SNIA CSTI | CLOUD STORAGE TECHNOLOGIES

Simplified Namespace Management: The Open Standards Way

Live Webinar

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Today's Presenters

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Intel

The SNIA Community

200
Corporations, universities, startups, and individuals

2,500
Active contributing members

50,000
Worldwide IT end users and professionals

SNIA CSTI | CLOUD STORAGE TECHNOLOGIES

What We Do

Educate vendors and users on cloud storage, data services and orchestration

Support & promote business models and architectures: OpenStack, Software Defined Storage, Kubernetes, Object Storage

Understand Hyperscaler requirements Incorporate them into standards and programs

Collaborate with other industry associations

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Agenda

- Overview of namespaces in storage systems
- Challenges of namespace management
- A brief SNIA CDMI™ primer
- CDMI namespace management
- Recap of benefits
- Call for participation

Overview of Namespaces in Storage Systems

Overview of Namespaces in Storage Systems

- From the SNIA Dictionary:
  - [General] A domain of identifiers.
  - [File System] The set of valid names recognized by a file system.
  - [Management] In CIM and WBEM, a collection of object definitions and instances that are logically consistent.
  - [NVMe] Formatted non-volatile storage that may be accessed by a host. For example, an NVMe namespace may contain logical blocks for storing data or key-value pairs for storing data.
- More generally:
  - Namespaces uniquely identify a group of locally-unique identifiers, and enable them to be globally-unique.

THE SNIA DICTIONARY

A glossary of storage and information management terminology

www.snia.org

SNIA.

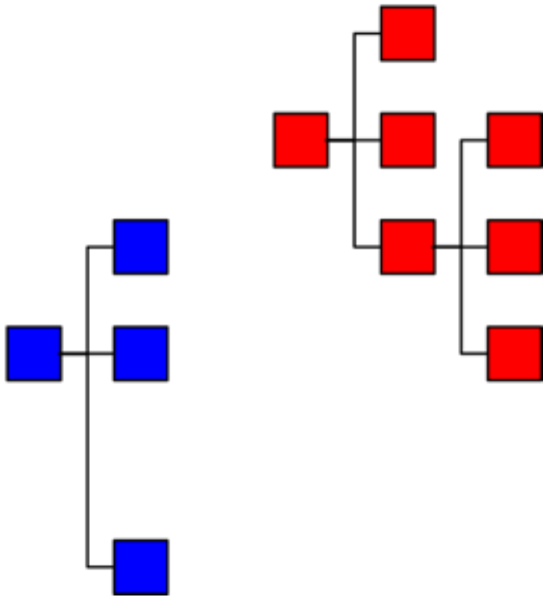
Advancing storage & information technology

www.snia.org/education/online-dictionary

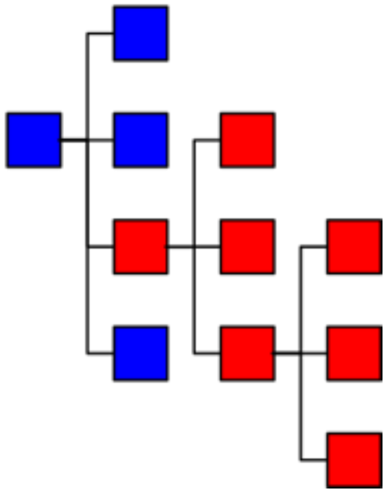
Why Do We Need Namespaces?

- Grouping
  - All of the files within a file system, all the blocks within a LUN, etc, can be referred to as a single namespace entity.
- Uniqueness
  - Two file system directories can both contain the file “readme.txt” because each directory is a separate namespace.
- Delegation
  - All identifiers under a first namespace can be directed to a first system, and all identifiers under a second namespace can be directed to a second system.

How Can Namespaces Interact?

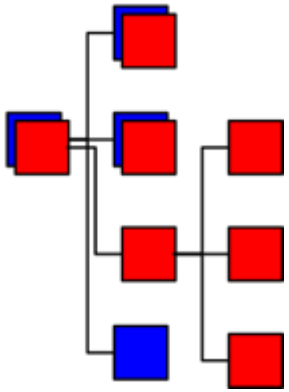


Disjoint Namespaces



Mounted Namespace

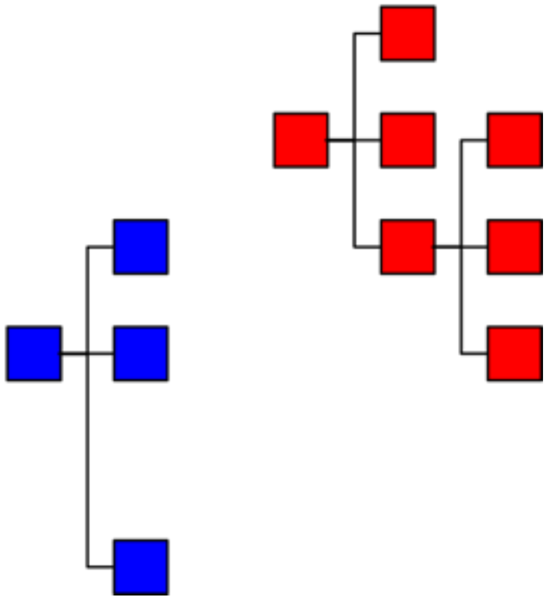
(Red accessible from within Blue)



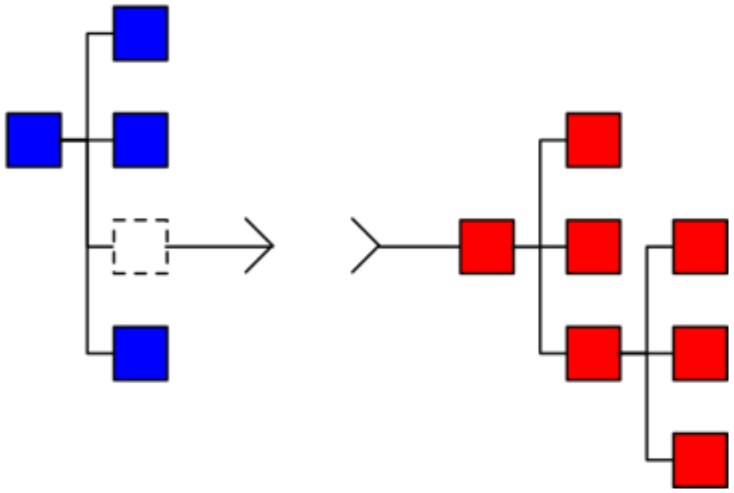
Overlay Namespace

(Red overrides Blue)

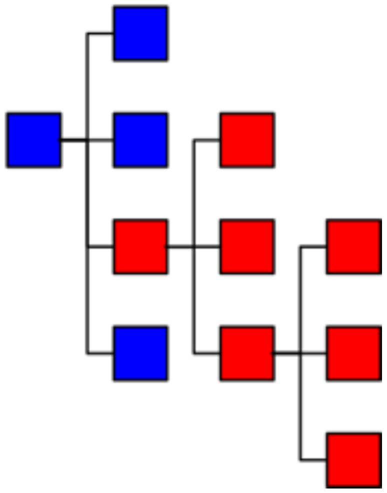
Exports and Imports



Disjoint Namespaces

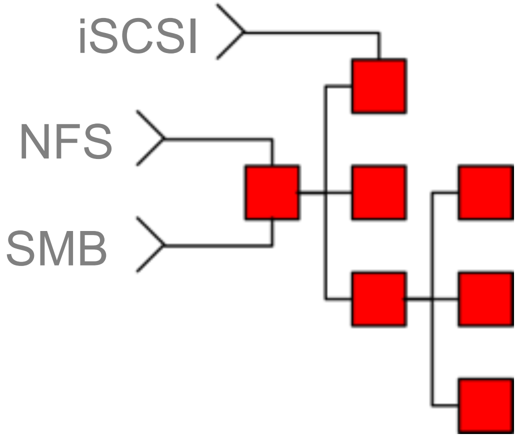


Red Namespace Export
Blue Namespace Mount

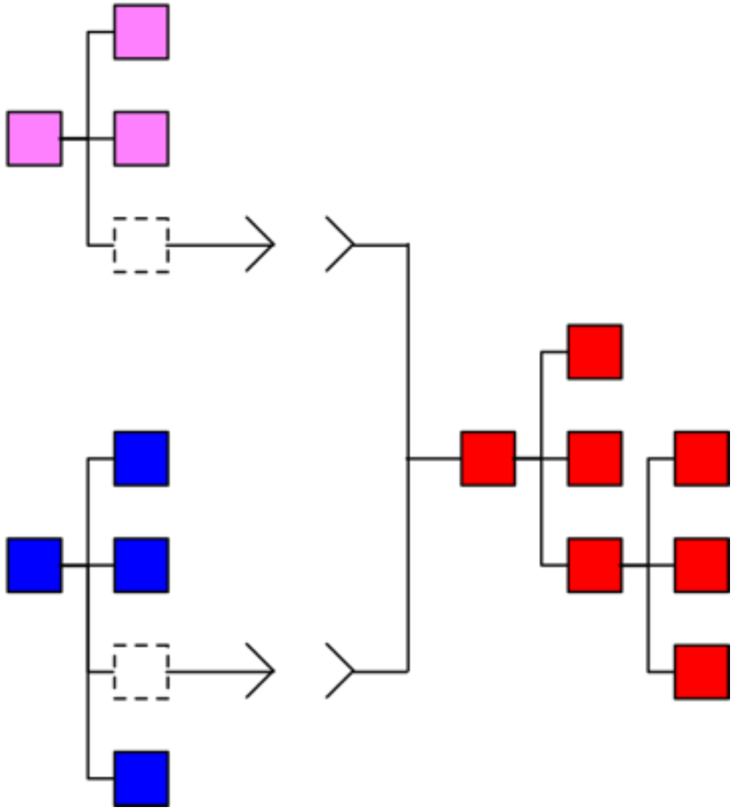


Mounted Namespace

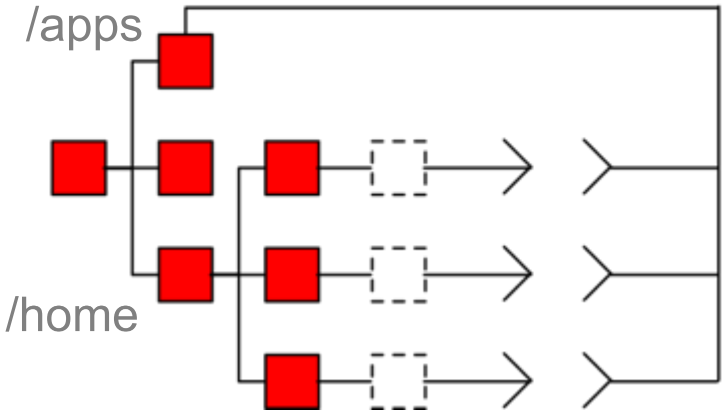
More Examples



Namespaces may have multiple exports of differing protocols



Multiple namespaces may mount a given namespace



A namespace may even mount another part of the same namespace

Key Namespace Concepts

- Namespaces contain entities
- Namespaces can export entities via protocols
- Namespaces can import entities that are exported
  - Can be imported (“mounted”) into a new, empty entity defined in the importing namespace
  - Can be imported (“overlaid”) onto an existing entity in the importing namespace

Challenges of Namespace Management

Challenges of Namespace Management

- Different types of namespaces are often managed using different protocols
  - LUN management
  - NAS file system management
  - Object bucket management
- Different vendor’s namespaces are often managed using different protocols
  - Unlike the export protocols (iSCSI, NFS, SMB, S3, etc), the management protocols are not widely standardized
- This is a significant challenge for management clients

Some Example User Stories

- As a client, I want to export a directory as a NFS share
- As a client, I want to mount a NFS share into a file system
- As a client, I want to export a ISO image stored in a NAS namespace as an iSCSI LUN
- As a client, I want to mount an iSCSI LUN as a file system
- As a client, I want to export a directory as a S3 bucket
- As a client, I want to mount an S3 bucket as a directory

Current State of the Industry

- Wouldn’t it be nice if there was a standard way to do all of these?
  - That took into account security?
  - That is out-of-band with respect to the data protocols?
  - That is declarative?
  - That is easy to implement for both servers and clients?
- Well, you’ve come to the right place…
- This is one of the primary use cases for the open SNIA Cloud Data Management Interface (CDMI™) standard

A Brief CDMI Primer

What is SNIA CDMI?

- CDMI (Cloud Data Management Interface), is an open ISO standard (ISO/IEC 17826:2022) for managing data namespaces.
- HTTP-based, only implement the parts you need
- Key capabilities are:
  - Discover, traverse and introspect namespaces
  - Supports block, file and object namespaces (+ future-proof for graph & table)
  - Supports rich metadata, including declarative hinting for storage providers
  - Supports advanced storage functionality including versioning, snapshots, bulk jobs, queues and more
  - Namespace exports and imports

SNIA

Cloud Data Management Interface

(CDMI$^{\text{TM}}$)

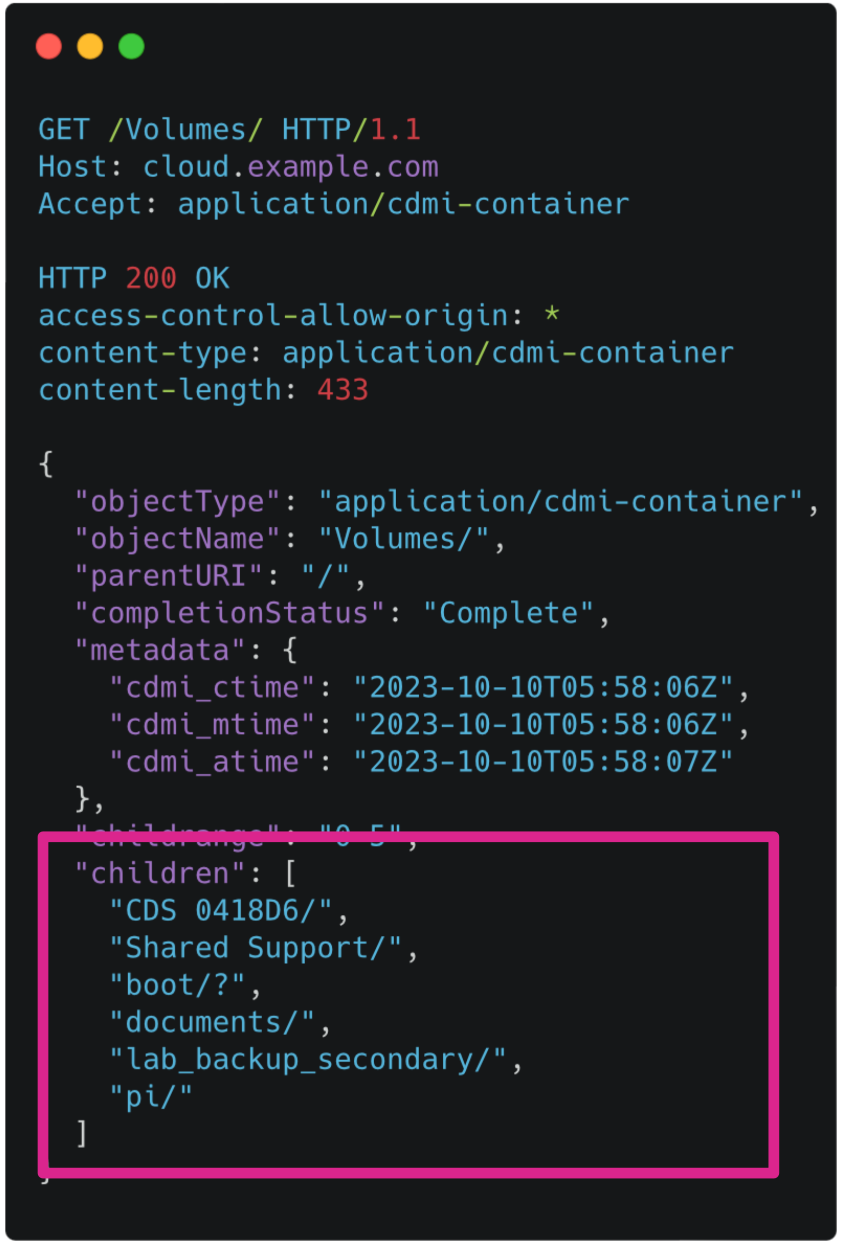
Version 2.0.0

A Brief CDMI Primer

- Discover and traverse namespaces:
  - CDMI allows you to easily list namespaces.
  - In the example to the right, a CDMI server provides a set of namespaces in the “volumes” container.
  - Performing a “GET” with a CDMI media type shows the list of namespaces in the “children” field.

- This allows clients to discover namespaces in a consistent way.

- Let’s take a look at the “pi/” namespace…

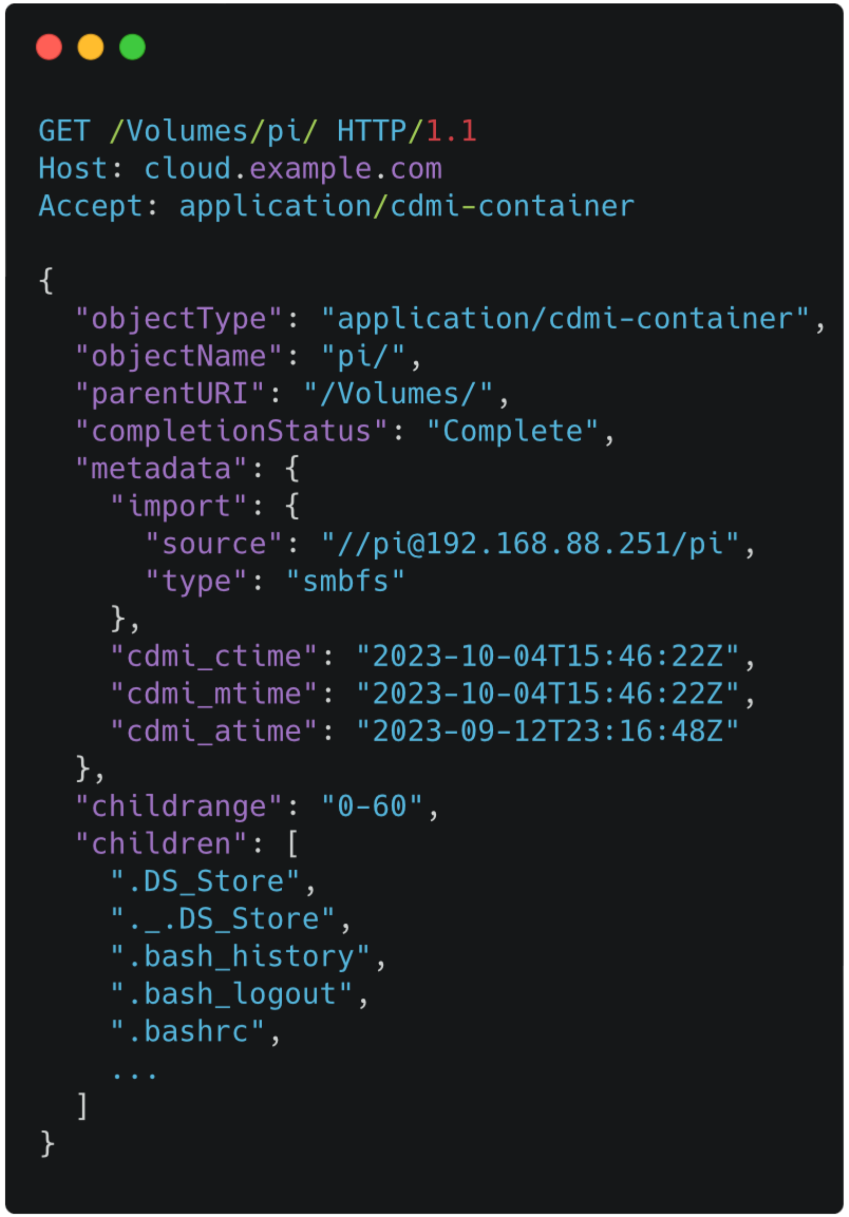


```
GET /Volumes/ HTTP/1.1
Host: cloud.example.com
Accept: application/cdmi-container

HTTP 200 OK
access-control-allow-origin: *
content-type: application/cdmi-container
content-length: 433

{
  "objectType": "application/cdmi-container",
  "objectName": "Volumes/",
  "parentURI": "/",
  "completionStatus": "Complete",
  "metadata": {
    "cdmi_ctime": "2023-10-10T05:58:06Z",
    "cdmi_mtime": "2023-10-10T05:58:06Z",
    "cdmi_atime": "2023-10-10T05:58:07Z"
  },
  "childrange": "0-5",
  "children": [
    "CDS 0418D6/",
    "Shared Support/",
    "boot/?",
    "documents/",
    "lab_backup_secondary/",
    "pi/"
  ]
}
```

A Brief CDMI Primer

- Introspect namespaces:
  - CDMI allows you to access extended metadata about namespaces.
  - In the example to the right, a CDMI server provides details about a mounted namespace via SMB.
  - CDMI allows you to only request specific properties of an object, so you can get just request the metadata, for example.

- This allows clients to inspect namespaces in a consistent way.



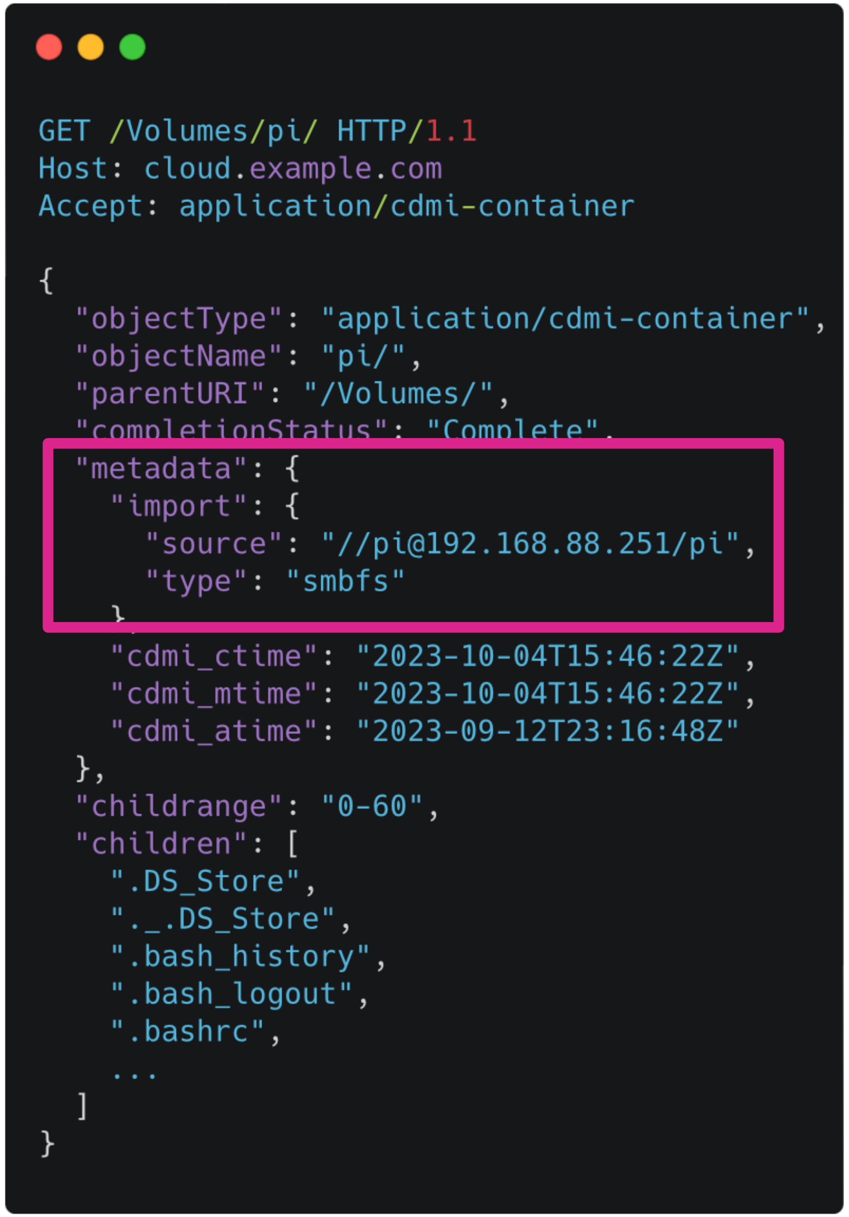
```
GET /Volumes/pi/ HTTP/1.1
Host: cloud.example.com
Accept: application/cdmi-container

{
  "objectType": "application/cdmi-container",
  "objectName": "pi/",
  "parentURI": "/Volumes/",
  "completionStatus": "Complete",
  "metadata": {
    "import": {
      "source": "//pi@192.168.88.251/pi",
      "type": "smbfs"
    },
    "cdmi_ctime": "2023-10-04T15:46:22Z",
    "cdmi_mtime": "2023-10-04T15:46:22Z",
    "cdmi_atime": "2023-09-12T23:16:48Z"
  },
  "childrange": "0-60",
  "children": [
    ".DS_Store",
    "._.DS_Store",
    ".bash_history",
    ".bash_logout",
    ".bashrc",
    ...
  ]
}
```

CDMI Namespace Management

CDMI Namespace Imports

- Import namespaces:
  - CDMI allows you to specify that a given namespace should be imported from a remote location. This allows clients to provide instructions to the server to import (mount) that namespace.
  - In the example to the right, a given container is requested to be imported via the SMB protocol.

- CDMI currently supports “references” via URIs.
  - The SNIA Cloud Storage Technical Work Group is planning to formally specify imports, participation is welcomed!

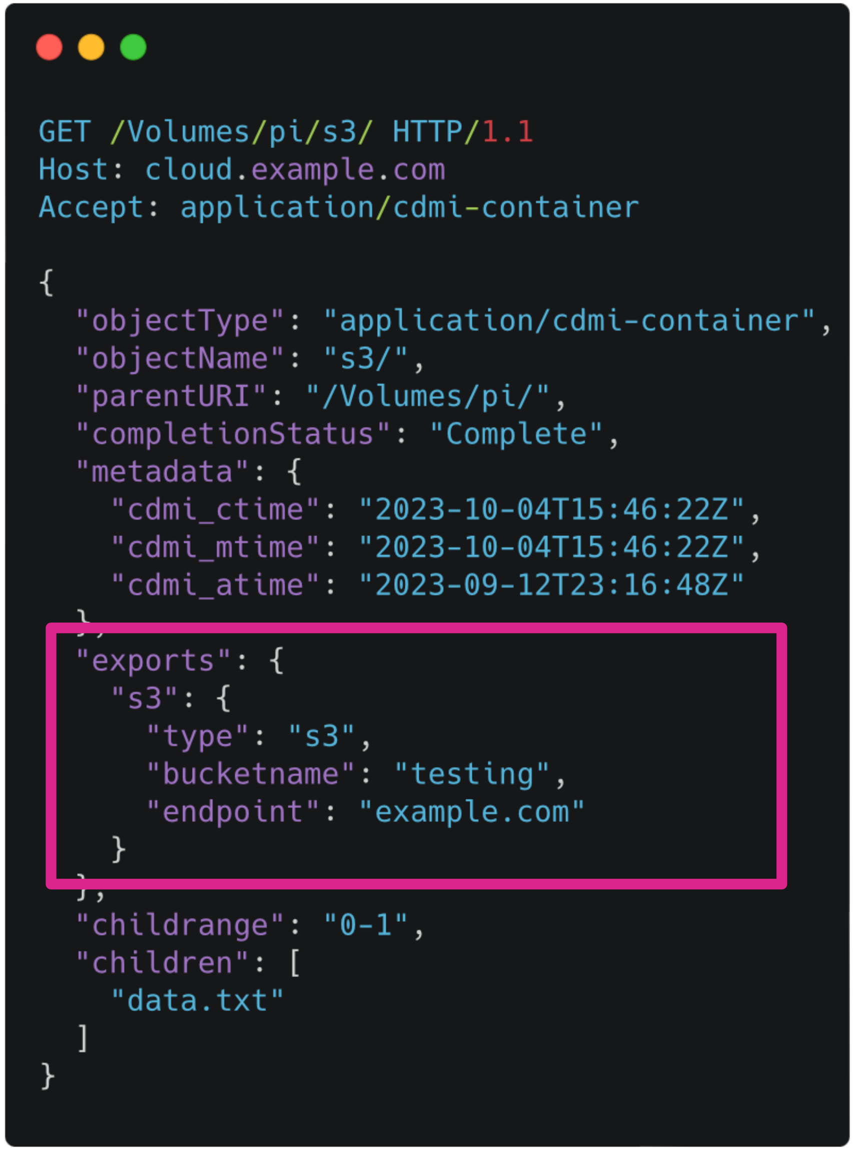


```
GET /Volumes/pi/ HTTP/1.1
Host: cloud.example.com
Accept: application/cdmi-container

{
  "objectType": "application/cdmi-container",
  "objectName": "pi/",
  "parentURI": "/Volumes/",
  "completionStatus": "Complete",
  "metadata": {
    "import": {
      "source": "//pi@192.168.88.251/pi",
      "type": "smbfs"
    },
    "cdmi_ctime": "2023-10-04T15:46:22Z",
    "cdmi_mtime": "2023-10-04T15:46:22Z",
    "cdmi_atime": "2023-09-12T23:16:48Z"
  },
  "childrange": "0-60",
  "children": [
    ".DS_Store",
    "._.DS_Store",
    ".bash_history",
    ".bash_logout",
    ".bashrc",
    ...
  ]
}
```

CDMI Namespace Exports

- Export namespaces:
  - CDMI allows you to specify that a given namespace should be exported. This allows clients to provide instructions to the server to export that namespace.
  - In the example to the right, a given container is requested to be exported via the S3 data access protocol.

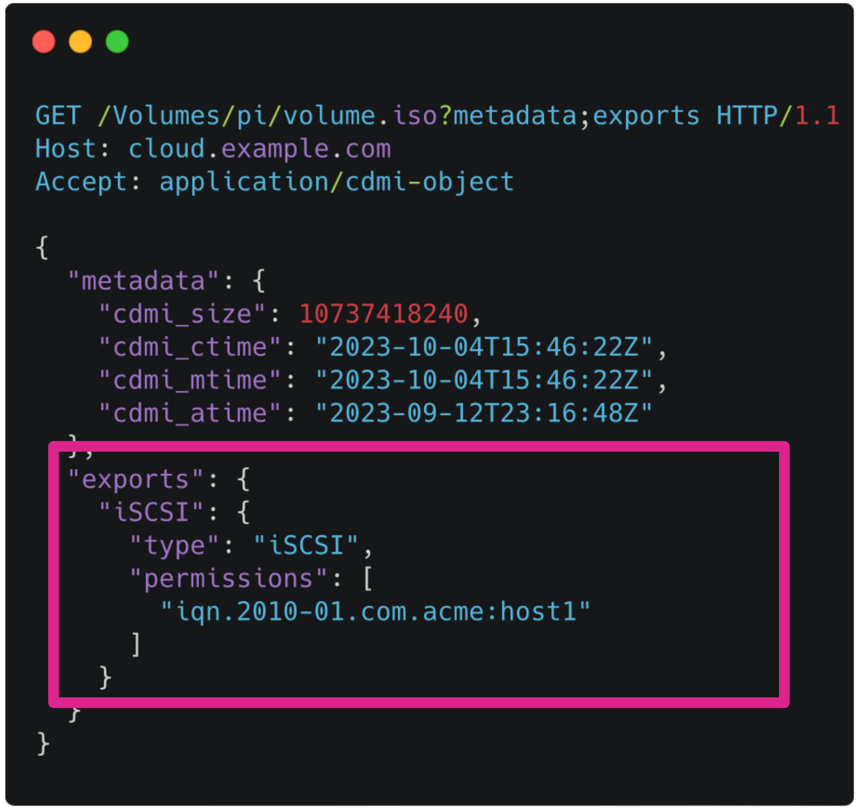
- CDMI currently specifies how to export via NFS, SMB, iSCSI, WebDAV and OCCI.
  - The SNIA Cloud Storage Technical Work Group is actively specifying S3 exports, participation is welcomed!



```
GET /Volumes/pi/s3/ HTTP/1.1
Host: cloud.example.com
Accept: application/cdmi-container

{
  "objectType": "application/cdmi-container",
  "objectName": "s3/",
  "parentURI": "/Volumes/pi/",
  "completionStatus": "Complete",
  "metadata": {
    "cdmi_ctime": "2023-10-04T15:46:22Z",
    "cdmi_mtime": "2023-10-04T15:46:22Z",
    "cdmi_atime": "2023-09-12T23:16:48Z"
  },
  "exports": {
    "s3": {
      "type": "s3",
      "bucketname": "testing",
      "endpoint": "example.com"
    }
  },
  "childrange": "0-1",
  "children": [
    "data.txt"
  ]
}
```

CDMI Namespace Exports

- Data objects can be exported as block devices. For example, an ISO image or VMDK file can be exported as LUN via iSCSI.
- This can then be mounted via a CDMI import to allow the file system contained within the ISO image to be accessed.
- This mounted namespace can then be further exported via NFS, etc.



```
GET /Volumes/pi/volume.iso?metadata;exports HTTP/1.1
Host: cloud.example.com
Accept: application/cdmi-object

{
  "metadata": {
    "cdmi_size": 10737418240,
    "cdmi_ctime": "2023-10-04T15:46:22Z",
    "cdmi_mtime": "2023-10-04T15:46:22Z",
    "cdmi_atime": "2023-09-12T23:16:48Z"
  },
  "exports": {
    "iSCSI": {
      "type": "iSCSI",
      "permissions": [
        "iqn.2010-01.com.acme:host1"
      ]
    }
  }
}
```

Current State of CDMI Namespace Management

- The following namespace operations are specified in CDMI 2.0:
  - Export a container via NFS, SMB, and WebDAV
  - Export an object as a LUN via iSCSI and OCCI

- The following operations are being added as extensions to CDMI:
  - Export a container via S3 (active standardization work)
  - Import a container via NFS, SMB, S3, and iSCSI

- Storage vendors can add additional extensions:
  - Export an object as a LUN via Fibre Channel,
  - Export an NVMe Namespace via NVMe-oF over RDMA, etc.

Recap of Benefits

CDMI Namespace Management Benefits

- Single protocol for namespace management
- Enables client namespace management operations
- Simple HTTP-based protocol
- Only implement required subset
- Supports block, file and object, extensible to graph and table
- Open vendor-independent standard
- Add extensions for new functionality

Call for Participation

- Interested in using the CDMI standard in your project?
  - Read the spec - https://www.snia.org/sites/default/files/technical-work/cdmi/release/CDMI-v2.0.0.pdf
  - Learn more about CDMI - https://www.snia.org/cdmi
  - Join the SNIA Cloud Storage Technical Work Group - https://www.snia.org/tech_activities/work/twgs
  - Create a CDMI implementation
  - Add an extension - https://www.snia.org/tech_activities/publicreview/cdmi
  - Join us at a plugfest
  - Give us feedback! - cloudtwg@snia.org

Questions?

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Thank You