Combining SNIA Cloud, Tape and Container Format Technologies for the Long Term Retention of Big Data

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Outline

- **Introduction**
- SNIA Long Term Retention technology
  - Self-contained Information Retention Format (SIRF)
- Other SNIA technologies in development
  - Cloud Data Management Interface (CDMI)
  - Linear Tape File System (LTFS)
- Combining SNIA technologies
  - SIRF Serialization for CDMI
  - SIRF Serialization for LTFS
- EU Project ForgetIT and SIRF
- Summary
Big Data…..

- Really is BIG…..
  - 2.5 quintillion \((10^{18})\) bytes of new data created per day in 2012 (source IBM)
- And the move to the “Internet of Things” is only going to increase this volume
  - 19.8 Billion connected devices by 2020 (source McKinsey)
    - Only 4.2 billion smartphones and tablets, 3.4 billion PCs
- Data analytics is improving all the time
  - Therefore historical information has significant value
    - Apply new techniques and algorithms to gain new insights
    - Need to ensure ALL necessary information is captured to extract full value
- Therefore Big Data has similarities to (long term) preservation
The Need for Digital Preservation of Big Data

- Regulatory compliance and legal issues
  - Sarbanes-Oxley, HIPAA, FRCP, intellectual property litigation
- Emerging web services and applications
  - Email, photo sharing, web site archives, social networks, blogs
- Many other fixed-content repositories
  - Scientific data, intelligence, libraries, movies, music
- Domains that have Big Data require preservation

- Satellite data is kept for ever
- Scientific and Cultural
- We would like to keep digital art for ever
- Healthcare
  - X-rays are often stored for periods of 75 years
- M&E
  - Film Masters, Out takes. Related artifacts (e.g., games). 100 Years or more
- Records of minors are needed until 20 to 43 years of age
- Healthcare
SNIA Survey from 2007

Top External Factors Driving Long-Term Retention Requirements: Legal Risk, Compliance Regulations, Business Risk, Security Risk

Source: SNIA-100 Year Archive Requirements Survey, January 2007.

What does Long-Term Mean? Retention of 20 years or more is required by 70% of responses.
Goals of Digital Preservation

- Digital assets stored now should remain
  - Accessible
  - Undamaged
  - **Usable**

- For as long as desired – beyond the lifetime of
  - Any particular storage system
  - Any particular storage technology

- And at an **affordable cost**
Real Life Example Problem

2003
To: roger.cummings@veritas.com
From: fred@nowhere.com
Subject: Something or other

2007
To: roger_cummings@symantec.com
From: sue@somewhere.com
Subject: Something else

Same people?? Could you PROVE it 20 years on?

To: gary.phillips@veritas.com
From: fred@nowhere.com
Subject: Something or other

To: gary_phillips@symantec.com
From: sue@somewhere.com
Subject: Something else
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SIRF: Self-contained Information Retention Format

Being developed by SNIA Long Term Retention (LTR) TWG

An Analogy

- Standard physical archival box
  - Archivists gather together a group of related items and place them in a physical box container
  - The box is labeled with information about its content e.g., name and reference number, date, contents description, destroy date

- SIRF is the digital equivalent
  - Logical container for a set of (digital) preservation objects and a catalog
  - The SIRF catalog contains metadata related to the entire contents of the container as well as to the individual objects
  - SIRF standardizes the information in the catalog
SIRF Properties

- SIRF is a logical data format of a **storage container** appropriate for long term storage of digital information
  - A storage container may comprise a logical or physical storage area considered as a unit.
    - Examples: a file system, a tape, a block device, a stream device, an object store, a data bucket in a cloud storage

**Required Properties**

- **Self-describing** – can be interpreted by different systems
- **Self-contained** – all data needed for the interpretation is in the container
- **Extensible** – so it can meet future needs
SIRF Components

A SIRF container includes:

- **Magic object**: identifies SIRF container and its version
- **Preservation objects** that are immutable
- **Catalog** that is
  - Updatable
  - Contains metadata to make container and preservation objects portable into the future without external functions
SIRF Level 1 Properties

- 1 Container Information
  - 1.1 Specification ID and version
  - 1.2 SIRF level
  - 1.3 Container ID
  - 1.4 State
  - 1.5 Container Provenance
  - 1.6 Audit log object ID

- 2 Object Information
  - 2.1 Object IDs
  - 2.2 Related objects
  - 2.3 Dates
  - 2.4 Packaging format
  - 2.5 Fixity
  - 2.6 Retention
  - 2.7 Preservation profile
  - 2.8 Audit log object ID
  - 2.9 Extension

For each preservation object
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Cloud Data Management Interface (CDMI)

- An ISO/IEC 17826:2012 Information technology standard being developed by SNIA CDMI TWG
- The CDMI standard defines an interoperable format for moving data and associated metadata between cloud providers
- CDMI data objects can be accessed by standard browsers and internet tools (subject to owner’s access control lists)
- CDMI data objects may “order” data services from the cloud
  - Secure Erasure, Encryption, Replication, Retention, Backup/Restore, Tiering, Hashing, Preservation, etc. (extensible)
  - Done through Data System Metadata (key/value) on the Containers or Objects
- Has several implementations including in OpenStack
Model for the CDMI Interface

Resources accessed through RESTful interface:

Root
https://<offering>

Capabilities - cdmi-capability
https://<offering>/cdmi_capabilities

Container A - cdmi-container
https://<offering>/containerA

Key Value
Key Value
......

Container B - cdmi-container
https://<offering>/containerB

Key Value
Key Value
......

Domains - cdmi-domain
https://<offering>/cdmi_domains

Key Value
Key Value
......

DataObject1 - cdmi-object
https://<offering>/containerA/dataobject1

Key Value
Key Value
......

DataObject2 - cdmi-object
https://<offering>/containerA/dataobject2

Key Value
Key Value
......

Queue - cdmi-queue
https://<offering>/containerB/queue1

Key Value
Key Value
......
Linear Tape File System (LTFS)

- A file system implemented on dual-partition linear tape:
  - Index Partition and Data Partition
    - Index Partition is “small” (2 wraps, 37.5 GB out of 1.5 TB on LTO5)
    - Data Partition is remainder of the tape
  - File System module that implements a set of standard file system interfaces
    - Implemented using FUSE
    - On Linux and Mac OS X
    - Windows implementation uses FUSE-like framework
  - Includes an on-tape structure used to track tape contents
    - XML Index Schema

- Format becoming the standard for linear tape
  - Formal standardization through SNIA LTFS TWG
Logical View of LTFS Volume

Index Partition

Guard Wraps

Data Partition

LTFS XML Index

File

File

File

File
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Goals of SIRF Serialization for CDMI/LTFS

- SIRF serialization for CDMI/LTFS specifies how a CDMI container or LTFS Tape also becomes SIRF-compliant.
- A SIRF-compliant CDMI container or LTFS Tape enables a future CDMI/LTFS client to “understand” containers created by today’s CDMI/LTFS client.
  - The properties of the future client is unknown to us today.
  - “Understand” means identify the preservation objects in the container, the packaging format of each object, its fixities values, etc. (as defined in the SIRF catalog).
CDMI API can be used to access the various preservation objects and the catalog object in a SIRF-compliant CDMI container.

**Example**

- Assume we have a cloud container named "PatientContainer" that is SIRF-compliant
  - the container has a catalog object
  - each encounter is a preservation object
  - each image is a preservation object

We can read the various preservation objects and the catalog object via CDMI REST API as follows:

```bash
GET <root URI>/ PatientContainer>/sirfCatalog
GET <root URI>/<PatientContainer>/encounterJan2001
GET <root URI>/<PatientContainer>/chestImage
```
SIRF Serialization for CDMI

PatientContainer

SIRF magic object:
specification=1111
SIRF level = 1
Catalog object=sirfCatalog

sirfCatalog
{
"encounterJan2001": [
"IDs": [{ ...}],
"Fixity": [{ ...}],
"chestImage": [
"IDs": [{ ...}],
"Fixity": [{ ...}]]
}

Simple PO

Composite PO

Encounter Jan2001
A CDMI Container can be qualified also as a SIRF Container when:

- The SIRF magic object is mapped to the CDMI container metadata and includes, for example, specification ID and version, SIRF level, SIRF catalog object ID.

- The SIRF catalog is an object in the CDMI container formatted in JSON.

- A SIRF preservation object (PO) that is a simple object (contains one element) is mapped to a CDMI data object
  - The simple object can be a tar/zip.

- A SIRF PO that is a composite object (contains several elements) is mapped to:
  - A set of data objects (one for each element) and a manifest data object that its content includes the IDs and fixities of the element data objects.
The index partition of the tape is 2 wraps which is 37.5 GB in LTO-5 and probably larger in LTO-6.

- The tape index partition is large enough to hold the LTFS index, the SIRF catalog, and even additional information e.g. thumbnails of images.
SIRF Serialization for LTFS: General

- A LTFS Tape can also be a SIRF Container when:
  - The SIRF magic object is mapped to extended attributes of the “LTFS index” root directory
    - The magic object includes, for example, specification ID and version, SIRF level, reference to SIRF catalog
  - The SIRF catalog resides in the index partition and formatted in XML
  - A SIRF preservation object (PO) that is a simple object (contains one element) is mapped to a LTFS file
  - A SIRF PO that is a composite object (contains several elements) is mapped to:
    - a set of LTFS files (one for each element) and a manifest file that its content includes the IDs and fixities of the element data objects
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ForgetIT is an FP7 EU Project in the area of preservation
- Three year Integrated Project (IP) started Feb. 1, 2013
- Consortium of 11 partners (industry and academic)
- ForgetIT combines new concepts for easing the adoption of preservation in personal and organizational contexts
ForgetIT - Concise Preservation by combining Managed Forgetting and Contextualized Remembering

- couples information management and preservation management
- as opposed to the current “forgetting by accident”
- inspired by human forgetting
- bringing back information into active use in a meaningful way
PDS and SIRF in ForgetIT

- Preservation DataStores (PDS) provides preservation-aware storage services for ForgetIT that is based on the OAIS model.
- The SIRF Handler can create SIRF-complaint containers in OpenStack Swift Cloud.

Diagram:

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Preservation DataStores (PDS) provides preservation-aware storage services for ForgetIT that is based on the OAIS model.

- The SIRF Handler can create SIRF-complaint containers in OpenStack Swift Cloud.
Summary

- Need to retain not only information of interest but ALL other information to make it fully usable in future
  - Put it all in the SIRF “digital box”, preserve that as a unit
  - SIRF includes metadata about the storage container, to help “understand” the contents of the container in the future

- No single technology will be usable over the timespans mandated by current digital preservation needs
  - SNIA CDMI and LTFS technologies are among best current choices
    - Are good for perhaps 10-20 years
  - SIRF provides a vehicle for collecting all of the information that will be needed to transition to new technologies in the future
    - SIRF can be serialized for the future technologies as they come
For further information

- SIRF use cases and requirements document is released for public review
  - [http://www.snia.org/tech_activities/publicreview](http://www.snia.org/tech_activities/publicreview)

- More information on SIRF (& other SNIA LTR activities) is available at
  - [http://www.snia.org/ltr](http://www.snia.org/ltr)

- More information on ForgetIT is available @:
  - [http://www.forgetit-project.eu/](http://www.forgetit-project.eu/)