

Title: Measurement Data Archive Prototype Design
Organization: CNRI
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Measurement Data Archive

1. Introduction

Measurement Data Archive service will provide a stable archive of GENI measurement data and metadata, for the purpose of sharing results, analyzing results, comparing results, replicating instrumentation activities (possibly through federation with existing provenance and other types of registries within and external to the GENI environment), and making it possible to provide long term access to measurement datasets that can be cited in publications and become part of the persistent scientific and engineering record. It will allow authorized GENI entities to publish measurement data and metadata with suitable keywords, and also allow them to catalog indexes for future search and retrieval purposes. Additionally, an optional workspace capability will be provided for ease of data management and curation.

There are three basic areas of information management: real-time data gathering from the instrumentation (source data), temporary storage and management of that data (workspace data), and permanent storage and accessibility (archive data). Data flows from the experimenter (and researcher) space to the workspace to the archive. Each stage from initial gathering to final archiving is expected to have different requirements. The measurement tools may need to be programmed to allow for wide variability in data gathering methods that are unique to both the needs of the experiment and network variables.

The workspace into which measurement data initially flows can be used to begin the data management work. Here, data can be organized, annotated, made available for initial analysis, etc. In some cases, moving data to the long-term archive will involve mapping, or normalizing, ad hoc structures (e.g., text files and spreadsheets) into more tightly structured formats for both the source data, and the metadata describing the source data. In some cases it may be that the initial measurement tools produce data in final format, and moving it to the archive will be a selection process.

The long-term archive will allow direct dissemination of the archived data in its original format. Such disseminations will be enabled via persistent references. Alternatively, the archive may provide custom disseminations of the data, e.g., upon requesting a resolution to an archived object, the archive may redirect to a Google Visualization service that produces an interactive time-series based bar graph of the underlying dataset.

While several pertinent protocols and capabilities can be specified and defined depending on the GENI community requirements for enabling data flows to and

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from workspace and archive, an initial prototype from CNRI made a few simplifying assumptions. The details of the prototype are defined below.

2. Prototype

The Measurement Data Archive prototype system consists of two components: 1) User Workspace and 2) Object Archive. Each of those components are internally enabled using several sub-services:

2.1. User Workspace

The User Workspace component is an entry point for users (e.g., experimenters, instrumentation researchers, etc.) to store and transfer measurement data, which could be in a variety of forms (e.g., formatted datasets, raw files, etc.). Metadata corresponding to the metadata files may also be stored and transferred into the workspace. Users can then curate the data and metadata held in the workspace, e.g., make changes to the files, delete the files, etc.

User workspace provides 'browse' functionality similar to the directory list functionality available on modern operating systems. Additionally, data can be discovered and filtered using a search capability employed on the metadata. Users can issue keyword-based queries on the metadata to refine and filter the data from the workspace.

As an option, users can select to share 'read' and 'write' permissions on the data across other users and groups within the system.

2.2. Object Archive

Data and metadata files managed in the user workspace can be archived for long-term storage in an Object Archive. Once data is archived, a persistent and unique identifier is created. Additionally, a persistent reference to the data is provided. Discovery and filtering of the archived data is enabled using a search service.

Note that objects once archived are made read-only, and cannot be overwritten. New versions of data will be created when archived objects are re-archived. However, the persistent identifiers will remain the same. Persistent references will resolve to the latest version of the archived data. Resolving to prior versions is enabled.

2.3. System Design and Implementation Choices

User Workspace is partially based on a Linux Operating System. Early adopters from the GENI community will be given user accounts on the system that in turn enable a file system share that can be mounted on a variety of machines (e.g., personal laptops, server machines, etc.) using the 'SMB' protocol. Once mounted, users can copy data into their account mount points. Optionally, users may transfer files securely using SFTP. Users can also access a secure shell (SSH) to modify

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permissions and group settings, and perform other operations on the transferred data.

In addition to the OS view, data in the User Workspace is made available through a repository instance deployed using CNRI's Digital Object Repository software, made available to public at <http://www.dorepository.org/>. This enables various functions such as search and persistent identifier resolution to be carried out in the User Workspace using our standard repository tools and processes.

Object Archive is enabled via another instance of the Digital Object Repository. This instance of the repository has its own storage for long-term data persistence. Directory structures from the User Workspace, when set to archive, will be mapped to digital objects and pushed into the repository. Objects are assigned handles, unique, globally resolvable, persistent identifiers that use the Handle System. (The Handle System software and documentation is made available here: <http://www.handle.net/>). Handles, assigned and managed long-term, will provide persistent references to the archived data. The repository indexes the metadata (of the archived data) to enable search and filtering capabilities.

3. Prototype Access

The prototype allows access to the Workspace using SMB protocol. Users are required to get an account on the system for use by contacting Giridhar Manepalli (gmanepalli@cnri.reston.va.us). Once an account is established, users can mount a 'workspace network drive' specific to their account using the assigned credentials. SMB is a widely used protocol that works on almost all platforms including Windows, Mac OS, and Linux. Once mounted, users can create directories, sub-directories, and files as required for streamlining I&M activities. For indexing and archiving services to function within the workspace, the directories and files from user accounts are mapped to digital objects. While the prototype does not limit the files and formats of the data stored in the workspace, a specific convention for directory structure is recommended:

An object corresponds to a directory tree with a file METADATA.txt in the root of the tree. The elements of the object are all of the files, including in subdirectories recursively, unless one specifies another METADATA.txt (which indicates a new object instead).

For instance, directories and files like

```
/home/objectdir/  
/home/objectdir/METADATA.txt  
/home/objectdir/somefile  
/home/objectdir/subdir/  
/home/objectdir/subdir/someotherfile
```

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/home/objectdir/newobjectdir/
/home/objectdir/newobjectdir/METADATA.txt
/home/objectdir/newobjectdir/someotherfile

would be interpreted as two objects; object "10510.3.0.1/hash-of-string-object" and object "10510.3.0.1/hash-of-string-newobjectdir". The directory structure within an object is preserved. Here, "10510.3.0.1" is a Handle prefix assigned to objects, the use of which will be seen in Archive. The contents of the METADATA.txt file are indexed, allowing searches to be made on the objects.

3.1. Website

Data stored in the workspace, which are mapped to objects, can be searched, browsed, and retrieved using a web front-end, which is available at <http://mda.doregistry.org/>. Data may be filtered using keywords or using timestamps on the website by selecting appropriate toggle buttons shown in the top-right in Figure 1. Keywords specified in the search input box are matched against the described metadata, and matching objects are returned for browsing in the left Results panel as illustrated in Figure 1. Users may browse data by clicking on objects and their sub-directories. Metadata for the active (selected) object is shown in the right Metadata panel.

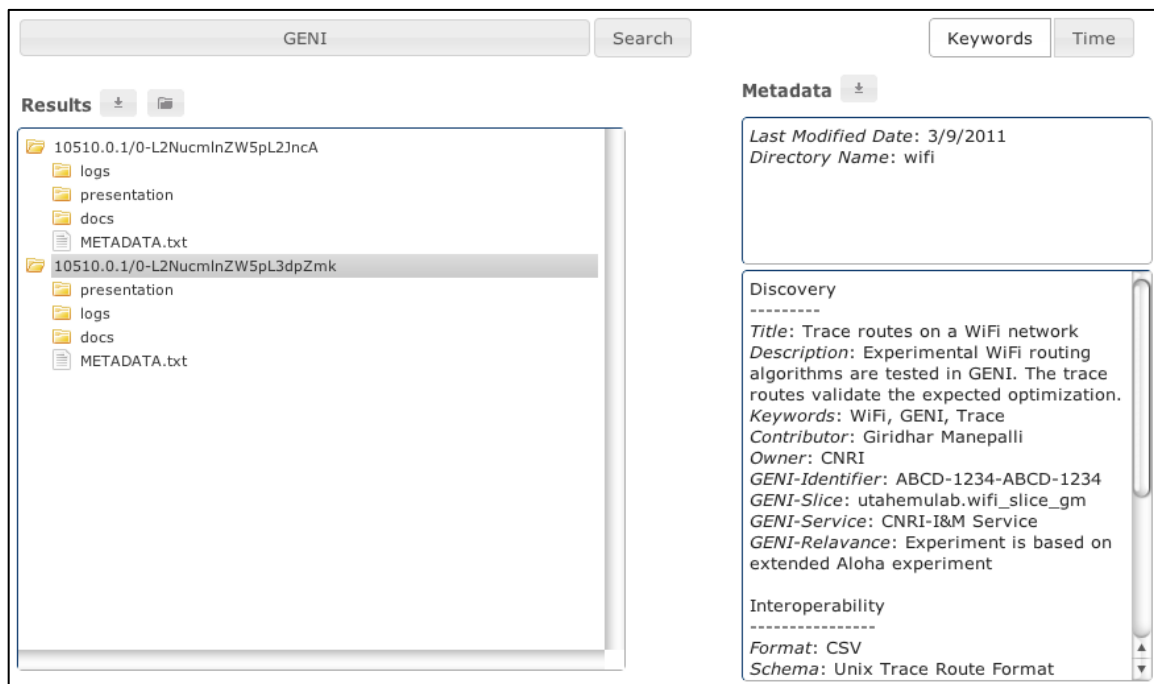





Figure 1: User Workspace Web Interface

Users may select the object, or its sub-directories, or files, and click on the download link [] above the left panel. This will download the selected data to the users'

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computers. Alternatively, users may download just the metadata by clicking on the download link above the right panel.

Finally, users may archive any object, by selecting an object (or its sub-directories or files) and clicking on the archive link [] next to the download link above the left panel. This will archive the object and returns a persistent identifier (e.g., 10510.0.1/0-L2NucmlnZW5pL3dpZmk). References to any archived object can be made using the Handle System Proxy. A hypothetical example of the persistent reference would be <http://hdl.handle.net/10510.0.1/0-L2NucmlnZW5pL3dpZmk>.

Once archived, users may perform the search, browse, and retrieve actions in an identical fashion to that of workspace except for the 'archive' function. Users can click on a reference link [] as illustrated in Figure 2 for resolving to the selected object. That link can also be used for making persistent references to objects in journals, etc.

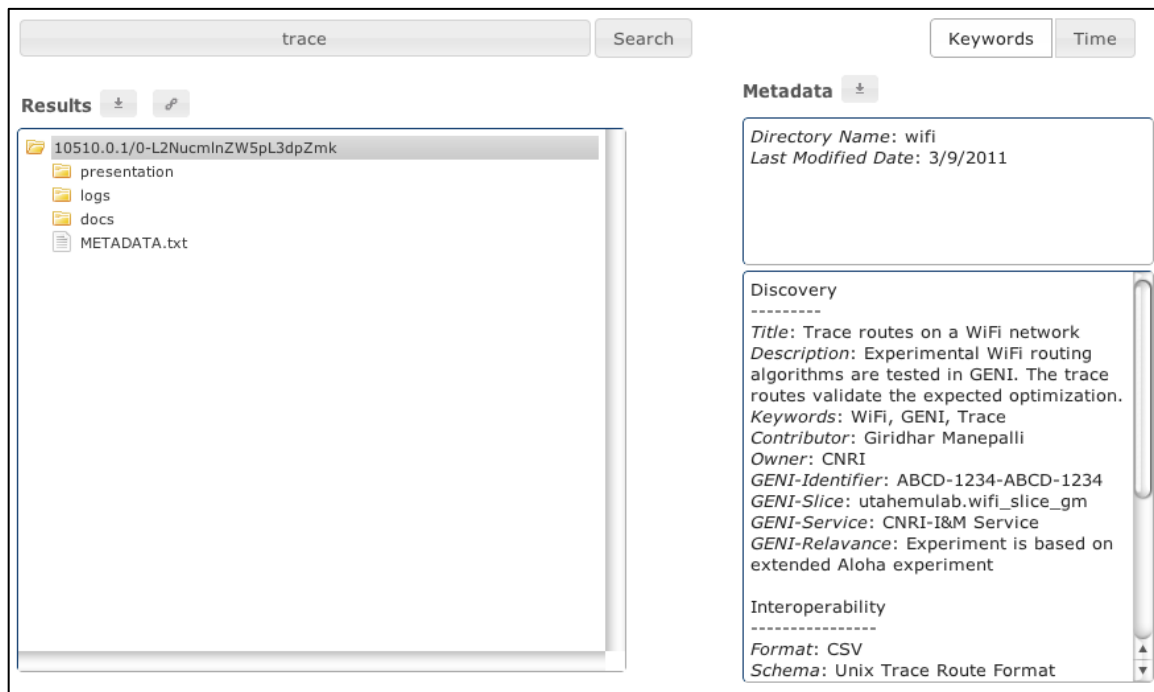


Figure 2: Persistent Archive Web Interface

3.2. API

In addition to accessing data via the website, users may store, retrieve, archive, and reference data in a programmatic fashion. The various API calls supported are classified based on the protocol of use below:

Protocol: SMB

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Available Functions: Store and Retrieve

Smb://mda.doregistry.org/<user login>

The various SMB calls supported are per the standard protocol, which is sufficiently described here: <http://www.samba.org/cifs/docs/what-is-smb.html>. Workspace directory structure convention described above should be followed for storing.

Protocol: HTTP

Available Functions: Get ID, Retrieve, Archive

Get ID: This function returns the assigned ID when stored in workspace.

<http://mda.doregistry.org/gateway?command=getid&user=<user login>&path=<relative file path to the root of the object>&target=workspace>

Retrieve object or metadata: This function returns the object or metadata from either workspace or archive.

<http://mda.doregistry.org/gateway?command=retrieve&type=<object|metadata>&id=<object id>&target=<workspace|archive>>

Archive: This function pushes data from workspace to archive.

<http://mda.doregistry.org/gateway?command=archive&id=<object id>&target=archive>

3.3. Note

The prototype does not currently provide any access control features. Nor does it support any control framework integration. The GENI I&M team is currently working on evolving the MDA specification to include those details.