2nd GENI Instrumentation and Measurement Workshop
Chicago, IL, June 8-9, 2010

Contents

1. Technical Goals

The first GENI measurement workshop was held on June 26, 2009[1]. It brought together measurement experts to review the following topics: 1) measurement architecture, 2) instrumentation, 3) experiment specification, and 4) data management. The speakers suggested approaches to each topic that would allow GENI to meet its goals. The consensus was that the design of an effective GENI measurement architecture had just begun.

To continue the effort, six GENI Instrumentation and Measurement (I&M) prototyping projects were established following Solicitation 2, joining three I&M prototyping projects continuing from Solicitation 1. Also, a GENI I&M Working Group (WG) was formed at the beginning of Spiral 2.

The WG has affirmed that GENI I&M systems will provide broad data gathering, analysis and archival capability, sufficient for GENI's research mission and sufficient for operations. Furthermore, the GENI I&M WG will create and document a GENI I&M architecture in Spiral 2, and coordinate the design and deployment of a first GENI I&M system in Spiral 3.

The objective of this 2nd GENI I&M workshop is to gather contributors from key I&M prototyping projects to define priority pieces of the I&M architecture by consensus, assemble teams to complete the documentation, and draft a roadmap for implementations during Spirals 2 and 3.

A GENI I&M Capabilities Catalog[2] has been drafted, which reviews each current GENI I&M project, and other selected projects, and lists: architecture components addressed or implemented; implementations in GENI or elsewhere; and uses in GENI or elsewhere. This document identifies projects that can best contribute to architecture topics and to identify projects that can implement enhanced GENI I&M capabilities in Spirals 2 and 3.

Based upon this catalog, several key projects were identified (see invitee list below) that could contribute to a GENI I&M architecture because they have already implemented pieces of I&M functionality in a manner consistent with GENI goals. Four of these projects were invited to give presentations at the GEC7 WG meeting, highlighting how their work mapped into the evolving GENI I&M architecture. Since then, the organizing committee has gathered technical references from and had

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[1] See http://groups.geni.net/geni/wiki/GENIMeasWS

[2] See http://groups.geni.net/geni/wiki/GENIIandMCAPCAT

extended discussions with these projects, and gained a better understanding of how they can best contribute to the GENI I&M architecture.

An early draft of a GENI I&M Architecture document was completed[3] and reviewed at the GEC7 WG meeting. Although there was general agreement on the draft of the architecture, the following priority topics were identified as needing to be defined first:
GENI I&M use cases
GENI measurement plane
GENI I&M services
Interfaces, protocols and schema for measurement data in GENI

This workshop will:
- Gather contributors from the key projects (see invitee list below).
- For each priority topic, the organizers will outline a suggested approach or solution, including how certain key projects might contribute functionality.
- Then, a representative from these key projects will review how they could best contribute the suggested functionality.
- Finally, each priority topic will be discussed in a structured manner, with the goal of achieving a consensus on a proposed solution or approach, plus identifying gaps that need further work.
- Assemble teams for each priority topic, identify the action items required to close any identified gaps, complete the proposed solution or approach, and write a revised section(s) for the architecture document
- Draft a roadmap for implementations in Spiral 2 and 3 by the key projects to realize the proposed solutions.

The revised architecture document will then be reviewed by the WG. It and the roadmap will be used for guiding future work on GENI I&M systems.

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[3] See http://groups.geni.net/geni/wiki/GeniInstrumentationandMeasurementsArchitecture

2. Organization

Dates: Tuesday, June 8, 2010, 1:00 pm – Wednesday, June 9, 2010, 2:00 pm

Location: Hilton Chicago O'Hare Airport, Chicago, IL,
http://www1.hilton.com/en_US/hi/hotel/CHIOHHH-Hilton-Chicago-O-Hare-Airport-Illinois/index.do

By Monday, May 24, please contact the hotel at 773-686-8000 , and book a room using the code "BBN", to receive a discounted rate.

Number of attendees: 19

Agenda for June 8:

1:00 pm	Welcome and introductions
1:15 pm	Suggest a basic set of GENI I&M use cases, and review contributions from key projects
1:45 pm	Discuss basic set of GENI I&M use cases, summarize consensus and identify gaps
2:30 pm	Break
2:45 pm	Suggest definition of GENI I&M measurement plane, services, interfaces and protocols (APIs), and review possible contributions from key projects
4:15 pm	Break
4:30 pm	Discuss GENI I&M measurement plane, services, interfaces and protocols (APIs), summarize consensus and identify gaps
6:00 pm	Adjourn
7:00 pm	Dinner

Agenda for June 9:

8:00 am	Suggest contents and structure of GENI measurement data schema, and review possible contributions from key projects

9:30 am	Break
9:45 am	Discuss contents and structure of GENI measurement data schema, summarize consensus and identify gaps
11:15 am	Break
11:30 am	Identify teams for each priority topic, draft action items to close identified gaps, and make writing assignments for revised sections of the architecture document
12:30 pm	Lunch
1:00 pm	Review consensus of GENI I&M use cases; GENI I&M measurement plane, services, interfaces and protocols (APIs); and contents and structure of GENI measurement data schema; and draft roadmap for how key projects could implement them in Spirals 2 and 3
2:00 pm	Adjourn

Participation: Attendance will be limited to invitees. The capacity of the current room is 16+ attendees. Currently, we expect at least 18 attendees to be present, and we are looking to accommodate even a few more if at all possible,

It is important that each attendee come prepared with possible contributions from their project for certain priority topics, as requested by the organizers (coming soon), and be willing to help write revised sections for the architecture document.

Sponsorship: Funding for the workshop will be provided by the NSF through the GPO. This will cover all expenses associated with the workshop itself, including travel expenses for all participants.

Within 30 days upon returning from your trip, please submit a brief invoice, along with receipts for all travel expenses incurred (*including meals*), to BBN Technologies. (See the attached instructions)

Please email your invoice and receipts as a single PDF file to: krich@bbn.com

Organizing Committee:

Paul Barford - University of Wisconsin – Madison (no)
Bruce Maggs – Duke University and Akamai (yes)
Harry Mussman – BBN/GPO (yes)

Vic Thomas - BBN/GPO (yes)
Evan Zhang – BBN/GPO (yes)

Invitee List:
OML (ORBIT Measurement Library) OMF (ORBIT Management Framework)
Max Ott – NICTA (yes, by phone)
Ivan Seskar – Rutgers WINLAB (yes)
Instrumentation Tools
Jim Griffioen - Univ Kentucky (yes)
perfSONAR
Matt Zekauskas - Internet2 (no)
Jason Zurawski – Internet2 (yes)
Martin Swany - Univ Delaware (yes)
Guilherme Fernandes – Univ Delaware (yes)
Ezra Kissel – Univ Delaware (yes)
Scalable Sensing Service (S3)
Sonia Fahmy – Purdue (yes)
Puneet Sharma - HP Labs (yes)
OnTimeMeasure for network measurements
Prasad Calyam - Ohio Supercomputing Ctr (yes)
GENI Meta-Operations Center and NetKArma
Jon-Paul Herron - Indiana Univ (no)
Camilo Viecco - Indiana Univ (yes)
Chris Small - Indiana Univ (yes)
Virtual Machine Introspection (VMI)
Brian Hay – Univ Alaska (yes)
Data-Intensive Cloud Control for GENI
Michael Zink (yes)
Experiment Management Service – Digital Object Registry
Jim French - CNRI (yes)
Giridhar Manepalli - CNRI (yes)

3. GENI I&M Use Cases and Architecture Requirements

Agenda for June 8:

1:15 pm	Suggest a basic set of GENI I&M use cases, and review contributions from key projects
1:45 pm	Discuss basic set of GENI I&M use cases, summarize consensus and identify gaps
2:30 pm	Break

3.1 Suggest a basic set of GENI I&M use cases and architecture requirements

Initial view of I&M vision, requirements, strawman, and WG Objectives for Spiral 2:
Paul Barford, University of Wisconsin, WG Co-Chair
November 18, 2009

Vision for GENI I&M
instrumentation and measurement systems provide broad data gathering, analysis and archieval capability
sufficient for scientific mission
sufficient for operations
key for success of the infrastructure
Requirements
measure details of GENI behavior with high precision and accuracy
no impact on experiments
ubiquitous
extensible
large capacity
high availability
resilient
strong access control
tight integration with CFs
Conceptual strawman
instrumentation - taps in the metwork and systems that provide basic signals
collection and synthesis - programmable systems that collect, combine and transform basic signals
archieve - measurement data index and repository
Instrumentation

link sensors - deployed on network links via taps, provide basic link signals
node sensors - deployed on all systems , provide basic utilization/state/configuration data
time sensors - deployed at all sites, provide fine-grained, synchronized timestamps

Collection and synthesis
programmable systems connected to sensors
transform basic signals into data suitable for more standard analysis
transformations can be more sophisticated
select/transfer protocol moves data from node sensors
short term storage capability

Data archieve
high capacity data repository deployed
data catalog

Security and access control
only accessible by authorized users
different views depending on authorization level
secure
private
some mechanisms defined by CF

An overview of basic GENI I&M use cases:
Ref GIMS_Design_UseCases: "Use-cases for GENI Instrumentation and Measurement Architecture Design", Prasad Calyam - Ohio Supercomputing Ctr

Basic types of I&M services, and requirements:

1) Experiment I&M services
Structure part of Researcher's slice
Configured by Researcher
Measurement data "owned" by Researcher, and they decide who can use it
Can Operator ever see this data?
Needs to be easy to use
Like OMF/OML
Like Instrumentation Tools

2) Network/Testbed I&M services
Structure part of Operator's slice
Structure and basic measurements configured by Operator

2a) Common set of measurement data
In public domain
Advertised

Can be shared with other Operators and Researchers, when authorized by Operator

Like perfSONAR

When used by a Researcher, they are receiving data from multiple slices

2b) Customized sets of measurement data

Each set of data measurement created by a sliver that is part of a slice, typically a slice belonging to a Researcher

Each sliver provides customized data using, for example, distinct filters.

Each set of measurement data “owned” by corresponding Researcher, and they decide who can use it

Like ShadowNet

3) Interoperability of I&M services

Essential for efficient development of I&M structure

Essential for efficient use of I&M structure, including mix of measurement data from both experiment and network/testbed I&M services

Requires services within essentially all Aggregates to exchange data, even when an Aggregate uses private IP space

Interoperability between services needs to be authorized and established via Control Framework mechanisms

One method to authorize communications between services: CF drops keys or credentials into both services

3.2 Review contributions from key projects

Brief contributions from:
OML (ORBIT Measurement Library) OMF (ORBIT Management Framework)
Instrumentation Tools
perfSONAR
Scalable Sensing Service (S3)
OnTimeMeasure for network measurements
GENI Meta-Operations Center and NetKArma
Virtual Machine Introspection (VMI)
Data-Intensive Cloud Control for GENI
Experiment Management Service – Digital Object Registry

3.3 Discuss basic set of GENI I&M use cases and architecture requirements, summarize consensus and identify gaps

What use cases should we document?

Can we agree on basic types of I&M services, and requirements?

What gaps have been identified?

4. GENI I&M Measurement Plane, Services, Interfaces and Protocols

Agenda for June 8:

2:45 pm	Suggest definition of GENI I&M measurement plane, services, interfaces and protocols (APIs), and review possible contributions from key projects
4:15 pm	Break
4:30 pm	Discuss GENI I&M measurement plane, services, interfaces and protocols (APIs), summarize consensus and identify gaps
6:00 pm	Adjourn

4.1 Suggest definition of GENI I&M services

Fig 1-1: I&M Services for Researchers

Fig 1-2: I&M Services for Operators

Fig 1-3: I&M Services

4.2 Review possible contributions from key projects, and discuss

Review how each project maps to the suggested I&M Services:

Fig 2-1: OML (ORBIT Measurement Library) OMF (ORBIT Management Framework)

Fig 2-2: Instrumentation Tools

Fig 2-3: perfSONAR

Fig 2-4: Scalable Sensing Service (S3)

Fig 2-5: OnTimeMeasure for network measurements

Fig 2-6: Data-Intensive Cloud Control for GENI

Note: Flow of measurement data is central to Data-Intensive Cloud Control project. Does this enlarge our view of the I&M architecture?

Fig 2-7: Experiment Management Service – Digital Object Registry

4.3 Summarize consensus and identify gaps

Our consensus is summarized in the following figure:

Fig 1-3b: I&M Services

What gaps have been identified?

4.4 Suggest definition of GENI I&M measurement plane and interfaces

GENI basics:

Includes infrastructure from a wide variety of Aggregates

Resources from any of these aggregates can be included in a Researcher's slice.

GENI backbone networking resources:

Currently provided by Internet 2 and NLR.

Including both IP backbones, and Layer 2 (VLAN) services.

Addresses on the IP backbones are not always reachable from the Internet.

GENI control and experiment traffic:

Control traffic is carried by the Internet and/or Internet2 and NLR backbones, so that a Researcher can setup experiments on GENI, while located at any site, without the need for special network access.

Question: Does this mean that Aggregates and other GENI resources connected to Internet2 or NLR must have publically reachable addresses? Or that the Researcher in this case must have access to the Internet2 or NLR backbones?

Experiment Traffic may be carried on a Layer 2 (VLAN) connections, setup as part of a Researcher's slice, to carry traffic between the included Aggregates.

Layer 2 (VLAN) connections are carried by arrangements of Ethernet switches and/or tunnels.

Some Experiment Traffic may flow to or from the Internet.

This is consistent with current ProtoGENI practice.

GENI Aggregates:

Some (or possibly most) of the Aggregates will have their resources (hosts, etc.) connected via private address space. They will not be directly reachable from the Internet, or Internet2 or NLR backbones.

Experiment Traffic carried by a Layer 2 (VLAN) network connection into the Aggregate will be able to connect with hosts, etc., in their private address space.

The Aggregate Manager is expected to have a public (or reachable) IP address, so that the Researcher can send messages to reserve resources, etc. In turn, it will interact with the hosts.

Some arrangement will be necessary for the Researcher to login to an assigned host in the private address space to load code, etc.

Assume: Researcher can login to a host in the private address space using an SSH Proxy, provided as part of the Aggregate, which has a public (or reachable) IP address.

Assume: Researcher, once logged-in to a host, can use SCP to download code from a repository with a public (or reachable) IP address to a host.

GENI Measurement Traffic:

The flow of GENI Measurement Traffic (the “measurement plane”) has not yet been defined.

We have two obvious choices: Internet, or Internet2 or NLR backbones, like Control Traffic; or an assigned Layer 2 (VLAN) connection like Experiment Traffic.

Some Measurement Traffic will flow between the Researcher and the I&M services, like Control Traffic.

Some Measurement Traffic will flow between I&M services, like Experiment Traffic.

If we require a Layer 2 (VLAN) network connection for Measurement Traffic, it is another complication in setting up I&M services.

Assume: Carry most (if not all) Measurement Traffic like we carry Control Traffic, via Internet, or Internet2 or NLR backbones

Assume: When an I&M service is in an Aggregate with private IP addresses, include proxies (or other access servers) to allow the necessary access.

Assume: Some measurement traffic may be carried via a Layer 2 (VLAN) network connections, but preferably implemented by a tunnel arrangement, to avoid the need for Ethernet switches

This approach is summarized in Fig 3-1.

Fig 3-1: Measurement Traffic Flows

GENI Measurement Traffic Proxies:

Proxies are required when the desired I&M services are located in an Aggregate that uses private IP addresses.

Several proxies are required, depending on the underlying protocol.

Authentication and authorization must be managed by the GENI Control Framework (CF). Is is assumed that this is done by “dropping keys or credentials” into appropriate services.

The suggested proxies are shown in Fig 3-2.

SSH Proxy

HTTP Proxy

VPN Access Server, to provide a tunnel between two Aggregates.

Fig 3-2: Measurement Traffic Proxies

Reference that explains two approaches to HTTP-based web services:

Ref MeasPlane-1: RESTful Web Services vs. “Big” Web Services:
Making the Right Architectural Decision

4.5 Review possible contributions from key projects, and discuss

OML (ORBIT Measurement Library) OMF (ORBIT Management Framework):
Carries measurement traffic between hosts and services within a site via a dedicated VLAN.

Instrumentation Tools
Follows protoGENI arrangements, and carries measurement traffic like control traffic, using Internet2 backbone.

perfSONAR
Carries measurement traffic over backbone IP network

Scalable Sensing Service (S3)
Carries measurement traffic over backbone IP network

OnTimeMeasure for network measurements
Carries measurement traffic over backbone IP network

GENI Meta-Operations Center and NetKarma

Virtual Machine Introspection (VMI)

Data-Intensive Cloud Control for GENI
Carries measurement data over VLAN connection

Experiment Management Service – Digital Object Registry

Suggested:
Continue discussion after we consider interfaces and protocols.

4.6 Suggest definition of GENI I&M interfaces and protocols (APIs)

Referring to Fig 1-3, we define these I&M interfaces and messages/flows/APIs:

1) Discover Resources and Assign Slivers: EC srvc uses CF to discover resources, and then assign slivers to slice/researcher for I&M srvc's

2) Configure and Program Slivers: EC srvc uses CF and/or ssh to load std or customized software images for I&M srvc's

Note: 1) and 2) are not specific to I&M services

3) Manage Services: EC srvc and MO srvc use CF and/or https to check status of I&M srvcs, receive event notifications, and execute functions such as start, stop, reset, reboot, and checkpoint

4) Measurement Data Flows: Measurement data flows between I&M srvcs. Two options: Pull and Push.

5) Measurement Data File Transfers: Measurement data file transfers between I&M srvcs. Expect to Pull from and Push to Repository

6) Register I&M Service: Operator configures I&M srvc to register with Lookup Srvc, advertising name, location, and available metadata

7) Discover I&M Service and Establish Meas Data Flow: ECS or I&M srvc discovers I&M srvc advertisement, and establishes data flow

8) Conduct and Observe Experiment: Researcher uses browser to interact with and observe services via web portals

Fig 1-3: I&M Services

4.7 Review possible contributions from key projects

4.7.1 OML (ORBIT Measurement Library) OMF (ORBIT Management Framework)

Summary:
Fig 4-1: OMF/OML Services and Messages

Also these references:
Fig 4-2: OML Component Architecture
Fig 4-3: OMF/OML Overview
Fig 4-4: ORBIT Network Diagram

Ref OMF_OML-1: "XDR: External Data Representation Standard"
Ref OMF_OML-2: "ORBIT Measurements Framework and Library (OML): Motivations, Design, Implementation, and Features"
Ref OMF-OML-3: "OML Overview" slides
Ref OMF-OML-4: "Measurement Architectures for Network Experiments with Disconnected Mobile Nodes"

Interfaces and protocols:

3) Manage Services

Via HTTP to all srvc's, with APIs based on REST.

Via HTTP to OML Client srvc, to config files specifying filtering and streaming, which are then compiled into code

4) Measurement Data Flows

Researcher defines measurement streams, gathering data samples and averaging, etc.

Meas data is series of typed vectors, XDR coded, and then streamed from client to collection server using proprietary OML protocol, on top of TCP, over dedicated Control VLAN

Considering using IPFIX instead of prop OML protocol; IPFXI typically uses SCTP for transport

If path becomes disconnected from time-to-time. data is cached in Proxy Server FIFO, and then forwarded when path is reestablished

5) Measurement Data File Transfers

Meas Analysis Present Srvc running outside of OMF/OML.

Can import directly from SQL DB

EC can arrange to convert tables into graphs

6) Register I&M Service
7) Discover I&M Service and Establish Meas Data Flow
8) Conduct and Observe Experiment

Experiment Portal early prototype

Each experiment results in a separate page containing all the experiment related information (script, parameter, resources used, time) as well as a pointer to the measurement database.

Where?

4.7.2 Instrumentation Tools

Summary:

Fig 5-1: Instrumentation Tools Services and Messages

Also these references:

Fig 5-2: Instrumentation Tools Components

Fig 5-3: Instrumentation Tools Topology

Ref InsTools-1: "Architectural Design and Specification of the INSTOOLS Measurement System"

Interfaces and protocols:

3) Manage Services
   - MC Srvc has collection control software
   - MP Srvc includes remote access daemon to execute capture software

4) Measurement Data Flows
   - MC Srvc gets data from MP Srvc via SSH/SCP
   - MC Srvc gets data from MP Srvc via SNMP
   - Emulab (ssh) key distribution mechanism used to authorize MC to get data from MPs

5) Measurement Data File Transfers

6) Register I&M Service

7) Discover I&M Service and Establish Meas Data Flow

8) Conduct and Observe Experiment
   - Portal to MCs, then GUI in MCs displays data as table or graph

4.7.3 perfSONAR

Summary:

Fig 6-1: perfSONAR Services and Messages

Also these references:

Fig 6-2: perfSONAR Measurement data Schema

Ref perfSONAR-1: "Scalable Framework for Representation and Exchange of Network Measurements"
Ref perfSONAR-2: "An Extensible Schema for Network Measurement and Performance Data"
Ref perfSONAR-3: "NM-WG/perfSONAR Topology Schema"

Interfaces and protocols:

3) Manage Services

Manage Services GUI: perfAdmin (CGI script to locate and manage perfSONAR services and data)

How does this work?

4) Measurement Data Flows

Pulls data from MA srvc, with these messages:
Echo Request
Metadata Key Request
Setup Data Request

Note:

All perfSONAR Messages
addressed to each service at a service URL
formatted in XML using SOAP over HTTP
always a Request and then a Response
(currently) no encryption
(currently) no authentication and authorization
(since Authentitcation Srvc (AS) not yet built or deployed)

Note:

Each message follows perfSONAR schema, and contains;
message container
one or more one metadata elements
zero or more data elements

5) Measurement Data File Transfers

6) Register I&M Service

Each MA service registers with LS service
homeLS registers with globalLS
globalLS updates other globalSL
LS Register Request
LS Deregister Request
LS Keepalive Request
Also, operator (?) registers topology information, with these messages:
TS Query Request
TS Add Request
TS Update Request
TS Replace Request

7) Discover I&M Service and Establish Meas Data Flow

Client can discover service and gain access to data using these messages:
LS Query Request - XQuery
LS Query Request – Discovery
LS Key Request

8) Conduct and Observe Experiment
   GUI types on MAP srvc includes:
   active Service
   GMAPS
   acad (Java-based visualization)
   E2EMon (link monitoring)
   ESNet (domain utilization)
   trace (traceroute visualization)
   perfAdmin (CGI script to locate and manage perfSONAR services and data)
   perfER GUI (displys the results of pingER testing)
   perfSONAR-BUOY (displays the results of latency and bandwidth testing)

4.7.4 Scalable Sensing Service (S3)

Summary:

Fig 7-1: Scalable Sensing Services (S3) Services and Messages

Interfaces and protocols:

3) Manage Services
   Via HTTP to GUI on Sensing Info Mgmt Backplane
   Via HTTP to GUI on Sensor Pods
   How?
4) Measurement Data Flows
   Pull via HTTP from Sensor Pod web intfc
   Query, specified by URL parameters
   Control?
   Notification?
5) Measurement Data File Transfers
6) Register I&M Service
7) Discover I&M Service and Establish Meas Data Flow
8) Conduct and Observe Experiment
   GUI on Sensing Info Mgmt Backplane

4.7.5 OnTimeMeasure for network measurements

Summary:

Fig 8-1: OnTimeMeasure Services and Messages

Interfaces and protocols:

3) Manage Services
4) Measurement Data Flows
   Pull via HTTP from Node Beacon and Root Beacon web interfaces?
5) Measurement Data File Transfers
6) Register I&M Service
7) Discover I&M Service and Establish Meas Data Flow
8) Conduct and Observe Experiment
   Via HTTP from GUI on Policy/Publish Authority?

4.7.6 Data-Intensive Cloud Control for GENI

Summary:
Fig 9-1: Data Intensive Cloud Services and Messages

Interfaces and protocols:
3) Manage Services
4) Measurement Data Flows
   A large amount of radar data flows “in real time” from radar system, through ViSE server, to Amazon EC2 and S3 resources, where it is collected and analyzed
   Radar data follows NetCDF format.
   Radar data flows to Amazon public IP address. How is this done? Push or pull? Always as a file? How? Streamed in chunks? How?
   One option: File transferred with ftp (or equivalent)
   One option: File transferred with OPenDAP, that uses http to transfer data that can be in NetCDF format.
5) Measurement Data File Transfers
6) Register I&M Service
7) Discover I&M Service and Establish Meas Data Flow
8) Conduct and Observe Experiment

4.7.7 Digital Object Registry

Summary:
Fig 10-1: DOR MDA Service Services and Messages

Also these references:
Fig 10-2: DOR MDA Service File Organization

Interfaces and protocols:
3) Manage Services
4) Measurement Data Flows
5) Measurement Data File Transfers
   Interfaces to the MDA srvc include: https; scp or sftp

From another I&M srvc, MDA srvc can provide these basic functions: put/update file; get file; delete file

When file is first introduced, it is assumed that file contains type info (extension), metadata, and "file self description" info. A wide range of files and associated metadata is permitted by the MDA srvc.

Each file is "owned" by a GENI slice and one or more users (operators/researchers)

MDA srvc allows the owner to specify who has read and/or write access to the file.

MDA srvc utilizes the mechanisms provided by the CF to authenticate and authorize users.

Assume: CF drops public keys of authorized users into MDA srvc, so that: presence of key indicates an "account" on the MDA srvc; additional info indicates nature of access (CNRI)

6) Register I&M Service
7) Discover I&M Service and Establish Meas Data Flow
8) Conduct and Observe Experiment

4.8 Discuss GENI I&M interfaces and protocols (APIs)

Summary of interfaces and protocols from all projects:

3) Manage Services

OMF/OML:

Via HTTP to all srvc's, with APIs based on REST.

Instrumentation Tools:

MC Srvc has collection control software

MP Srvc includes remote access daemon to execute capture software

perfSONAR:

Manage Services GUI: perfAdmin (CGI script to locate and manage perfSONAR services and data)

How does this work?

Scalable Sensing Service:

Via HTTP to GUI on Sensing Info Mgmt Backplane

Via HTTP to GUI on Sensor Pods

How?

4) Measurement Data Flows

OMF/OML:

Meas data is series of typed vectors, XDR coded, and then streamed from client to collection server using proprietary OML protocol, on top of TCP, over dedicated Control VLAN

Considering using IPFIX instead of prop OML protocol; IPFXI typically uses SCTP for transport

If path becomes disconnected from time-to-time. data is cached in Proxy Server FIFO, and then forwarded when path is reestablished

Instrumentation Tools:

MC Srvc gets data from MP Srvc via SSH/SCP

MC Srvc gets data from MP Srvc via SNMP

Emulab (ssh) key distribution mechanism used to authorize MC to get data from MPs

perfSONAR:

Pulls data from MA srvc, with these messages:

Echo Request

Metadata Key Request

Setup Data Request

Note:

All perfSONAR Messages

addressed to each service at a service URL

formatted in XML using SOAP over HTTP

always a Request and then a Response

(currently) no encryption
(currently) no authentication and authorization
(since Authentitcation Srvc (AS) not yet built or deployed)
Note:
Each message follows perfSONAR schema, and contains;
message container
one or more one metadata elements
zero or more data elements

Scalable Sensing Service:
Pull via HTTP from Sensor Pod web intfc
Query, specified by URL parameters
Control?
Notification?

OnTimeMeasure:
Pull via HTTP from Node Beacon and Root Beacon web interfaces?

Data-Intensive Cloud Control;

A large amount of radar data flows "in real time" from radar system, through ViSE server, to Amazon EC2 and S3 resources, where it is collected and analyzed

Radar data follows NetCDF format.

Radar data flows to Amazon public IP address. How is this done? Push or pull? Always as a file? How? Streamed in chunks? How?

One option: File transferred with ftp (or equivalent)

One option: File transferred with OPenDAP, that uses http to transfer data that can be in NetCDF format.

5) Measurement Data File Transfers

OMF/OML:

Meas Analysis Present Srvc running outside of OMF/OML can import directly from SQL DB

DOR:

Interfaces to the MDA srvc include: https; scp or sftp

From another I&M srvc, MDA srvc can provide these basic functions: put/update file; get file; delete file

When file is first introduced, it is assumed that file contains type info (extension), metadata, and "file self description" info. A wide range of files and associated metadata is permitted by the MDA srvc.

Each file is "owned" by a GENI slice and one or more users (operators/researchers)

MDA srvc allows the owner to specify who has read and/or write access to the file.

MDA srvc utilizes the mechanisms provided by the CF to authenticate and authorize users.

Assume: CF drops public keys of authorized users into MDA srvc, so that: presence of key indicates an "account" on the MDA srvc; additional info indicates nature of access (CNRI)

6) Register I&M Service
    perfSONAR:
    Each MA service registers with LS service
    homeLS registers with globalLS
    globalLS updates other globalSL
    LS Register Request
    LS Deregister Request
    LS Keepalive Request
    Also, operator (?) registers topology information, with these messages:
    TS Query Request
    TS Add Request
    TS Update Request
    TS Replace Request

7) Discover I&M Service and Establish Meas Data Flow
    perfSONAR:
    Client can discover service and gain access to data using these messages:
    LS Query Request - XQuery
    LS Query Request – Discovery
    LS Key Request

8) Conduct and Observe Experiment
    OMF/OML:
    Experiment Portal
    Instrumentation Tools:
    Portal to MCs, then GUI in MCs displays data as table or graph
    perfSONAR:
    Many GUI types on MAP srvc
    Scalable Sensing Service:
    GUI on Sensing Info Mgmt Backplane
    OnTimeMeasure:
    Via HTTP from GUI on Policy/Publish Authority?

4.9 Summarize consensus and identify gaps

Possible consensus set of GENI interfaces and protocols:

3) Manage Services

Consider all contributions, but particularly OMF/OML and perfSONAR

a) Via HTTP (or HTTPS) to all services, standardized API, following SOAP to allow use of credentials that flow through HTTP proxy

4) Measurement Data Flows

Define a variety of supported flows

Both pull and push

Both repeated transactions and streaming

a) Pull with repeated transactions via SSH/SCP

Like **Instrumentation Tools:**

MC Srvc gets data from MP Srvc via SSH/SCP

Emulab (ssh) key distribution mechanism used to authorize MC to get data from MPs

Restricted to one site?

b) Pull with repeated transactions via SNMP

Like **Instrumentation Tools:**

MC Srvc gets data from MP Srvc via SNMP

Emulab (ssh) key distribution mechanism used to authorize MC to get data from MPs

Restricted to one site?

c) Pull with repeated transactions via HTTP (HTTPS), can use HTTP proxy to traverse some site boundaries

Like **perfSONAR:**

Pulls data from MA srvc

All perfSONAR Messages

addressed to each service at a service URL

formatted in XML using SOAP over HTTP

always a Request and then a Response

(currently) no encryption

(currently) no authentication and authorization

Each message follows perfSONAR schema, and contains;

message container

one or more one metadata elements

zero or more data elements

But consider also **Scalable Sensing Service** and **OnTimeMeasure:**

d) Consider (?) push with repeated transactions via HTTP (HTTPS); can use HTTP proxy to traverse site boundaries

e) Push stream via TCP or SCTP; needs VPN Access Server (or VLAN connection) to traverse site boundaries

Like **OMF/OML:**

Meas data is series of typed vectors, XDR coded, and then streamed from client to collection server using proprietary OML protocol, on top of TCP, over dedicated Control VLAN

Considering using IPFIX instead of prop OML protocol; IPFXI typically uses SCTP for transport

If path becomes disconnected from time-to-time. data is cached in Proxy Server FIFO, and then forwarded when path is reestablished

f) Push high-bandwidth stream via TCP or SCTP, needs VPN Access Server (or VLAN connection) to traverse some site boundaries

Like: **Data-Intensive Cloud Control:**

A large amount of radar data flows "in real time" from radar system, through ViSE server, to Amazon EC2 and S3 resources, where it is collected and analyzed

Radar data follows NetCDF format.

Radar data flows to Amazon public IP address. How is this done? Push or pull? Always as a file? How? Streamed in chunks? How?

One option: File transferred with ftp (or equivalent)

One option: File transferred with OPenDAP, that uses http to transfer data that can be in NetCDF format.

5) Measurement Data File Transfers

a) Define a basic method to push or pull files, using HTTPS, SCP or perhaps SFTP

Like **DOR:**

Interfaces to the MDA srvc include: https; scp or sftp

From another I&M srvc, MDA srvc can provide these basic functions: put/update file; get file; delete file

When file is first introduced, it is assumed that file contains type info (extension), metadata, and "file self description" info. A wide range of files and associated metadata is permitted by the MDA srvc.

Each file is "owned" by a GENI slice and one or more users (operators/researchers)

MDA srvc allows the owner to specify who has read and/or write access to the file.

MDA srvc utilizes the mechanisms provided by the CF to authenticate and authorize users.

Assume: CF drops public keys of authorized users into MDA srvc, so that: presence of key indicates an "account" on the MDA srvc; additional info indicates nature of access (CNRI)

6) Register I&M Service

a) Messages formatted in XML using SOAP over HTTP to Lookup Service

Like **perfSONAR:**

Which GENI services should be registered? Even those dedicated to experiments?

7) Discover I&M Service and Establish Meas Data Flow

a) Messages formatted in XML using SOAP over HTTP to Lookup Service and other services

Like **perfSONAR:**

8) Conduct and Observe Experiment

a) HTTP (HTTPS) to GUIs at web services.

Following SOAP so that credentials can pass through HTTP proxies
Many GUIs have been defined and can be used

Is there anything standardized about these GUIs?

Can we reach a consensus on defining these interfaces and protocols?

Which gaps have been identified?

4.10 Discuss GENI I&M measurement plane and interfaces, summarize consensus and identify gaps

Based upon our discussion of interfaces and protocols, can we agree on modified measurement traffic flows and proxies?

Fig 3-1b: Measurement Traffic Flows

Fig 3-2b: Measurement Traffic Proxies

What gaps have been identified?

5. GENI Measurement Data Schema

Agenda for June 9:

8:00 am	Suggest contents and structure of GENI measurement data schema, and review possible contributions from key projects
9:30 am	Break
9:45 am	Discuss contents and structure of GENI measurement data schema, summarize consensus and identify gaps
11:15 am	Break

5.1 Suggest contents and structure of GENI measurement data schema

GENI measurement data schemas:

Multiple schemas will be defined and used within GENI, reflecting many different I&M arrangements

Examples from current projects:

a) perfSONAR defines certain network measurements, identifies source and/or point of measurement, and stores time, value pairs (not arrays, that I can tell)

b) OMF/OML has researchers define experiments, and collect data. No metadata, since researcher knows what it is. Probably time, value pairs, but I suppose it could be arrays.

c) ViSE radar collects arrays of data, following one of the NetCDF formats; later, can be used as input to well-defined visualization programs.

Definition of a GENI measurement data schema:

1) Mechanism:
    - Packets of chunks, in messages or flows
    - Files or records, in transfers or storage

2) Format of data:
    - Text
    - Bytes
    - Binary

3) Metadata:
    - How attached
    - Format of contents

How is GENI measurement data schema defined?

Contents of metadata:

1) Flow or record identifier (1 or more):
    - Index
    - Local
    - Globally unique
2) Annotation, for identification and/or searching (1 or more):
    - Slice, experiment, run
    - Researcher's notes
3) Provenance:
    - Owner, contact
    - Access rules
    - Encryption
4) Privacy:
    - Type of private info
    - Access rules
    - Anonymity applied
5) Processing of data (zero or more):
    - Where, when, what
    - Filters applied
6) Collection of data
    - Where, when, what
    - Filters applied
7) Description of data:
    - Time and value, pairs or tuples
    - Logs or events, with timestamps
    - File(s)
    - Binary images

5.2 Review possible contributions from key projects

5.2.1 OML (ORBIT Measurement Library) OMF (ORBIT Management Framework)

Summary:
Fig 4-1: OMF/OML Services and Messages

References:
Ref OMF_OML-1: RFC4506 – XDR: External data Representation Standard
Ref OMF_OML-2: "ORBIT Measurements Framework and Library (OML): Motivations, Design, Implementation, and Features"
Ref OMF-OML-3: "OML Overview" slides
Ref OMF-OML-4: "Measurement Architectures for Network Experiments with Disconnected Mobile Nodes"

Interfaces and protocols:

4) Measurement Data Flows

Researcher defines measurement streams, gathering data samples and averaging, etc.

Meas data is series of typed vectors, XDR coded, and then streamed from client to collection server using proprietary OML protocol, on top of TCP, over dedicated Control VLAN

Considering using IPFIX instead of prop OML protocol; IPFXI typically uses SCTP for transport

If path becomes disconnected from time-to-time. data is cached in Proxy Server FIFO, and then forwarded when path is reestablished

5) Measurement Data File Transfers

Meas Analysis Present Srvc running outside of OMF/OML.
Can import directly from SQL DB
EC can arrange to convert tables into graphs

Measurement data schema:

4b) Measurement data flow schema:

Meas data follows schema defined by researcher, including: measurement-point id's, metric id's, etc.

A sensor (or application, or service) define a set of measurement points, with each measurement point defined by a name and a typed vector (sensor schema).

At runtime, the experimenter (or operator) provides a streams spec which defines what measurement points are going to be activated and what initial processing is going to be performed - that defines the actual schema going over the wire and/or ending up in the collection database

5b) Measurement data storage schema:

Application definition is used to create DB schema for experiment, using XSLT.

DB table is created for each measurement point, names based on id attribute of the group element.

Includes mandatory fields for name/id, timestamp, sequence number

Protocol is self describing

Server automatically creates a table for every distinct stream (distinct in terms of schema not source).

Streams carry their own name which is translated into a database using a simple naming convention.

5.2.2 Instrumentation Tools

Summary:

Fig 5-1: Instrumentation Tools Services and Messages

Interfaces and protocols:

4) Measurement Data Flows

MC Srvc gets data from MP Srvc via SSH/SCP

MC Srvc gets data from MP Srvc via SNMP

Emulab (ssh) key distribution mechanism used to authorize MC to get data from MPs

Measurement data schema:

4b) Measurement data flow schema:

N/A?

5b) Measurement data storage schema:

Internal to Measurement Controller?

What?

5.2.3 perfSONAR

Summary:

Fig 6-1: perfSONAR Services and Messages

Also these references:

Fig 6-2: perfSONAR Measurement data Schema

Ref perfSONAR-1: "Scalable Framework for Representation and Exchange of Network Measurements"
Ref perfSONAR-2: "An Extensible Schema for Network Measurement and Performance Data"
Ref perfSONAR-3: "NM-WG/perfSONAR Topology Schema"

Interfaces and protocols:

4) Measurement Data Flows

Pulls data from MA srvc, with these messages:
Echo Request
Metadata Key Request
Setup Data Request

Note:

All perfSONAR Messages
addressed to each service at a service URL
formatted in XML using SOAP over HTTP
always a Request and then a Response
(currently) no encryption
(currently) no authentication and authorization
(since Authentitcation Srvc (AS) not yet built or deployed)

Note:

Each message follows perfSONAR schema, and contains;
message container
one or more one metadata elements
zero or more data elements

Measurement data schema:

4b) Measurement data flow schema:

5b) Measurement data storage schema:

Follows perfSONAR schema, and contains;
message container
one or more one metadata elements
zero or more data elements

From Ref perfSONAR-1

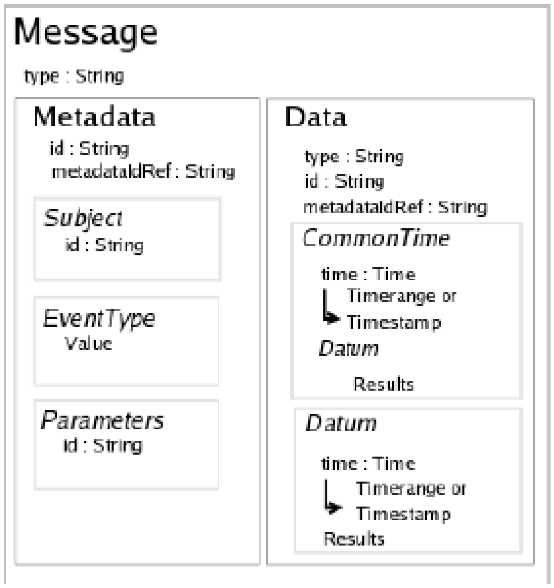

Figure 1. NM-WG Base Schema

The metadata section is subdivided into three parts, only the first of which is required:

- Subject – The physical or logical entity being described. For example, a host pair or router address. Like the subject of the sentence: *Host A to Host B* measured ICMP latency is 100ms.
- EventType – The canonical name of the aspect of the subject being measured, or the actual event (i.e. "characteristic") being sought. Like the object of the sentence: Host A to Host B *measured ICMP latency* is 100ms.
- Parameters – The way in which the description is being gathered or performed. For example, command-line arguments to *traceroute* or whether the round-trip delay packet used ICMP or UDP. Like the descriptive clause of the sentence: *When you use 100 byte packets*, Host A to Host B ICMP latency is 100ms.

Topology schema:

From Ref perfSONAR-3:

Structured by layers and the same elements recurring there

- Varied by namespaces
- Reuse visualization logic, etc.
- Validate layer- or technology-specific attributes
- 4 Layers: Base (both abstract and L1), L2, L3, L4

Identifiers use URN notation

- Prefixed with “urn:ogf:network:”
- Consists of name/value pairs separated by colons
- Possible field names: domain, node, port, link, path, network
- Set of rules defined for each field to keep identifiers compact and finite

Use Case:

- A client would use a topology service to look up the identifier for a network element and then would query a lookup service using the identifier to find the measurements associated with that element.

5.2.4 Scalable Sensing Service (S3)

Summary:

Fig 7-1: Scalable Sensing Services (S3) Services and Messages

Interfaces and protocols:

4) Measurement Data Flows

Pull via HTTP from Sensor Pod web intfc
Query, specified by URL parameters
Control?
Notification?

Measurement data schema:

4b) Measurement data flow schema:

What?

5b) Measurement data storage schema:

What?

5.2.5 OnTimeMeasure for network measurements

Summary:

Fig 8-1: OnTimeMeasure Services and Messages

Interfaces and protocols:

4) Measurement Data Flows

Pull via HTTP from Node Beacon and Root Beacon web interfaces?

Measurement data schema:

4b) Measurement data flow schema:

What?

5b) Measurement data storage schema:

What?

5.2.6 GENI Meta-Operations Center and NetKarma

Reference:
Ref GMOC-1: "GMOC Topology-Entity Data Exchange Format Specification"
Ref GMOC-2: "Proposal: Use of URN's as GENI Identifiers"

Measurement data schema:

4b) Measurement data flow schema:

5b) Measurement data storage schema:

From Ref GMOC-1:

Identifiers, encodings, and field sizes

We assume that at slices and devices are uniquely identified in GENI-wide by a human readable name. Names character set can be any unicode representable character set, but they must be encoded using UTF-8. Names are limited in size to 128 octets (bytes).

Principals are uniquely identified GENI-wide by a primary email address. Principals given names and last names are limited to 40 bytes. The email address is limited to 128 bytes.

Locations are uniquely identified (in the scope of each exchange document) by a human readable name.The minimal specification for a location is either the tuple (city, state_province, mail_code, country) or by the tuple (longitude and latitude).

Organizations are uniquely identified (in the scope of each exchange document) by a human readably name. These names are limited to 60 bytes.

Device's interfaces can be uniquely identified within a device by a device specific unique name. It is assumed that this name binding will be remain unique for subsequent documents as long as there are no changes in configuration of either the interface or the device.

Data model

In our data model every network device is considered a device. Devices can have a single parent device. The graph of the parent-hood for devices is a forest (a set of trees) .Slivers are modeled as virtual devices, that is a device with a parent device. Slices can be associated with both slivers and full devices. Each device can be associated with one sliver at most, this the graph of the relationship of slivers and devices is another forest.

A circuit is any network connection, between two or more devices. Circuits refer to any layer in the network stack and can be connected to any interface. Circuits can be build a multiplicity of other circuits. A circuit can be part of multiple circuits. The graph of circuit relationships is a disjoint set of directed acyclic graphs.

Data format

The date exchange format is defined using the relax-NG compact syntax as follows:

```
datatypes xsd = "http://www.w3.org/2001/XMLSchema-datatypes"
grammar {

start = element geni_aggregate {geni_aggregate-content}

geni_aggregate-content =
  attribute name {text},
  attribute public_key{text}?,
  element location {location-content}+,
  element contact  {contact-content}+,
  element organization {organization-content}+,
  element point_of_presence {pop-content}+,
  element device {device-content}+,
  element slice {slice-content}*,
  element net_topology {net_topology-content}

  location-content =
     attribute name {text},
     ( element address {address-content} |
       element geo_location {geo_location-content} |
       ( element address {address-content} ,

        element geo_location {geo_location-content} ) )

address-content =
   attribute address {text}?,
   attribute city    {text},
   attribute province {text},
   attribute country  {text}

geo_location-content =
   attribute latitude {xsd:double},
   attribute longitude {xsd:double}

contact-content=
   attribute email_address {text},
   attribute last_name {text},
   attribute given_names {text},
   attribute phone {text}?,
   attribute organization_name {text}?

organization-content=
   attribute name{text},
   element   primary_contact_email {text},
   element   location_name {text},
   element   parent_organization_name {text}?,
   element   url {text}?
```

```
pop-content =
     attribute name{text},
     attribute location_name{text},
     element  operator_org_name{text}?,
     element  admin_org_name{text}?

administrative_state-content =
     attribute state {"Planning"|"Provisioning"|"Available"|"NormalOperation"|
Maintenance" |"Unknown" | "Decomissioned"}

operational_state-content =
     attribute state {"Up" | "Degraded" | "Down" | "Unknown"}

device-content =
    attribute name {text},
    element  device_location {device_location-content},
    element  operator_org_name {text},
    element  admin_org_name {text}?,
    element  device_type {text},
    element  sw_version {text}?,
    element  hw_version {text}?,
    element  operational_state {operational_state-content}?,
    element  administrative_state {administrative_state-content}?,
    element  interface {interface-content}*

device_location-content =
     element pop_name {text} |
     element parent_device_name {text}

interface-content =
     attribute name {text},
     element contracted_bw {xsd:double}?,
     element max_bps        {xsd:double}?,
     element administrative_state {administrative_state-content}?,
     element net_addr {net_addr-content}*

net_addr-content =
     element net_addr_type {text},
     element addr{text},
     element netmask{text}

slice-content =
     attribute name {text},
     element   operator_org_name {text},
     element   primary_contact_email {text},
     element   device_names {text}+

net_topology-content =
     element  network {network-content}+,
     element  circuit {circuit-content}+,
     element  circuit_hierarchy {circuit_hierarchy-content}*
```

```
network-content =
    attribute name {text},
    element   operator_org_name {text}?,
    element   admin_org_name {text}?

circuit-content =
    attribute name {text},
    attribute circuit_type {text},
    element   channel {xsd:integer}?,
    element   reserved_bw {xsd:integer}?,
    element   vlan {xsd:integer}?,
    element   circuit_endpoint {circuit_endpoint-content}*

circuit_endpoint-content =
    attribute   device_name {text},
    attribute   interface_name {text}

circuit_hierarchy-content =
    element   upper_circuit_name {text},
    element   lower_circuit_name {text}
}
*
```

5.2.7 Virtual Machine Introspection (VMI)

Measurement data schema:

4b) Measurement data flow schema:

Suggestions by Brian Hay?

5b) Measurement data storage schema:

Suggestions by Brian Hay?

5.2.8 Data-Intensive Cloud Control for GENI

Summary:

Fig 9-1: Data Intensive Cloud Services and Messages

Interfaces and protocols:

4) Measurement Data Flows

A large amount of radar data flows "in real time" from radar system, through ViSE server, to Amazon EC2 and S3 resources, where it is collected and analyzed

Radar data follows NetCDF format.

Radar data flows to Amazon public IP address. How is this done? Push or pull? Always as a file? How? Streamed in chunks? How?

One option: File transferred with ftp (or equivalent)

One option: File transferred with OPenDAP, that uses http to transfer data that can be in NetCDF format.

5) Measurement Data File Transfers

Measurement data schema:
4b) Measurement data flow schema:
5b) Measurement data storage schema:
Radar data follows NetCDF format.
Radar data flows to Amazon public IP address. How is this done? Push or pull? Always as a file? How? Streamed in chunks? How?
One option: File transferred with ftp (or equivalent)
One option: File transferred with OPenDAP, that uses http to transfer data that can be in NetCDF format.

5.2.9 Digital Object Registry

Summary:
Fig 10-1: DOR MDA Service Services and Messages

Also these references:
Fig 10-2: DOR MDA Service File Organization

Interfaces and protocols:
5) Measurement Data File Transfers
Interfaces to the MDA srvc include: https; scp or sftp
From another I&M srvc, MDA srvc can provide these basic functions: put/update file; get file; delete file
When file is first introduced, it is assumed that file contains type info (extension), metadata, and "file self description" info. A wide range of files and associated metadata is permitted by the MDA srvc.
Each file is "owned" by a GENI slice and one or more users (operators/researchers)
MDA srvc allows the owner to specify who has read and/or write access to the file.
MDA srvc utilizes the mechanisms provided by the CF to authenticate and authorize users.
Assume: CF drops public keys of authorized users into MDA srvc, so that: presence of key indicates an "account" on the MDA srvc; additional info indicates nature of access (CNRI)

Measurement data schema:
5b) Measurement data storage schema:
From another I&M srvc, MDA srvc can provide these basic functions: put/update file; get file; delete file

When file is first introduced, it is assumed that file contains type info (extension), metadata, and “file self description” info. A wide range of files and associated metadata is permitted by the MDA srvc.

5.3 Discuss contents and structure of GENI measurement data schema, summarize consensus and identify gaps

Can we agree:

Multiple schemas will be defined and used within GENI, reflecting different I&M arrangements

Can we agree to include schemas that describe these different I&M arrangements:

a) perfSONAR defines certain network measurements, identifies source and/or point of measurement, and stores time, value pairs (not arrays, that I can tell)

b) OMF/OML has researchers define experiments, and collect data. No metadata, since researcher knows what it is. Probably time, value pairs, but I suppose it could be arrays.

c) ViSE radar collects arrays of data, following one of the NetCDF formats; later, can be used as input to well-defined visualization programs.

d) Are there additional I&M arrangements that need to be described?

Can we agree on the following approach to defining a schema?

1) Mechanism:
    - Packets of chunks, in messages or flows
    - Files or records, in transfers or storage
2) Format of data:
    - Text
    - Bytes
    - Binary
3) Metadata:
    - How attached
    - Format of contents

Can we describe the schema for perfSONAR-like data?
Can we describe the schema for OMF/OML-like data?
Can we describe the schema for ViSE-like data?

Can we agree on the following contents in metadata?

1) Flow or record identifier (1 or more):
    - Index
    - Local
    - Globally unique
2) Annotation, for identification and/or searching (1 or more):
    - Slice, experiment, run
    - Researcher's notes
3) Provenance:
    - Owner, contact
    - Access rules

Encryption

4) Privacy:
    Type of private info
    Access rules
    Anonymity applied
5) Processing of data (zero or more):
    Where, when, what
    Filters applied
6) Collection of data
    Where, when, what
    Filters applied
7) Description of data:
    Time and value, pairs or tuples
    Logs or events, with timestamps
    File(s)
    Binary images
8) Are there other items that may need to be included?

Can we map the metadata contents to GMOC-requested data?
Can we map the metadata contents to perfSONAR-like data?
Can we map the metadata contents to OMF/OML-like data?
Can we map the metadata contents to ViSE-like data?

Can we agree which metadata is required for all schemas?

6. Identify Teams for Each Priority Topic

Agenda for June 9:

11:30 am	Identify teams for each priority topic, draft action items to close identified gaps, and make writing assignments for revised sections of the architecture document
12:30 pm	Lunch

6.1 Identify teams for each priority topic, and make writing assignments for revised sections of the architecture document

Priority topics:

1) GENI I&M use cases

2) GENI I&M services

3) GENI I&M measurement plane and interfaces

4) GENI I&M interfaces and protocols (APIs)

5) GENI measurement data schema

Potential team members:

OML (ORBIT Measurement Library) OMF (ORBIT Management Framework)
Max Ott – NICTA (yes, by phone)
Ivan Seskar – Rutgers WINLAB (yes)

Instrumentation Tools
Jim Griffioen - Univ Kentucky (yes)

perfSONAR
Matt Zekauskas - Internet2 (no)
Jason Zurawski – Internet2 (yes)
Martin Swany - Univ Delaware (yes)
Guilherme Fernandes – Univ Delaware (yes)
Ezra Kissel – Univ Delaware (yes)

Scalable Sensing Service (S3)
Sonia Fahmy – Purdue (yes)
Puneet Sharma - HP Labs (yes)

OnTimeMeasure for network measurements
Prasad Calyam - Ohio Supercomputing Ctr (yes)

GENI Meta-Operations Center and NetKArma

Jon-Paul Herron - Indiana Univ

Camilo Viecco - Indiana Univ (yes)

Chris Small - Indiana Univ (yes)

Virtual Machine Introspection (VMI)

Brian Hay – Univ Alaska (yes)

Data-Intensive Cloud Control for GENI

Michael Zink (yes)

Experiment Management Service – Digital Object Registry

Jim French - CNRI (yes)

Giridhar Manepalli - CNRI (yes)

6.2 Draft action items to close identified gaps

Which are the key action items?

7. Review Consensus and Draft Roadmap

Agenda for June 9:

1:00 pm	Review consensus of GENI I&M use cases; GENI I&M measurement plane, services, interfaces and protocols (APIs); and contents and structure of GENI measurement data schema; and draft roadmap for how key projects could implement them in Spirals 2 and 3
2:00 pm	Adjourn

7.1 Review consensus of GENI I&M use cases; GENI I&M measurement plane, services, interfaces and protocols (APIs); and contents and structure of GENI measurement data schema

How close are we to consensus on each of these priority topics:

1) GENI I&M use cases

2) GENI I&M services

3) GENI I&M measurement plane and interfaces

4) GENI I&M interfaces and protocols (APIs)

5) GENI measurement data schema

7.2 Draft roadmap for how key projects could implement them in Spirals 2 and 3

How can each of the following projects move towards a standard GENI approach? With how much effort?

OML (ORBIT Measurement Library) OMF (ORBIT Management Framework)
Max Ott – NICTA (yes, by phone)
Ivan Seskar – Rutgers WINLAB (yes)
Instrumentation Tools
Jim Griffioen - Univ Kentucky (yes)
perfSONAR

Matt Zekauskas - Internet2 (no)
Jason Zurawski – Internet2 (yes)
Martin Swany - Univ Delaware (yes)
Guilherme Fernandes – Univ Delaware (yes)
Ezra Kissel – Univ Delaware (yes)

Scalable Sensing Service (S3)

Sonia Fahmy – Purdue (yes)
Puneet Sharma - HP Labs (yes)

OnTimeMeasure for network measurements

Prasad Calyam - Ohio Supercomputing Ctr (yes)

GENI Meta-Operations Center and NetKArma

Jon-Paul Herron - Indiana Univ
Camilo Viecco - Indiana Univ (yes)
Chris Small - Indiana Univ (yes)

Virtual Machine Introspection (VMI)

Brian Hay – Univ Alaska (yes)

Data-Intensive Cloud Control for GENI

Michael Zink (yes)

Experiment Management Service – Digital Object Registry

Jim French - CNRI (yes)
Giridhar Manepalli - CNRI (yes)

8. References

Ref GIMS_Design_UseCases: "Use-cases for GENI Instrumentation and Measurement Architecture Design"

Ref MeasPlane-1: "RESTful Web Services vs. "Big" Web Services: Making the Right Architectural Decision"

Ref OMF_OML-1: "XDR: External Data Representation Standard"

Ref OMF_OML-2: "ORBIT Measurements Framework and Library (OML): Motivations, Design, Implementation, and Features"

Ref OMF-OML-3: "OML Overview" slides

Ref OMF-OML-4: "Measurement Architectures for Network Experiments with Disconnected Mobile Nodes"

Ref InsTools-1: "Architectural Design and Specification of the INSTOOLS Measurement System"

Ref perfSONAR-1: "Scalable Framework for Representation and Exchange of Network Measurements"

Ref perfSONAR-2: "An Extensible Schema for Network Measurement and Performance Data"

Ref perfSONAR-3: "NM-WG/perfSONAR Topology Schema"

Ref GMOC-1: "GMOC Topology-Entity Data Exchange Format Specification"

Ref GMOC-2: "Proposal: Use of URN's as GENI Identifiers"