


zip
100
PC100
Iomega


12/3-14 seq. 3
Verbatim
DataLife
2HD


JENNIFER NEWSOM
YALE UNIVERSITY ARCHIVES
PORTFOLIO
05-16-05
2004-A-043


FD-2D-WP
diskettes
JD
IBM
Diskette

# Digital Forensics in the Archival Domain

- Increasing use of digital forensics tools/methodologies within the context of digital archives programs (Kirschenbaum et al. 2010)
- Technology-focused work (John 2008; Woods & Brown 2009; AIMS Work Group 2012; BitCurator 2012)
- Methodology-focused work (Duranti 2009; Xie 2011)

# Significant Barriers to use of Digital Forensics in Archives

- Cost (Kirschenbaum et al. 2010; Daigle 2012)
- Complexity (Kirschenbaum et al. 2010; Daigle 2012)
- Digital archives as an emerging market for forensics

# Potential of Open Source Digital Forensics Software

- Requires additional tool development work to be useful for archivists (Kirschenbaum et al. 2010)
- Requires additional integration work (Lee et al. 2012)

# Institutional Context

- Focus on implementation of and development with open source digital forensics software at Yale University Library
- Work must support accessioning, arrangement, description, and management of born-digital archival material
- Material received on physical media as primary focus

# Design Principles

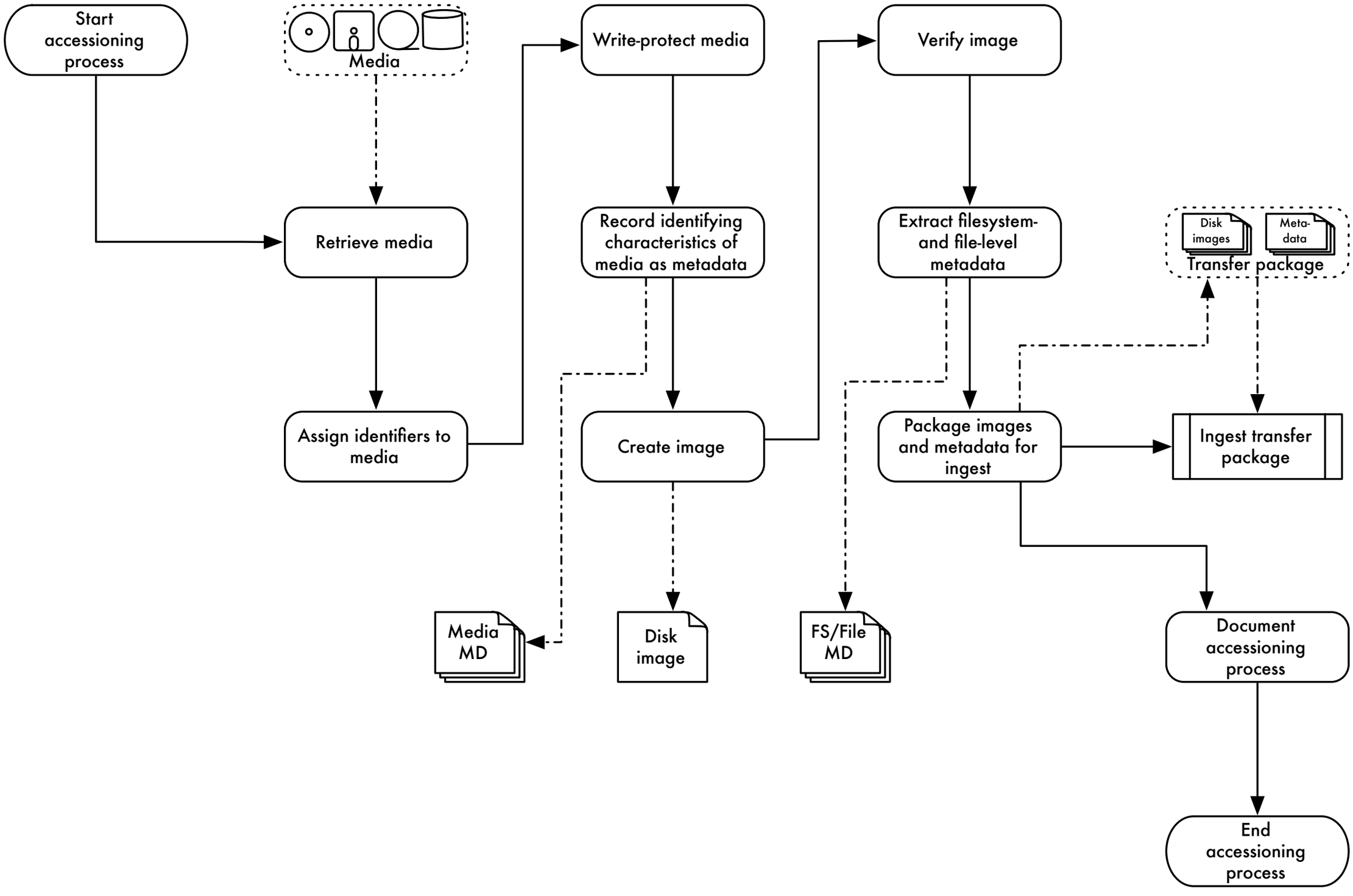
- Use and develop with open source digital forensics software to support accessioning, arrangement, and description of born-digital archival records
- Focus on first two phases (preservation and searching) of Carrier's (2005) model of digital investigation process
- Curation micro-services (Abrams, et al. 2010) as philosophical basis to guide development and implementation
- Digital objects needing management are both disk images themselves (Woods, Lee, and Garfinkel 2011) and bitstreams that they contain
- Intention of forensic soundness, but assume much of state is lost

# Micro-services as Design Philosophy*

| Principles | Preferences | Practices |
| --- | --- | --- |
| • Granularity | • Small and simple over large and complex | • Define, decompose, recurse |
| • Orthogonality | • Minimally sufficient over feature-laden | • Top down design, bottom up implementation |
| • Parsimony | • Configurable over the prescribed | • Code to interfaces |
| • Evolution | • The proven over the merely novel | • Sufficiency through a series of incrementally necessary steps |
| | • Outcomes over means | |

*UC Curation Center/California Digital Library, 2010

# Workflow


Start accessioning process
Media
Write-protect media
Verify image
Retrieve media
Record identifying characteristics of media as metadata
Extract filesystem- and file-level metadata
Disk images
Meta-data
Transfer package
Assign identifiers to media
Create image
Package images and metadata for ingest
Ingest transfer package
Media MD
Disk image
FS/File MD
Document accessioning process
End accessioning process

# Disk Image Acquisition

- Requires a combination of hardware (drives/media readers, controller cards, write blockers) and software
- In some cases, hardware requires specific software (e.g. floppy disk controller cards that sample magnetic flux transitions)
- Goal: sector image interpretable by multiple tools


MSSA100
TABLEAU
T3458is Forensic Bridge
ASUS

# Metadata Extraction

- Use open source digital forensics software (Sleuth Kit, fiwalk) and other open source tools to characterize media, volume, file system, and file information
- Attempt to repurpose this information as descriptive, structural, and/or technical metadata to support accessioning, appraisal, and processing
- Extracted metadata expressed in Digital Forensics XML
- Easily extensible and straightforward to process

# Extraction Plugins

- Created Fiwalk plugins to perform additional analysis and evaluation of files/bitstreams within disk images
- Virus identification plugin using ClamAV/pyclamd
- File format identification against PRONOM format registry using Open Planets Foundation's FIDO
- Code (including additional plugins) available online: https://github.com/anarchivist/fiwalk-dgi/

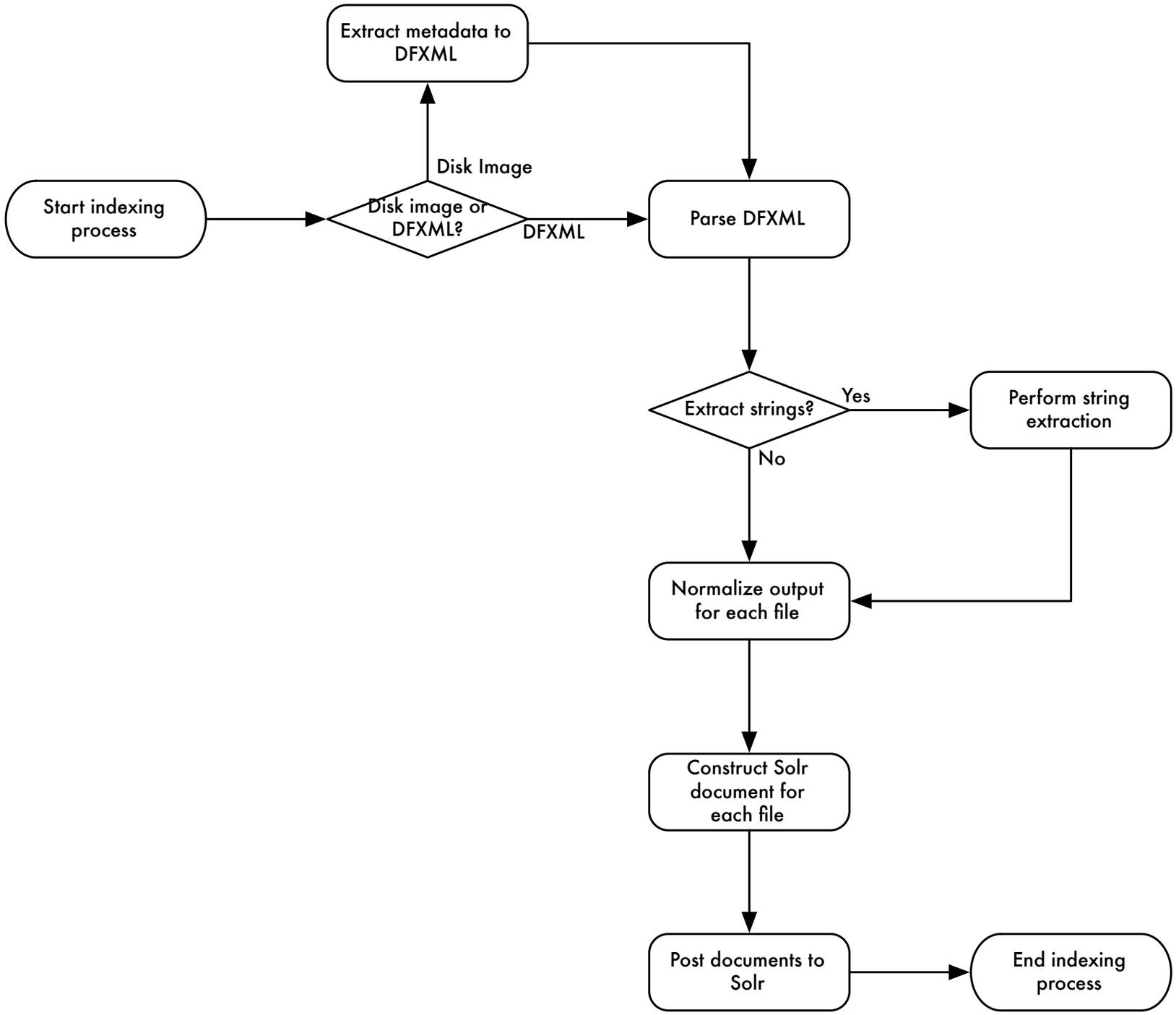
# Gumshoe

- Prototype web application to provide search/browse interface to metadata extracted from disk images
- Built as a Ruby on Rails application using Blacklight
- http://github.com/anarchivist/gumshoe

# Blacklight

- http://projectblacklight.org
- Ruby gem for use in Rails applications
- Provides discovery layer over Solr indexes, with support for faceting, bookmarking, etc.
- Use is fairly common in library community
- Implementers include Stanford, Columbia, NC State, UVA, WGBH, National Agricultural Library (AGNIC) ...

# Indexing Process



# Data Normalization

- Depends on DFXML gem
- Translate metadata-layer data to more easily searchable or human-readable version (e.g. file type/file system codes to text labels; certain flags to booleans)
- Data type coercion (integers-as-strings to integers)
- Prepend full path data to filename
- Transform timestamps to ISO8601

# Features

- Basic browse view, with sorting by filename, size, modification/access/creation times
- Faceting by disk image, extension, file format, file type
- Searching based on metadata values (e.g. checksums), file content (still under development; somewhat slow)
- Basic bookmarking

Gumshoe

Search History

Fork me on GitHub

## Limit your search

Image File

ubnist1_casper_rw_gen2 (1,210)

ntfs1_gen2 (39)

Extension

Format

data (453)

empty (139)

ASCII text (112)

XML document text (58)

JPEG image data, JFIF standard 1.02 (48)

JPEG image data, JFIF standard 1.01 (34)

ASCII English text (29)

GNU dbm 1.x or ndbm database, little endian (26)

HTML document, ASCII text, with very long lines, with CRLF, LF line terminators (22)

PDF document, version 1.4 (22)

more »

Type

Regular file (793)

Directory (381)

Shadow (28)

Symbolic link (24)

Unknown type (22)

Named FIFO (1)

in All Fields Search

Displaying items **1 - 10** of **1,249**

Start over

Sort by size

Show 10 per page

« Previous 1 2 3 4 5 6 7 8 9 ... 124 125 Next »

**1. /home/ubuntu/Desktop/MyStuff/SEC Documents/spch121708cc-idata.wmv**

| | |
|---|---|
| Filename | spch121708cc-idata.wmv |
| Full Path | /home/ubuntu/Desktop/MyStuff/SEC Documents |
| Image file | ubnist1_casper_rw_gen2 |
| Type | Regular file |
| Size (bytes) | 37887210 |
| Inode number | 15697 |
| MD5 | 8e7d1611c0b870f658529d94556f9a21 |
| Format (libmagic) | Microsoft ASF |
| Modification Time | 2008-12-17T17:10:00Z |
| Access Time | 2008-12-29T05:35:21Z |
| Change Time | 2008-12-29T05:35:21Z |

**2. /Compressed/logfile1.txt**

| | |
|---|---|
| Filename | logfile1.txt |
| Full Path | /Compressed |
| Image file | ntfs1_gen2 |
| Type | Regular file |
| Size (bytes) | 21888890 |
| Inode number | 48 |

# Advantages

- Faster (and more forensically sound) to extract metadata once rather than having to keep processing an image

- Possibility of developing better assessments during accessioning process (significance of directory structure, accuracy of timestamps)

- Integrating additional extraction processes and building supplemental tools is simple

# Limitations

- Use of tools limited to specific types of file systems
- Requires additional integration and data normalization to work with additional tools
- DFXML is not (currently) a metadata format common within domains of archives/libraries; somewhat in flux
- Extracted metadata harder for archivists to repurpose in some cases based on level of granularity

# Work in Progress

- BitCurator project under development; early release available for testing: http://wiki.bitcurator.net
- The Sleuth Kit and related tools under continuing development (Autopsy, fiwalk, etc.): http://sleuthkit.org
- Additional testing, development integration under work at Yale and NYPL

# Thanks!

Mark A. Matienzo
mark@matienzo.org
http://matienzo.org
@anarchivist

# References


- Abrams, S., et al. (2011). "Curation Micro-Services: A Pipeline Metaphor for Repositories." *Journal of Digital Information* 12(2). http://journals.tdl.org/jodi/article/view/1605
- AIMS Work Group (2012). *AIMS Born-Digital Collections: An Inter-Institutional Model for Stewardship*. http://www2.lib.virginia.edu/aims/whitepaper/
- Carrier, B. (2003). "Defining Digital Forensic Examination and Analysis Tools Using Abstraction Layers." *International Journal of Digital Evidence* 1(4).
- Carrier, B. (2005). *File System Forensic Analysis*. Boston and London: Addison Wesley.
- Daigle, B.J. (2012). "The Digital Transformation of Special Collections." *Journal of Library Administration* 52(3-4), 244-264.
- Duranti, L. (2009). "From Digital Diplomatics to Digital Records Forensics." *Archivaria* 68, 39-66.
- Garfinkel, S. (2012). "Digital Forensics XML and the DFXML Toolset." *Digital Investigation* 8, 161-174.
- John, J.L. (2008). "Adapting Existing Technologies for Digitally Archiving Personal Lives: Digital Forensics, Ancestral Computing, and Evolutionary Perspectives and Tools." Presented at iPRES 2008. http://www.bl.uk/ipres2008/presentations_day1/09_John.pdf
- Kirschenbaum, M.G., et al. (2010). *Digital Forensics and Born-Digital Content in Cultural Heritage Collections*. Washington: Council on Library and Information Resources.
- Lee, C.A., et al. (2012). "BitCurator: Tools and Techniques for Digital Forensics in Collecting Institutions." *D-Lib Magazine* 18(5/6).
- UC Curation Center/California Digital Library (2019). "UC3 Curation Foundations." Revision 0.13. https://confluence.ucop.edu/download/attachments/13860983/UC3-Foundations-latest.pdf
- Woods, K. and Brown, G. (2009). "From Imaging to Access: Effective Preservation of Legacy Removable Media." In *Archiving 2009*. Springfield, VA: Society for Imaging Science and Technology.
- Woods, K., Lee, C.A., and Garfinkel, S. (2011). "Extending Digital Repository Architectures to Support Disk Image Preservation and Access." In *JCDL '11*.
- Xie, S.L. (2011). "Building Foundations for Digital Records Forensics: A Comparative Study of the Concept of Reproduction in Digital Records Management and Digital Forensics." *American Archivist* 74(2), 576-599.