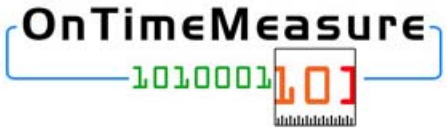

OnTimeMeasure: Centralized and Distributed Measurement Orchestration Software

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Tutorial at 3rd GENI I&M Workshop, GEC9

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Topics of Discussion

- Project Overview
- Software Components
- OnTimeMeasure Architecture
- Measurement Service Capabilities
- User Workflow
- GENI Integration and Interoperability

Project Overview

- Goal:
  - Provide GENI community with a shared measurement service for provisioning on-going and on-demand measurement requests
- Expected Outcomes:
  - OnTimeMeasure Software to perform centralized and distributed measurement orchestration and provisioning of active 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 uses OnTimeMeasure software in GENI experiments to enable:
    - Network paths monitoring
    - Network weather forecasting
    - Network performance anomaly detection
    - Network-bottleneck fault-location diagnosis

GENI Project Wiki – http://groups.geni.net/geni/wiki/OnTimeMeasure

Researcher Web-portal – http://ontime.oar.net

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
- Third module that is external to the GENI experiment slice
  - OnTime Beacon (Hosted by us - http://ontime.oar.net)
    - User management and web-interface to Node/Root Beacons

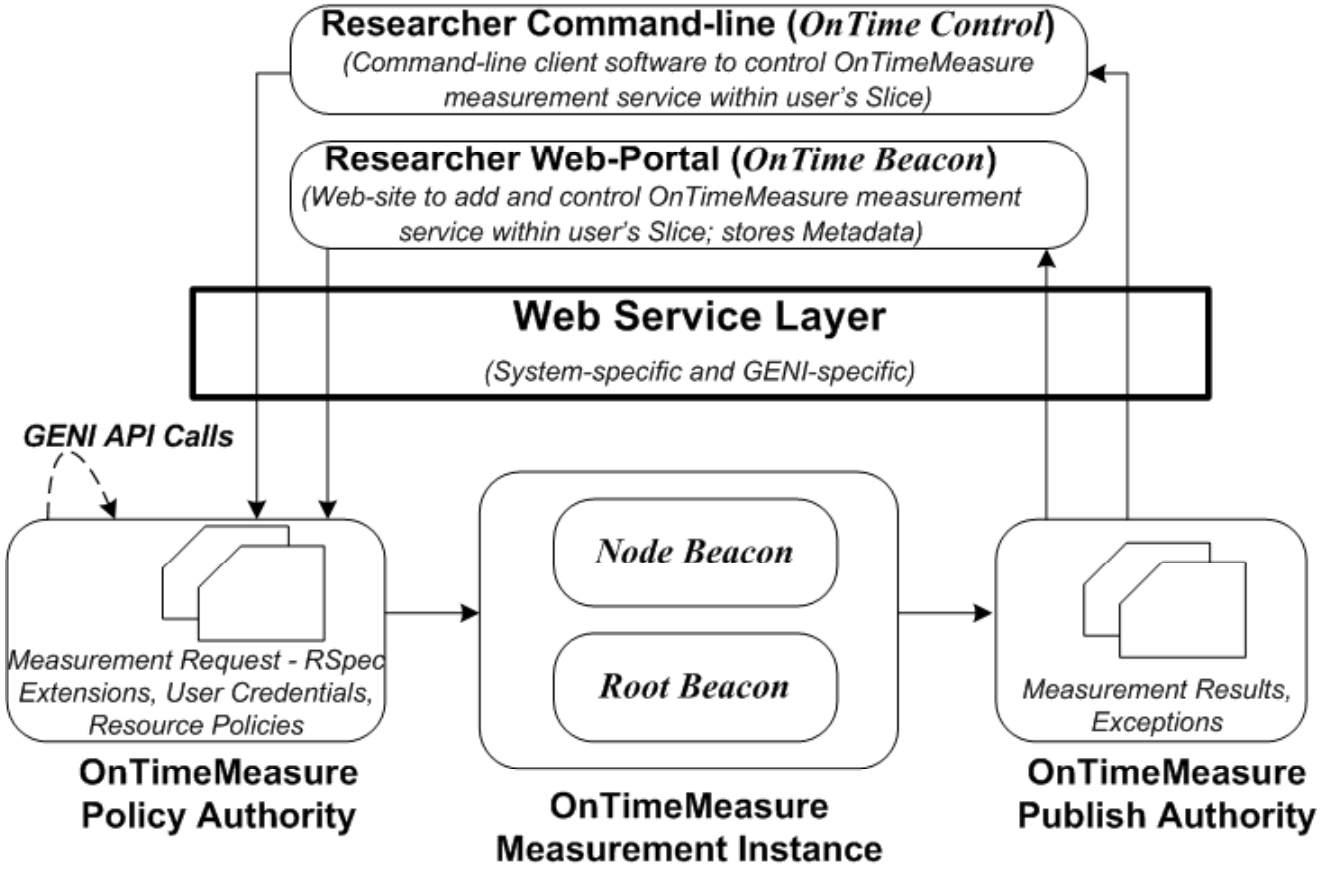
[*] P. Calyam, C.-G.Lee, E. Ekici, M. Haffner, N. Howes, "Orchestrating Network-wide Active Measurements for Supporting Distributed Computing Applications", *IEEE Transactions on Computers Journal (TC)*, 2006.

Mapping to GIMA Services

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

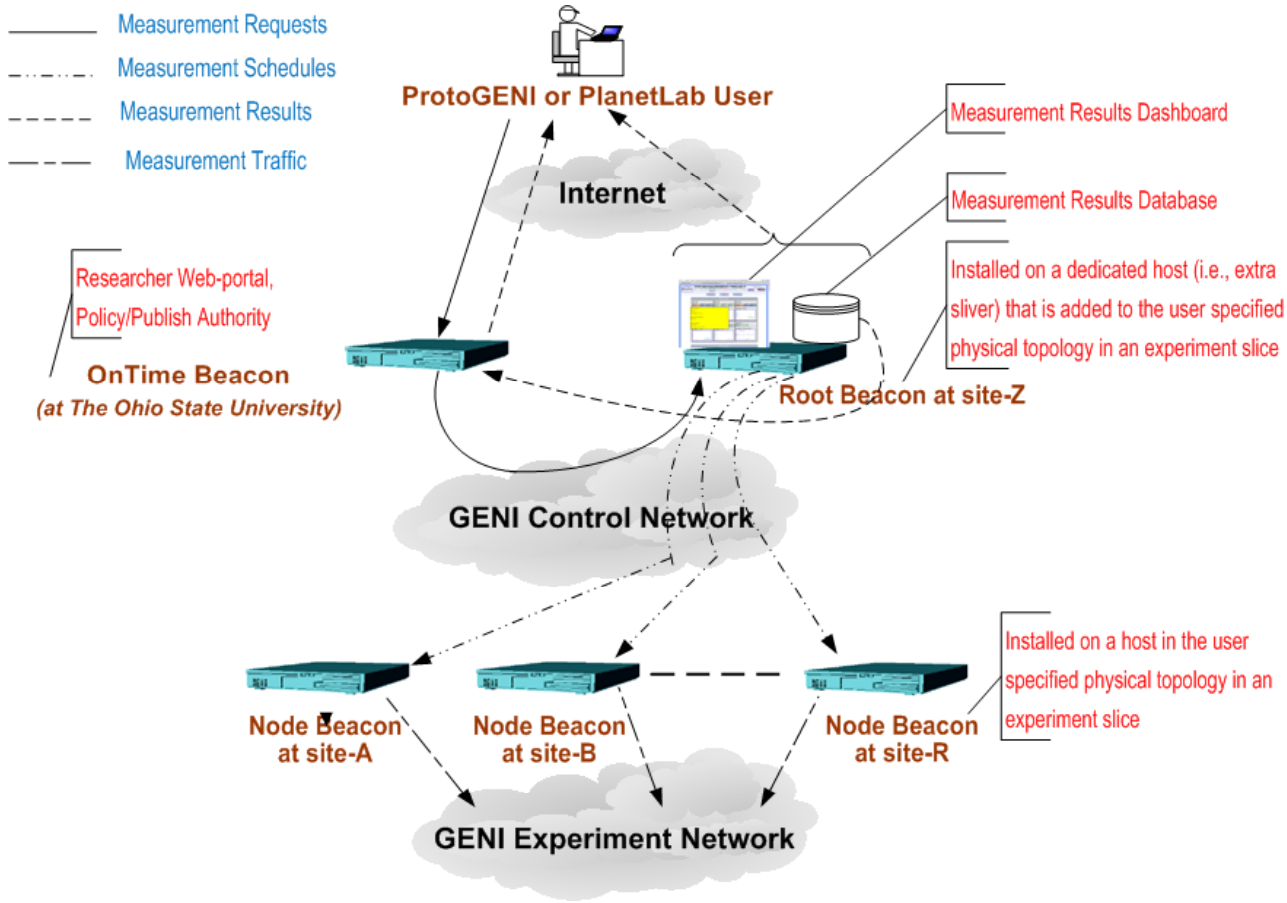
- For details of service requirements, see GENI Instrumentation and Measurement Architecture (GIMA) document - http://groups.geni.net/geni/wiki/GeniInstMeas

OnTimeMeasure Architecture



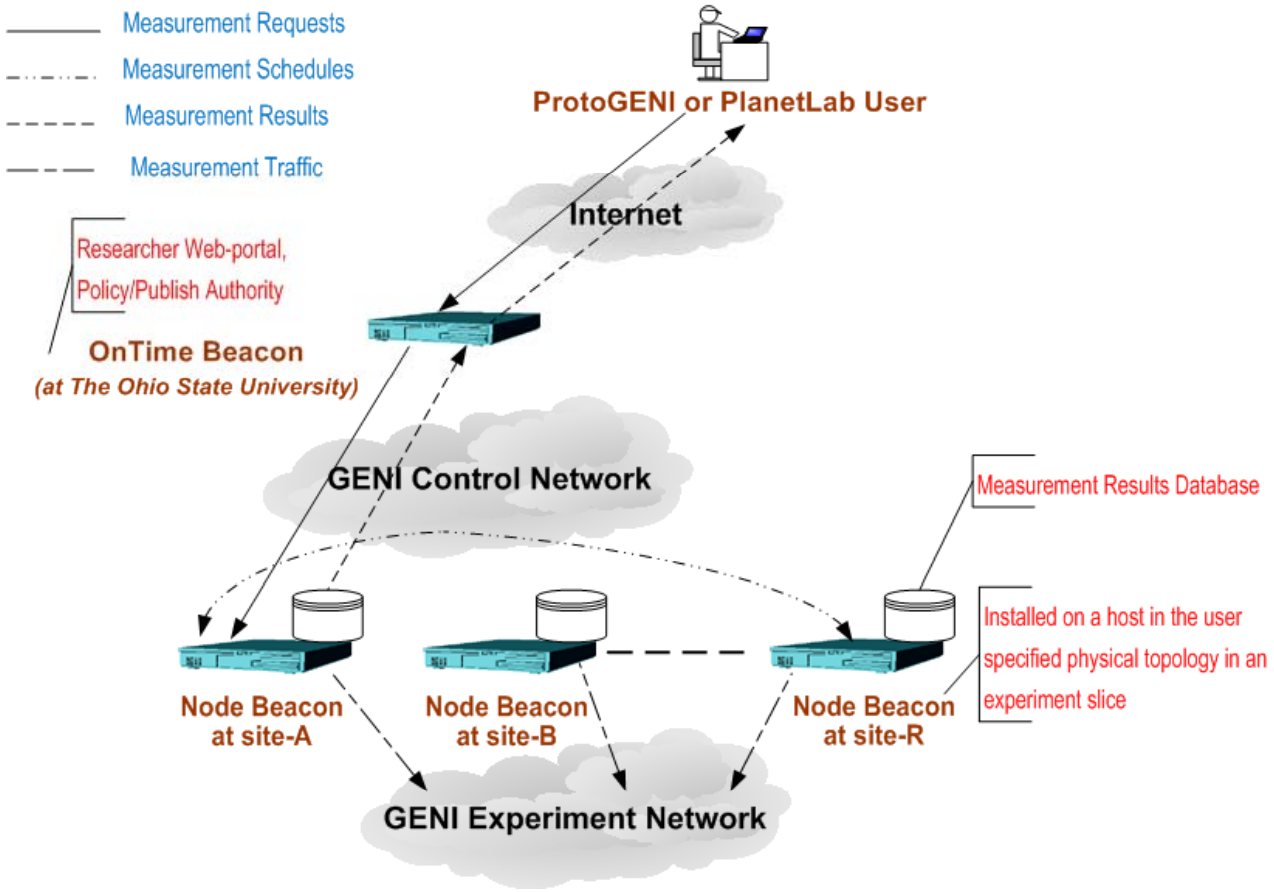
Download Node/Root Beacon Software – http://ontime.oar.net/download/OnTimeMeasure_latest.php
Download OnTime Control Software (*Beta!*) – http://ontime.oar.net/download/CommandLine_latest.php

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)

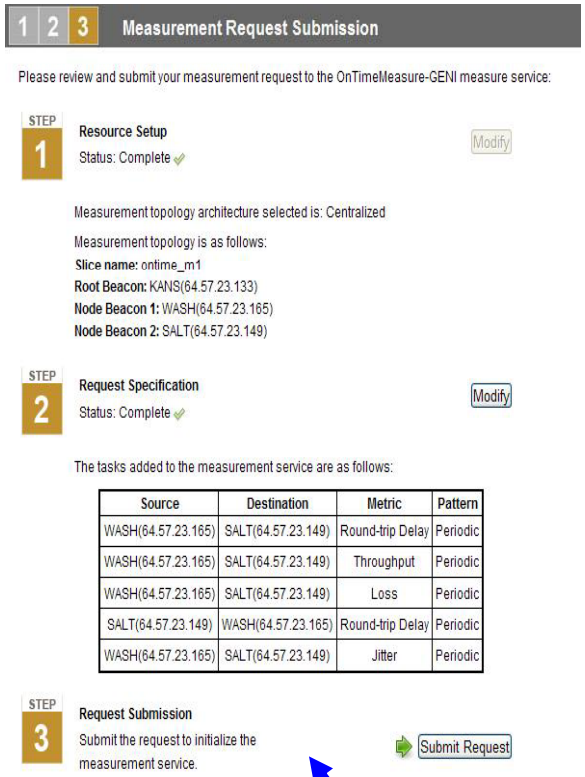
User Workflow
(ProtoGENI or PlanetLab Aggregates)

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), provides Slice Rspec information and requests installation of measurement instance
   - Slice RSpec should include reservation of any required measurement resources
3. Each experiment slice needing a measurement service gets its own OnTimeMeasure software instance
   - 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 interact with the measurement service in his/her experiment slice. Specifically, the user can:
   i. Submit measurement requests
   ii. Control the measurement service
   iii. Query measurement data

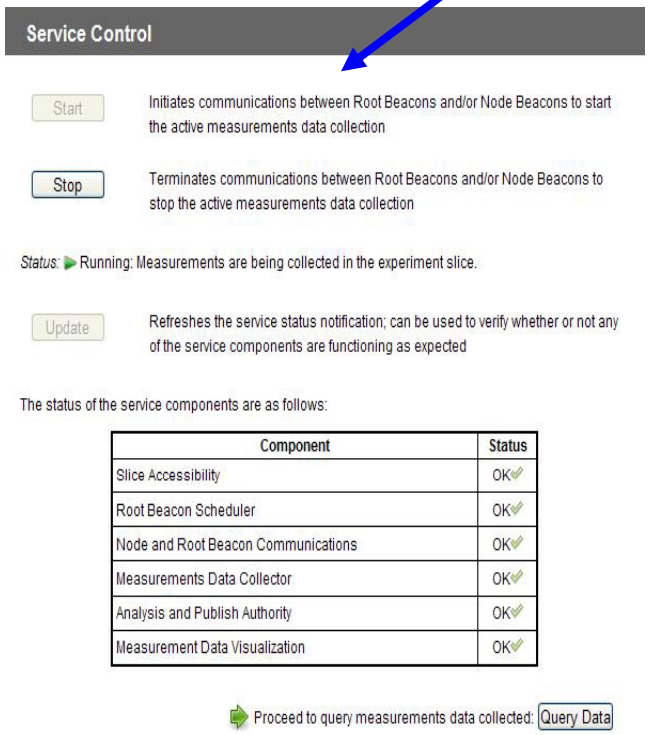
View OnTimeMeasure Demo Videos at – http://ontime.oar.net/demo

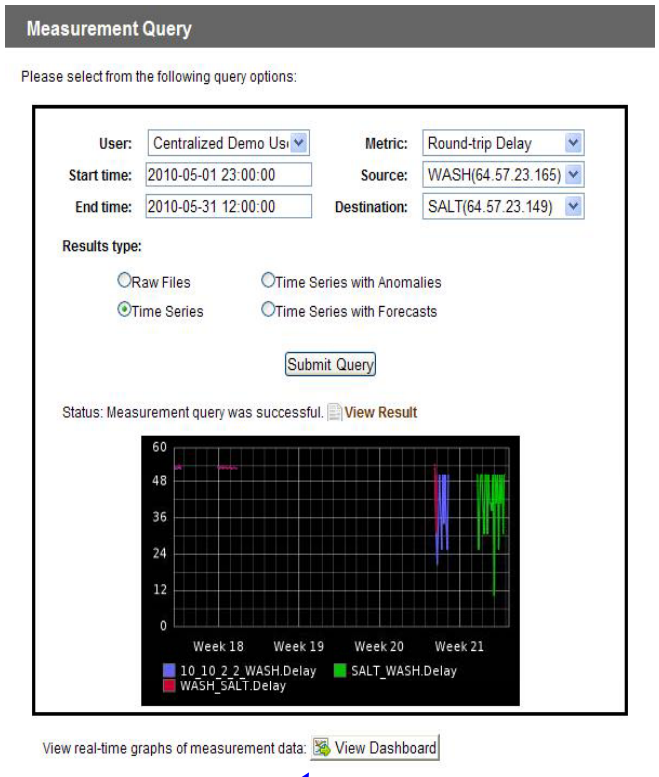
Screenshots

Centralized Service Control



Centralized Measurement Request



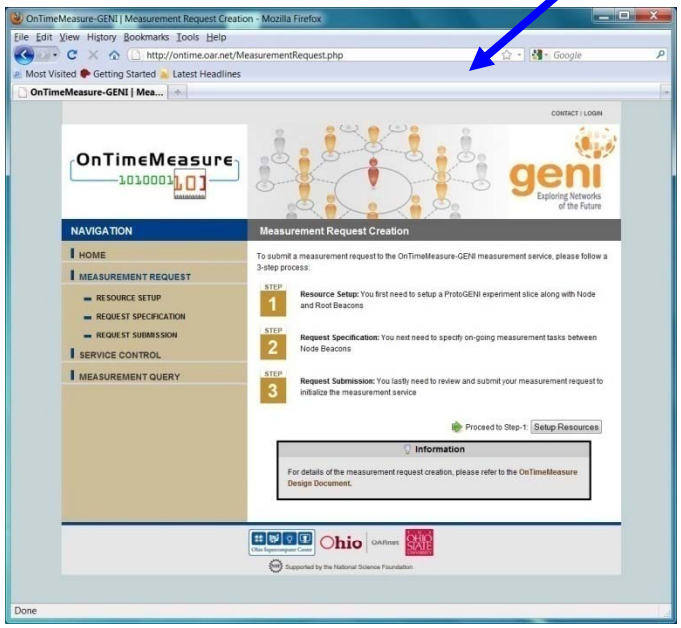


Centralized Measurement Query

View OnTimeMeasure Demo Videos at – http://ontime.oar.net/demo

Screenshots (2)

Researcher Web-Portal



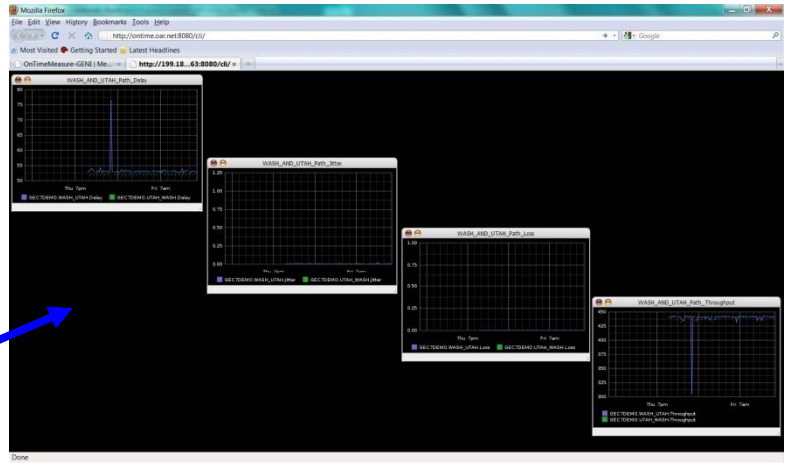
Measurement Result

Measurement completed, please see below. Download raw files: WASH

```
[ 15] local 64.57.23.149 port 5001 connected with 64.57.23.165 port 5001
[ 15]  0.0-10.0 sec    494 MBytes    414 Mbits/sec
[ 15] MSS size 1448 bytes (MTU 1500 bytes, ethernet)
bwctl: stop_exec: 3484246228.794817

RECEIVER END
```

```
[WASH]$ bwctl -c 64.57.23.149 -f m -u -b 768k -a 10

RECEIVER START
bwctl: exec_line: iperf -B 64.57.23.149 -s -f m -m -p 5001 -u -t 10
bwctl: start_tool: 3484246254.590082
------------------------------------------------------------
Server listening on UDP port 5001
Binding to local address 64.57.23.149
Receiving 1470 byte datagrams
UDP buffer size: 0.11 MByte (default)
------------------------------------------------------------
[  8] local 64.57.23.149 port 5001 connected with 64.57.23.165 port 5001
[  8]  0.0-10.0 sec  0.92 MBytes  0.77 Mbits/sec  0.011 ms    0/  655 (0%)
bwctl: stop_exec: 3484246280.789142

RECEIVER END
```

Distributed Measurement Result



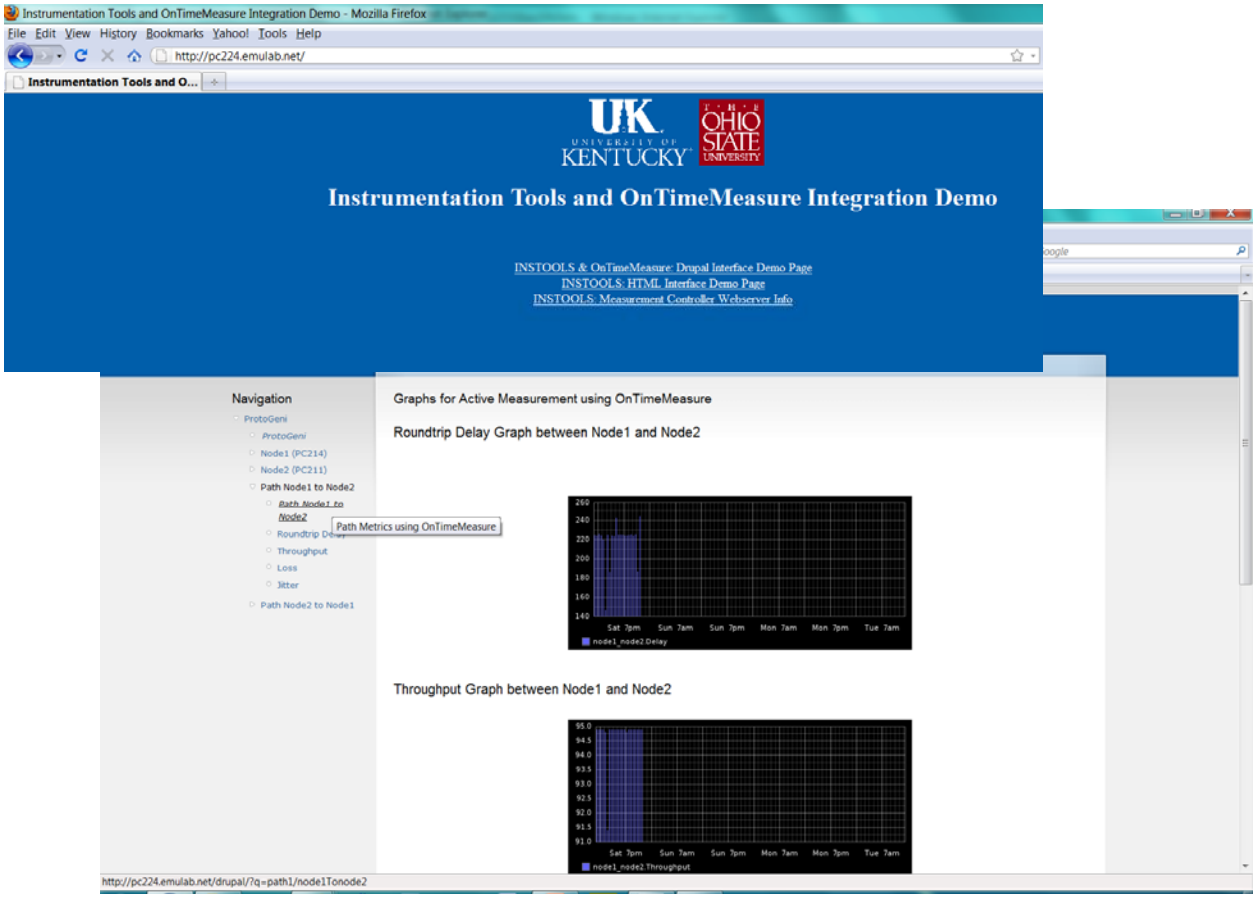
User Customizable Dashboard

Early Experimenters

- Software released to several early experimenters
  - GENI Project Office
  - CRON 10Gbps Testbed, Louisiana State University
  - GMOC, Indiana University
  - Instrumentation Tools, University of Kentucky
  - Experiments Security Analysis, University of Alabama
  - Digital Object Registry, CNRI
  - Davis Social Links, University of California, Davis
  - S3, Purdue University, HP Labs
  - PEIBAIRA, Rochester Institute of Technology

Integration with Instrumentation Tools

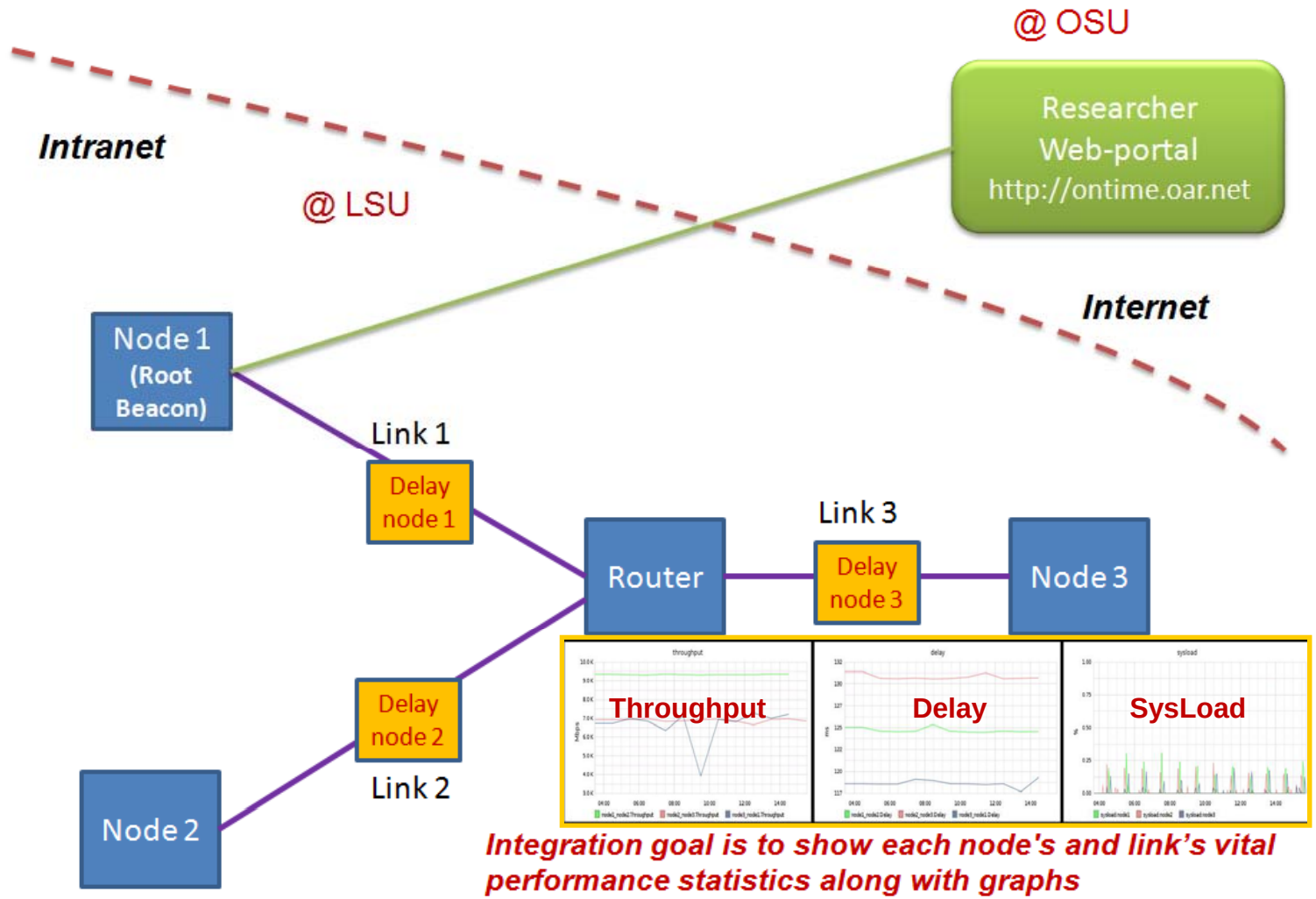
See details at - http://groups.geni.net/geni/wiki/OTM-InsToolsDemo



Integration goal is to having both INSTOOLS and OnTimeMeasure software running within the same slice, and OnTimeMeasure results and graphs accessible through INSTOOLS web-interface

Integration with CRON 10Gbps Testbed

See details at - 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

- Any active or passive measurement data source can be integrated into OnTimeMeasure framework
  - Instantaneous measurement, Measurement time series
  - E.g., OpenFlow, SNMP, …
- Integration steps
  - Write a new tool wrapper for Node Beacon (MP Service)
  - Modify measurement collector script, scheduler configuration and dB schema for Root Beacon (MC Service)
  - Request us to modify analysis and presentation scripts for OnTime Beacon (MAP Service)
- Links to other frameworks (e.g., Nagios, Ganglia) can be added into the measurement web-portal

Conclusion

- OnTimeMeasure measurement service is now available to experimenters
  - Please register at http://ontime.oar.net if you would like to be an experimenter, and we will follow-up with instructions
- 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 ! ☺

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