OnTimeMeasure Capabilities for GENI Experimenters
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Experimenter Use Cases

- **Experiment Environment Monitoring**
  - Have I got the system and network resources I asked in my slice?
  - Is the experiment environment functioning as expected over my slice lifetime?
  - Can I trace my non-intuitive results in my experiment to a problem in the slice environment?

- **Experiment Instrumentation and Measurements (I&M) Management**
  - I want to collect active and passive measurements at hop, link, path and slice levels for my experiments…
  - I need measurements feedback with anomaly detection and forecasts to control my experiment progress…
  - I would like to have a measurement framework in my experiment to be configured once and be re-usable for subsequent experiment runs…
  - I want an archive of the experiment measurements collected for offline analysis or to share with colleagues…
DIY: I&M service for Experimenters!

1. MP
2. MC
3. MO
4. MAP
5. MDA

Sub-services

1. Measurement Point (MP)
2. Measurement Collection (MC)
3. Measurement Orchestration (MO)
4. Measurement Analysis and Presentation (MAP)
5. Measurement Data Archive (MDA)

Every experiment requires a custom I&M service; a GENI I&M service should remove most of that burden for an experimenter....
Topics of Discussion

• OnTimeMeasure Project Overview
• OnTimeMeasure Architecture
• Software Components
• User Workflow
• *Hands-on:* Registration, Installation, Test
• GENI Integration and Interoperability
• Example Experiment Demo
OnTimeMeasure Project Overview

GENI Project Wiki – [http://groups.geni.net/geni/wiki/OnTimeMeasure](http://groups.geni.net/geni/wiki/OnTimeMeasure)

- **Goal:** Provide GENI community with capabilities for provisioning on-going and on-demand measurement requests
  - Used in forecasting, anomaly detection, and fault-location diagnosis in GENI experiments and GENI operations

- **Outcomes:**
  - *Software* to perform centralized and distributed measurement orchestration and provisioning of measurements
    - *Centralized orchestration* for continuous monitoring, persistent measurements storage and processed network measurement feeds
    - *Distributed orchestration* for on-demand (real-time) measurement requests without need for persistent measurements storage
  - *Measurement service* that enables users to utilize OnTimeMeasure software in GENI experiments
    - Registers users, slices, maintains meta-data, and allows user control of measurement service functions
      - Researcher Web-portal – [http://ontime.oar.net](http://ontime.oar.net) for interactive user control of measurement service
      - Command-line tools for measurement service *control automation*
OnTimeMeasure Architecture

- **Researcher Command-line** (*OnTime Control*): Command-line client software to control OnTimeMeasure measurement service within user’s Slice.
- **Researcher Web-Portal** (*OnTime Beacon*): Web-site to add and control OnTimeMeasure measurement service within user’s Slice; stores Metadata.

**Web Service Layer** *(System-specific and GENI-specific)*

- **GENI API Calls**
  - Measurement Request - RSpec
  - Extensions, User Credentials, Resource Policies

**OnTimeMeasure Policy Authority**

- **Node Beacon**
- **Root Beacon**

**OnTimeMeasure Measurement Instance**

- **OnTimeMeasure Publish Authority**

**Measurement Results, Exceptions**
OnTimeMeasure Software Modules

- Customizable software [*] developed at OSC/OARnet
- Two main modules installed within a GENI experiment slice
  - **Node Beacon**
    - Installs tools that measure network health metrics such as: route changes, delay, jitter, loss, bandwidth
      - TCP/UDP Iperf, Traceroute, Ping, Pathload, OWAMP, etc.
    - Runs measurements based on a schedule and outputs results
  - **Root Beacon**
    - Installs Apache, MySQL and other packages
    - Creates database tables and configuration files
    - Generates measurement schedules for node beacons
    - Collects data and provides dashboard visualization, statistical analysis (i.e., anomaly detection and weather forecasting) with alarm generation

**NOTE:** Typically, two or more Node Beacons and one Root Beacon need to be installed on separate dedicated servers in a slice; it is however possible to install Root Beacon on one of the Node Beacon servers


OnTimeMeasure Software Modules (2)

- Two modules that are external to the GENI experiment slice
  - OnTime Control
    - Command-line interface client for users to login, manage slice information and control Node/Root Beacons within their slices in an automated manner
    
    **NOTE:** Typically, users need to install OnTime Control software on their desktops along with other experiment workflow tools such as Gush


  - OnTime Beacon
    - **User Features:** Web-interface client for users to login, manage slice information and interactively control Node/Root Beacons within their slices
    - **Admin Features:** User management (approve new users, maintain user information), Meta-data information repository

    **NOTE:** Typically, users do **NOT** need to install OnTime Beacon software and should use the instance hosted at - [http://ontime.oar.net](http://ontime.oar.net); GENI aggregate providers who wish to have a dedicated OnTime Beacon for their users can install their own instance of OnTime Beacon on a dedicated server

## Mapping to GIMA Services

<table>
<thead>
<tr>
<th>Service Name</th>
<th>Functions</th>
<th>Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement Orchestration (MO)</td>
<td>Part of Experiment Control service, uses a language to orchestrate I&amp;M services</td>
<td>Root Beacon</td>
</tr>
<tr>
<td>Measurement Point (MP)</td>
<td>Instrumentation that taps into a network and/or systems, links and/or nodes, to capture measurement data and format it using a standardized schema</td>
<td>Node Beacon</td>
</tr>
<tr>
<td>Measurement Collection (MC)</td>
<td>Programmable systems that collect, combine, transform and cache measurement data</td>
<td>Root Beacon</td>
</tr>
<tr>
<td>Measurement Analysis and Presentation (MAP)</td>
<td>Programmable systems that analyze and then present measurement data</td>
<td>Root Beacon</td>
</tr>
<tr>
<td>Measurement Data Archive (MDA)</td>
<td>Measurement data repository, index and portal</td>
<td>Root Beacon</td>
</tr>
</tbody>
</table>

- For details of service requirements, see GENI Instrumentation and Measurement Architecture (GIMA) document - 
  [http://groups.geni.net/geni/wiki/GeniInstMeas](http://groups.geni.net/geni/wiki/GeniInstMeas)
Centralized Orchestration

- Centralized scheduling for continuous monitoring, persistent measurements storage and processed network measurement feeds
  - Useful for “network weathermaps” and long-standing experiments with advanced measurement analysis capabilities
Distributed Orchestration

- Distributed scheduling for on-demand (real-time) measurement requests without need for persistent measurements storage
  - Useful for users or helper apps needing one-off or occasional raw measurement tool outputs
Measurement Service Capabilities

- Measurement request handling
  - Path-based active measurements (e.g., delay, jitter, loss, throughput, route changes)
    - Measurement topology (e.g., full-mesh, tree, hybrid)
    - Sampling requirements (e.g., periodic, stratified random, random, adaptive)
  - Host-based system performance (e.g., CPU, memory)

- Enforce policies for measurements scheduling
  - Measurement level restrictions for probing tools (e.g., allowable measurement bandwidth and measurement flow duration for different nodes/paths/user-roles)

- Provide raw and processed measurement
  - Measurements provisioning interfaces (e.g., raw data or graph output to human/component-service, processed output of multiple tools to a dashboard)
  - Measurement use context hooks (e.g., verify network path(s) performance in a new slice, network-awareness in an experiment to develop a novel network control scheme)
  - OnTimeMeasure instance metadata (e.g., needed by GMOC, NetKarma)
User Workflow
(ProtoGENI or PlanetLab Aggregates)

1. User creates an experiment slice using ProtoGENI or PlanetLab control framework tools
   - For ProtoGENI slice creation, see: http://groups.geni.net/geni/wiki/OnTime-Install
   - For PlanetLab slice creation, see: http://groups.geni.net/geni/wiki/OTM-PlanetLabInstall

2. User registers at the “Researcher Web-Portal” (http://ontime.oar.net)

3. User installs OnTimeMeasure measurement instance in experiment slice
   - Slice RSpec should include reservation of any required measurement resources
   - Node/Root Beacons need to be installed as slivers based on the instructions provided in Step-1 for the specific aggregate

4. Valid login to the “Researcher Web-Portal” allows user to:
   A. Provide slice RSpec information for the measurement service
   B. Interact with the measurement service in user’s experiment slice
      i. Submit measurement requests
      ii. Control the measurement service
      iii. Query measurement data
View OnTimeMeasure Demo Videos at – [http://ontime.oar.net/demo](http://ontime.oar.net/demo)

Centralized Service Control

Centralized Measurement Request

Centralized Measurement Query
View OnTimeMeasure Demo Videos at – [http://ontime.oar.net/demo](http://ontime.oar.net/demo)

Screenshots (2)

**Measurement Result**

```
$ iwconfig

196: Local 64.97.28.149 port 5001 connected with 64.97.28.148 port 5001
152: 0.0-10.0 sec 496 Kbytes 411 KBytes/sec
152: 0.0-10.0 sec 1448 bytes (MIS 3900 bytes, ethernet)  
```

**Distributed Measurement Result**

![Distributed Measurement Result](image)

**User Customizable Dashboard**

![User Customizable Dashboard](image)

**Researcher Web-Portal**

![Researcher Web-Portal](image)
OnTimeMeasure Integration w/ other GENI Projects

• Not all Experimenter use cases can be supported by OnTimeMeasure alone; integration satisfies more use cases
  – Some use cases will require development based on your feedback!

• Integrated Projects:
  – OnTimeMeasure-ProtoGENI, OnTimeMeasure-PlanetLab
    • I&M service for GENI aggregate users
  – OnTimeMeasure-Gush
    • I&M service control through Experimenter workflow tool
  – OnTimeMeasure*-INSTOOLS**
    • Both active* and passive** measurements in experiment slice
  – OnTimeMeasure-CRON
    • I&M service for 10Gbps network path experiments
Integration with Gush

See details at - [http://groups.geni.net/geni/wiki/OTM-Gush](http://groups.geni.net/geni/wiki/OTM-Gush)

- OnTime Control package resides on Root/Node Beacon; Gush is installed on user desktop

- Set of XML experiment files in the Gush format interact with the OnTime Control Python scripts

- Gush topology description (directory.xml) is passed to the OnTime Control

- Output of OnTime Control is a URL of a text/plot file containing the results of the measurement
Integration with Instrumentation Tools
See details at - http://groups.geni.net/geni/wiki/OTM-InsToolsDemo

• Integration enables both INSTOOLS and OnTimeMeasure software running within same slice

• Set of INSTOOLS’ Drupal configurations have to be modified

• Results and graphs of OnTimeMeasure become accessible through INSTOOLS web-interface
Integration with CRON 10Gbps Testbed

See details at - [http://groups.geni.net/geni/wiki/OTM-CRONInstall](http://groups.geni.net/geni/wiki/OTM-CRONInstall)

Integration goal is to show each node's and link's vital performance statistics along with graphs
Steps to integrate new metrics custom to your experiment...

• Any active or passive *measurement data source* can be integrated into OnTimeMeasure framework
  – Instantaneous measurement, Measurement time series
  – E.g., OpenFlow, SNMP, Tools in VMware (today's demo), …

• Integration steps
  – Write a new tool wrapper for Node Beacon (MP Service)
  – Modify measurement collector script and dB schema for Root Beacon (MC Service)
  – Modify scheduler configuration for Root Beacon (MO Service)
  – Request us (Email: pcalyam@osc.edu) to modify analysis and presentation scripts for OnTime Beacon/Control (MAP Service)
• Experiment on dynamic resource allocation in virtual desktop clouds
• OnTimeMeasure provides on ProtoGENI and PlanetLab:
  – Active measurements of network resources
  – VMware measurements (via APIs) of system resources
Conclusion

• OnTimeMeasure measurement service is now available to experimenters
  – Please register at http://ontime.oar.net

• Development is on-going, but the core measurement service capabilities are ready for testing and use

• We are seeking ideas to use OnTimeMeasure in GENI experiments

• We are looking to integrate OnTimeMeasure with other GENI software systems
Thank you for your attention! 😊