Interoperable Cloud Storage with the CDMI Standard

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Abstract

The SNIA has published the CDMI Cloud Storage standard for implementation by cloud storage vendors as well as Public and Private clouds. This tutorial will provide an overview of the features of the standard and explain how interoperability between clouds is achieved.

- What should you be requiring from your cloud vendors?
- How can you expect this standard to roll out in implementations?

Learning Objectives

- How this cloud storage standard can achieve interoperability and what this interoperability means to you.
- How you can use the cloud storage standard both internally for private clouds as well as for public clouds.
Agenda

- Some background on cloud storage
  - CDMI Overview
  - What Is Cloud Storage Used For?

- SNIA Cloud Efforts
  - Cloud Storage TWG
  - Cloud Storage Initiative

- The Cloud Storage Reference Model
  - Existing Cloud APIs
  - Leveraging the Storage Industry Resource Domain Model
  - The Big Picture
  - Using a RESTful protocol
  - Why an Industry Standard?

- CDMI Status

- Object Model, Deployment possibilities
CDMI Overview

- **Data Portability Standard**
  - Move Data (and most importantly – Metadata) from cloud to cloud

- **Advanced Cloud Services**
  - Data System Metadata allows cloud vendors to up-sell!
  - Specialized storage clouds for specific use cases

- **Logging, Security, Audit Trails**

- **Extensible to accommodate rapid innovation in cloud market**

- **Moving on to ISO standardization**
What Is Cloud Storage Used For?

- Elastic demand for web based media (video, eBooks, audio)
- Backup to the cloud
  - Restore, Recovery, “Seed” the backup with hard drive
- Sync of files to the cloud and multiple devices
  - Internet “Drive” secondary storage
- Archive to the cloud
  - Including Compliance, Retention and eDiscovery
- Storage for Cloud Computing
  - Support for legacy storage interfaces is a key feature
Storage Vendors, Cloud Providers, Developers
- >230 Technical Work Group members from 90 orgs
- Google group for broader community (> 450 members): http://groups.google.com/group/snia-cloud

Cloud Data Management Interface (CDMI) v 1.0.1
- SNIA Architecture Standard
- Next step ISO standardization

CDMI Reference Implementation
- Java based, uses any POSIX filesystem
- Open Source License (BSD)
SNIA Cloud Storage Initiative

- Gaining Momentum for Cloud Storage
  - Supporting the development and adoption of CDMI, Cloud Storage
  - Marketing, Outreach, Education on Cloud Storage
  - Requirements gathering
  - Premier Organization promoting Cloud Storage and associated Standards
- 28 Member companies and growing
  - Multiple events including Cloud Burst event focused exclusively on cloud storage
Interoperable Cloud Storage with the CDMI Standard
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Applicable to three types of Cloud Storage:

- **Cloud Storage for Cloud Computing**
  - Whitepaper at snia.org/cloud – the management interface for the lifecycle of storage in a compute cloud

- **Public Storage Cloud**
  - Whitepaper at snia.org/cloud – both a Data Path for the Cloud and a Management Path for the Cloud Data

- **Private Cloud Storage**
  - As well as hybrid clouds
  - An API for Storage Vendors selling into Cloud based solutions

**Semantics**

- Simple Containers and Data Objects with tagged Metadata
- Data System Metadata expresses the data requirements

**Protocol**

- RESTful HTTP as “core” interface style
- JSON (JavaScript Object Notation) – format of the representations are extensible
REST / RESTful

- **Representation State Transfer**
  - Started with [Dissertation by Roy Fielding](https://www.royfielding.com/) outlining the principles
  - A form of web services (but not based on WS-*)

- **Addressability**
  - Every object (resource) is addressable through a unique identifier

- **Uniform, Constrained Interface**
  - Use only HTTP verbs and model other semantics in the data model
  - Allows for Familiarity (low learning curve), Interoperability and Scalability

- **Representation Oriented**
  - Complexity is in the representations

- **Communicate Statelessly**
  - No persistent client-server connections
Why a RESTful approach for a Cloud Storage Standard

- Simplicity Rules!
- Common Infrastructures in many Languages on many Platforms
- Low learning curve leads to developer adoption
- Developer adoption creates eco-system around API
- Eco-system eases adoption by vendors and customers
- Scale-out implementation feasibility
Why not just a common library?

There are several common Cloud Libraries available

- **Libcloud** (python), **Jclouds** (Java), **Simple Cloud** (PHP), etc.
- They all write adapters from the common library to each of the proprietary interfaces
- Adapters must be maintained as interfaces evolve
- Library is under control of 3rd party, so vendors not likely to support directly
- Each language ends up propagating it’s own common library with no common semantics between them
Why not just adopt one of the existing interfaces?

- Despite the “open” licensing of several existing cloud storage interfaces, they all remain under the change control of a single vendor.
- No cloud vendor wants to have a competitor have change control over their interface.
  - Thus they release their own interface which they do have change control over.
- This leads to the propagation of multiple interfaces, each essentially locking developers/customers into that service.
- CDMI is under change control of a standards body, accommodates requirements from multiple vendors and can be extended for proprietary functions.
Clients can be in the cloud or enterprise and provide additional services (computing, data, etc.).

Clients acting in the role of using a Data Storage Interface

Management of the Cloud Storage can be standalone or part of the overall management of your cloud computing.

Clients acting in the role of Managing Data/Storage

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Cloud Peering

Models for Cloud Ecology

- Object Storage Cloud
- Cloud Federation
- Computing Cloud
- Distribution Cloud

Cloud Peering

Multiple Distribution Points
CDMI Overview

CDMI Basic flow:

CDMI Client issues requests

HTTPS: PUT, GET, POST, DELETE
MimeType: application/cdmi-_______
cdmi-object, cdmi-container, cdmi-queue, cdmi-domain, cdmi-capability*
Data, Metadata

CDMI Implementation issues response

HTTP Status (200 OK, 201 Created, etc.)
MimeType: application/cdmi-_______
cdmi-object, cdmi-container, cdmi-queue, cdmi-domain, cdmi-capability
Data, Metadata

*CDMI MIME Types are Registered with IANA
Model for the Interface

The resources which are accessed through the 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
......
CDMI is maturing as a standard

<table>
<thead>
<tr>
<th>Maturity Level*</th>
<th>Description</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No Standards</td>
<td>Standardization needed</td>
<td>Encourage standards development</td>
</tr>
<tr>
<td>2. Under Development</td>
<td>Discussions within standards groups. Open source project launched.</td>
<td>Monitor and provide feedback to standards development</td>
</tr>
<tr>
<td>3. Specification Document Published</td>
<td>Initial specification posted for public review</td>
<td>Review specification and plan testing</td>
</tr>
<tr>
<td>4. Initial Reference Implementation</td>
<td>Reference implementation available</td>
<td>Evaluate reference implementation</td>
</tr>
<tr>
<td>5. Early Third Party Testing</td>
<td>Evaluation in test environments</td>
<td>Pilot Projects should consider use</td>
</tr>
<tr>
<td>6. Initial Production Implementations</td>
<td>Successful use in production</td>
<td>Mainstream projects should consider use</td>
</tr>
<tr>
<td>7. Many Deployments</td>
<td>Widespread use by many groups</td>
<td>Projects should use the standard as a default</td>
</tr>
<tr>
<td>8. Accepted Standard</td>
<td>De facto or de jure acceptance as a standards</td>
<td>Projects should use unless special circumstances require exemption</td>
</tr>
<tr>
<td>9. Aging Standards</td>
<td>Newer standards are under development</td>
<td>Projects should explore alternatives</td>
</tr>
</tbody>
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*Source: Draft NIST Cloud Standards Roadmap
CDMI addresses SAJACC Use Cases

- CDMI is an HTTP/RESTful protocol with TLS support for securing the data, metadata and communications
  - CDMI Content Types (MIME) are standardized by IANA (IETF RFC)

SAJACC Use Case 3.4: Copy Data Objects into a Cloud

CDMI Client issues requests
  - HTTPS: PUT
    - ContentType: application/cdmi-object
    - Data, Metadata

CDMI Implementation issues response
  - HTTP Status (200 OK)
    - ContentType: application/cdmi-object
    - Metadata
CDMI uses existing standards

- CDMI data objects can be accessed by standard browsers and internet tools (subject to owner’s access)

SAJACC Use Case 3.5: Copy Data Objects out of a Cloud

CDMI data path client

CDMI Client issues requests

HTTPS: GET
ContentType: application/cdmi-object
CDMI Implementation issues response

HTTP Status (200 OK)
ContentType: application/cdmi-object
Data, Metadata

Browser issues requests

HTTP: GET
Accept: *

Implementation issues response

HTTP Status (200 OK)
ContentType: (based on data type)
Data
CDMI defines interoperable services

- 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

SAJACC Use Case 3.6: Erase Data Objects in a Cloud

CDMI Client issues requests
- HTTPS: DELETE
  - ContentType: application/cdmi-object

CDMI Implementation issues response
- HTTP Status (200 OK)
CDMI enables Data Portability

- CDMI standard defines an interoperable format for moving data and associated metadata between cloud providers interoperably
- And ensuring that the new cloud provides the same services

SAJACC Use Case 4.1:
Copy Data Objects between Cloud Providers

CDMI Client issues requests

HTTPS: PUT
ContentType: application/cdmi-object
Metadata: serialize
(source container/object)

CDMI Implementation issues response

HTTP Status (200 OK)
ContentType: application/cdmi-object
Metadata

CDMI Client issues requests

HTTPS: PUT
ContentType: application/cdmi-object
Metadata: deserialize
(destination container/object)

CDMI Implementation issues response

HTTP Status (200 OK)
Domains of Resource Management

**Information Resource Domain**
Services understand the semantics of the content in context

**Data Resource Domain**
The content is opaque to the Services and without context

**Storage Resource Domain**
The bits are contained by these Services

**Information Policies**
Data classified according to importance to organization

**Data Policies**
Data treated according to requirements, lifecycle

**Storage Policies**
Ensure correct and reliable operation

Data System Metadata used as conditions in policies where actions are against storage and data services.
All of these interfaces support some or all of this model. The key to retaining the simplicity of the cloud, however, is in the use of metadata to drive the underlying services so that users need not manage the services themselves.
How does CDMI fit into a storage cloud?

- **Small Private Cloud**
  - Deployed as a layer above NAS box, or may also be embedded

- **CDMI Containers and Objects** are mapped to a mounted filesystem’s directories and files

- **CDMI** can also be used to configure NAS storage not available through CDMI data path
How does CDMI fit into a storage cloud?

- **Large Scale out Cloud**
  - Deployed as a horizontal set of parallel filesystem clients with requests balanced across them
  - Storage is implemented by a set of data servers with a common metadata server
For More information

❖ One Web Site to Remember: http://snia.org/cloud

❖ Large Cloud Storage Community
  ❖ http://groups.google.com/group/snia-cloud
  ❖ http://twitter.com/SNIAcloud (@SNIAcloud)

❖ SNIA Cloud Blog Site:
  ❖ http://sniacloud.com
Other Cloud Tutorials

Check out SNIA Tutorials:

- SNIA Tutorial: Enterprise Architecture and The Cloud (Wednesday 10:45 – 11:30)
- SNIA Tutorial: Deploying Public, Private and Hybrid Storage Clouds (Thursday 8:30 – 9:15)

Also visit the Cloud Hands on Lab
Please send any questions or comments on this presentation to SNIA: tracktutorials@snia.org

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