

# OnTimeMeasure: Centralized and Distributed Measurement Orchestration Software

Prasad Calyam, Ph.D. (PI)

Paul Schopis, (Co-PI)

Tony Zhu (Software Programmer)

Alex Berryman (REU Student)

***Tutorial at 3<sup>rd</sup> GENI I&M Workshop, GEC9***

*November 2<sup>nd</sup> 2010*

# 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 <sup>[\*]</sup> 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

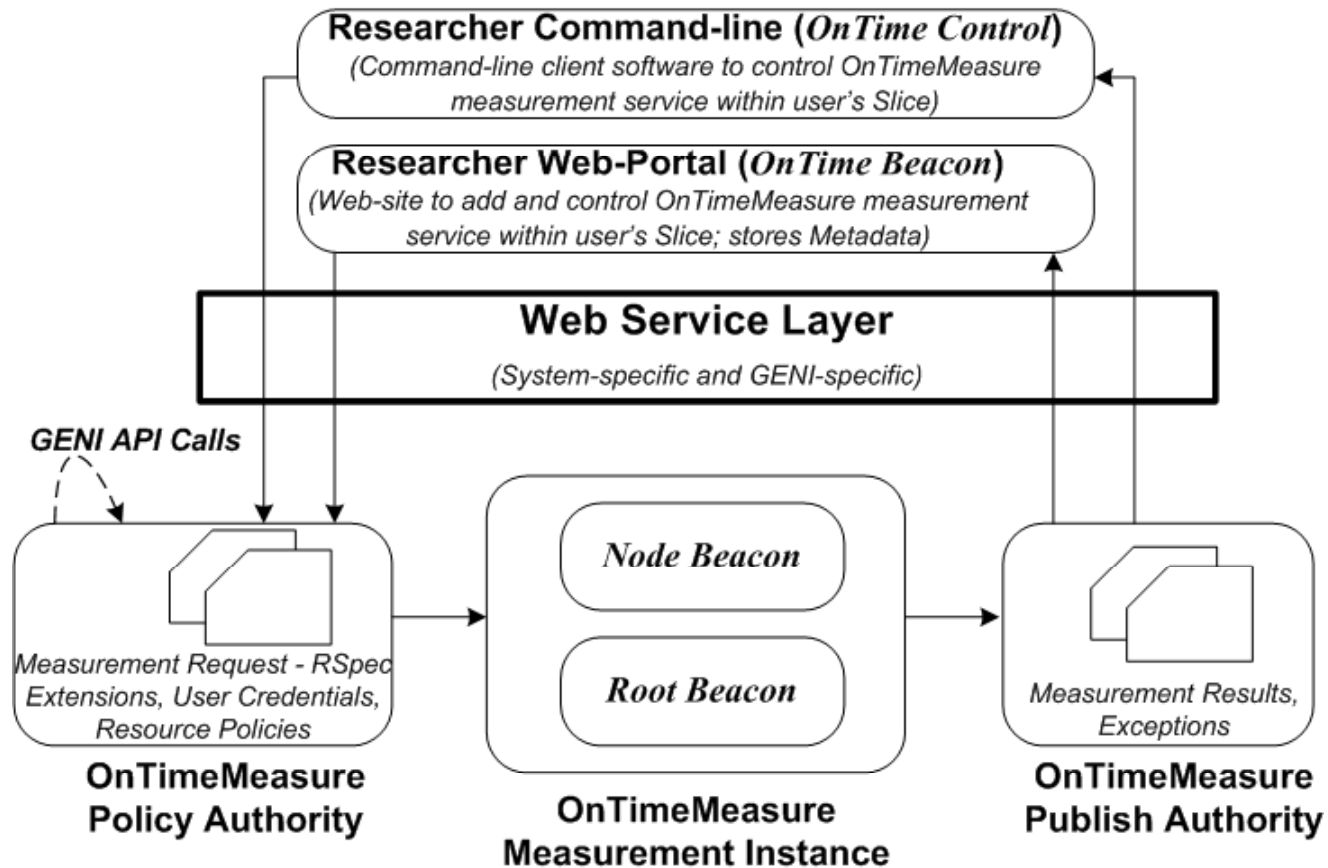
[\*] P. Calyam, C.-G.Lee, E. Ekici, M. Haffner, N. Howes, "Orchestrating Network-wide Active Measurements for Supporting Distributed Computing Applications", *IEEE Transactions on Computers Journal (TC)*, 2006.

# 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

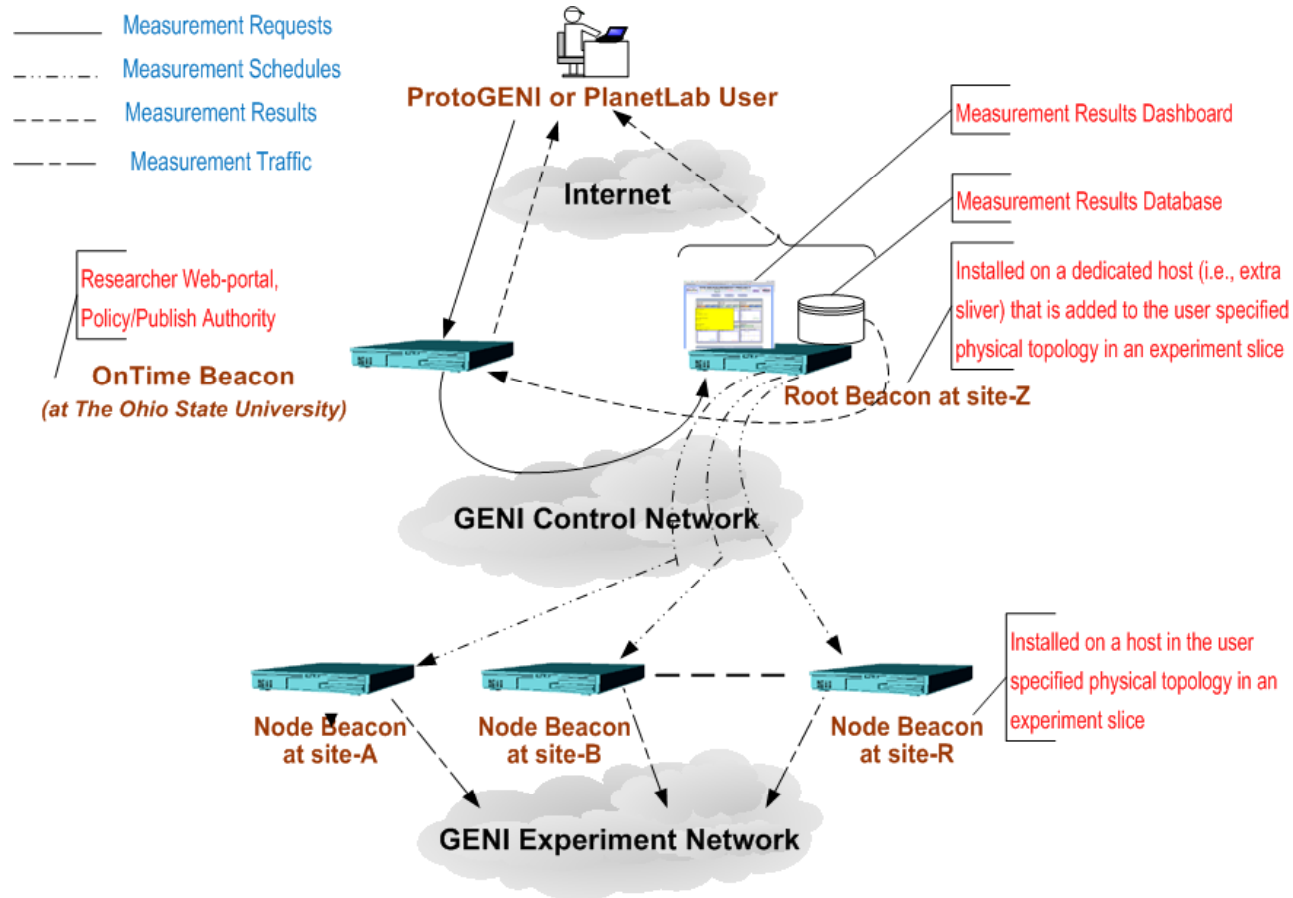
- For details of service requirements, see GENI Instrumentation and Measurement Architecture (GIMA) document - <http://groups.geni.net/geni/wiki/GeniInstMeas>

# OnTimeMeasure Architecture



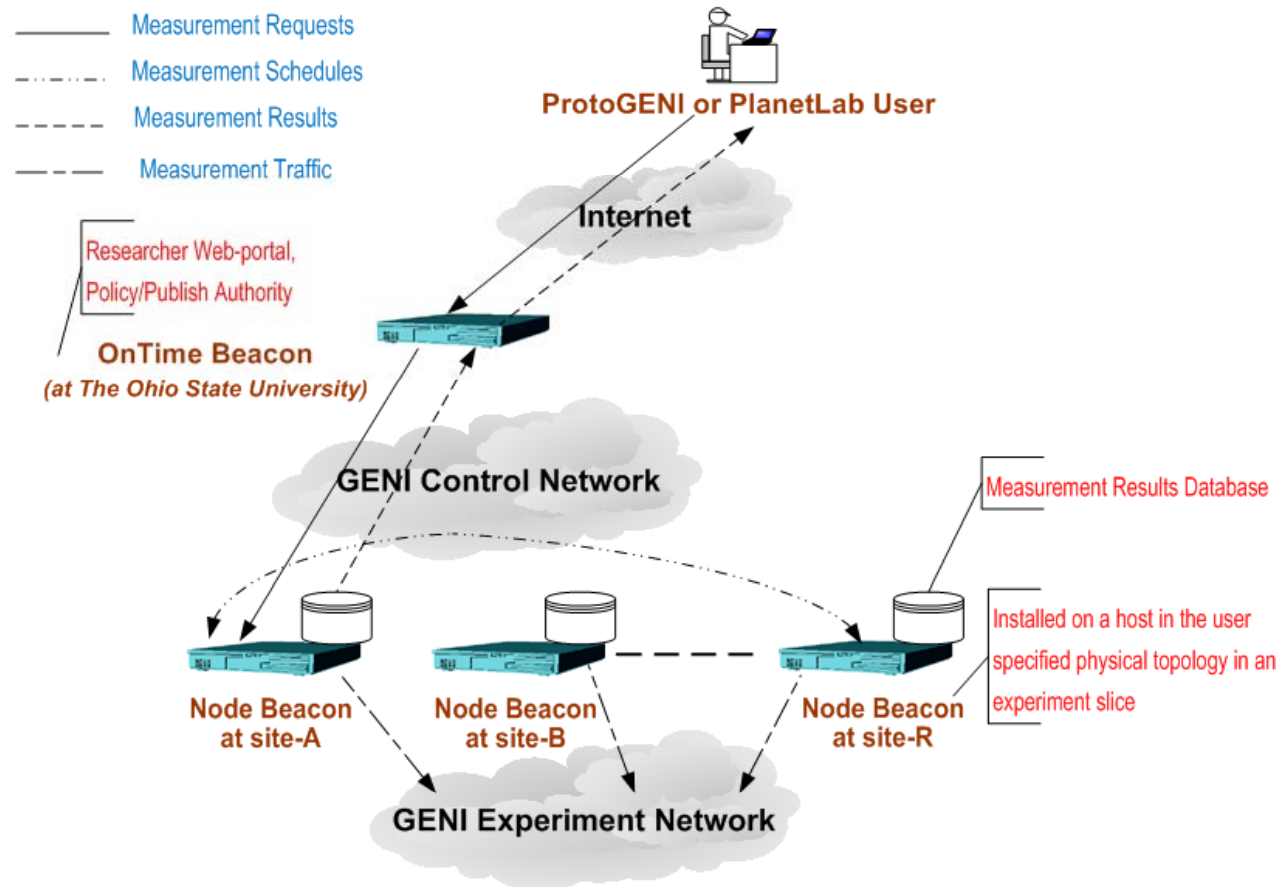
Download Node/Root Beacon Software – [http://ontime.oar.net/download/OnTimeMeasure\\_latest.php](http://ontime.oar.net/download/OnTimeMeasure_latest.php)  
Download OnTime Control Software (*Beta!*) – [http://ontime.oar.net/download/CommandLine\\_latest.php](http://ontime.oar.net/download/CommandLine_latest.php)

# 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

**1 2 3 Measurement Request Submission**

Please review and submit your measurement request to the OnTimeMeasure-GENI measure service.

**STEP 1 Resource Setup**  
Status: Complete ✓ [Modify](#)

Measurement topology architecture selected is: Centralized  
Measurement topology is as follows:  
Slice name: ontime\_m1  
Root Beacon: KANS(64.57.23.133)  
Node Beacon 1: WASH(64.57.23.165)  
Node Beacon 2: SALT(64.57.23.149)

**STEP 2 Request Specification**  
Status: Complete ✓ [Modify](#)

The tasks added to the measurement service are as follows:

Source	Destination	Metric	Pattern
WASH(64.57.23.165)	SALT(64.57.23.149)	Round-trip Delay	Periodic
WASH(64.57.23.165)	SALT(64.57.23.149)	Throughput	Periodic
WASH(64.57.23.165)	SALT(64.57.23.149)	Loss	Periodic
SALT(64.57.23.149)	WASH(64.57.23.165)	Round-trip Delay	Periodic
WASH(64.57.23.165)	SALT(64.57.23.149)	Jitter	Periodic

**STEP 3 Request Submission**  
Submit the request to initialize the measurement service. [Submit Request](#)

## Centralized Measurement Request

**Service Control**

[Start](#) Initiates communications between Root Beacons and/or Node Beacons to start the active measurements data collection

[Stop](#) Terminates communications between Root Beacons and/or Node Beacons to stop the active measurements data collection

Status: ▶ Running: Measurements are being collected in the experiment slice.

[Update](#) Refreshes the service status notification; can be used to verify whether or not any of the service components are functioning as expected

The status of the service components are as follows:

Component	Status
Slice Accessibility	OK ✓
Root Beacon Scheduler	OK ✓
Node and Root Beacon Communications	OK ✓
Measurements Data Collector	OK ✓
Analysis and Publish Authority	OK ✓
Measurement Data Visualization	OK ✓

[Proceed to query measurements data collected: Query Data](#)

**Measurement Query**

Please select from the following query options:

User: Centralized Demo Usr Metric: Round-trip Delay  
Start time: 2010-05-01 23:00:00 Source: WASH(64.57.23.165)  
End time: 2010-05-31 12:00:00 Destination: SALT(64.57.23.149)

Results type:  
 Raw Files  
 Time Series with Anomalies  
 Time Series  
 Time Series with Forecasts

[Submit Query](#)

Status: Measurement query was successful. [View Result](#)

View real-time graphs of measurement data: [View Dashboard](#)

## 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

OnTimeMeasure-GENI Measurement Request Creation - Mozilla Firefox

http://ontime.oar.net/MeasurementRequest.php

OnTimeMeasure-GENI | Mea...

CONTACT | LOGIN

OnTimeMeasure 1010001

geni Exploring Networks of the Future

NAVIGATION

MEASUREMENT REQUEST CREATION

To submit a measurement request to the OnTimeMeasure-GENI measurement service, please follow a 3-step process:

STEP 1 Resource Setup: You first need to setup a ProtoGENI experiment slice along with Node and Root Beacons

STEP 2 Request Specification: You next need to specify on-going measurement tasks between Node Beacons

STEP 3 Request Submission: You lastly need to review and submit your measurement request to initialize the measurement service

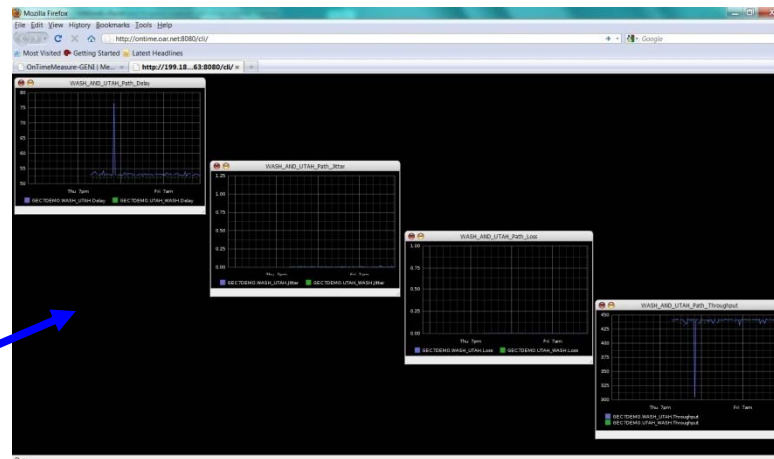
Proceed to Step-1: [Setup Resources](#)

Information

For details of the measurement request creation, please refer to the OnTimeMeasure Design Document.

Ohio | OARNet | SAGE

Supported by the National Science Foundation



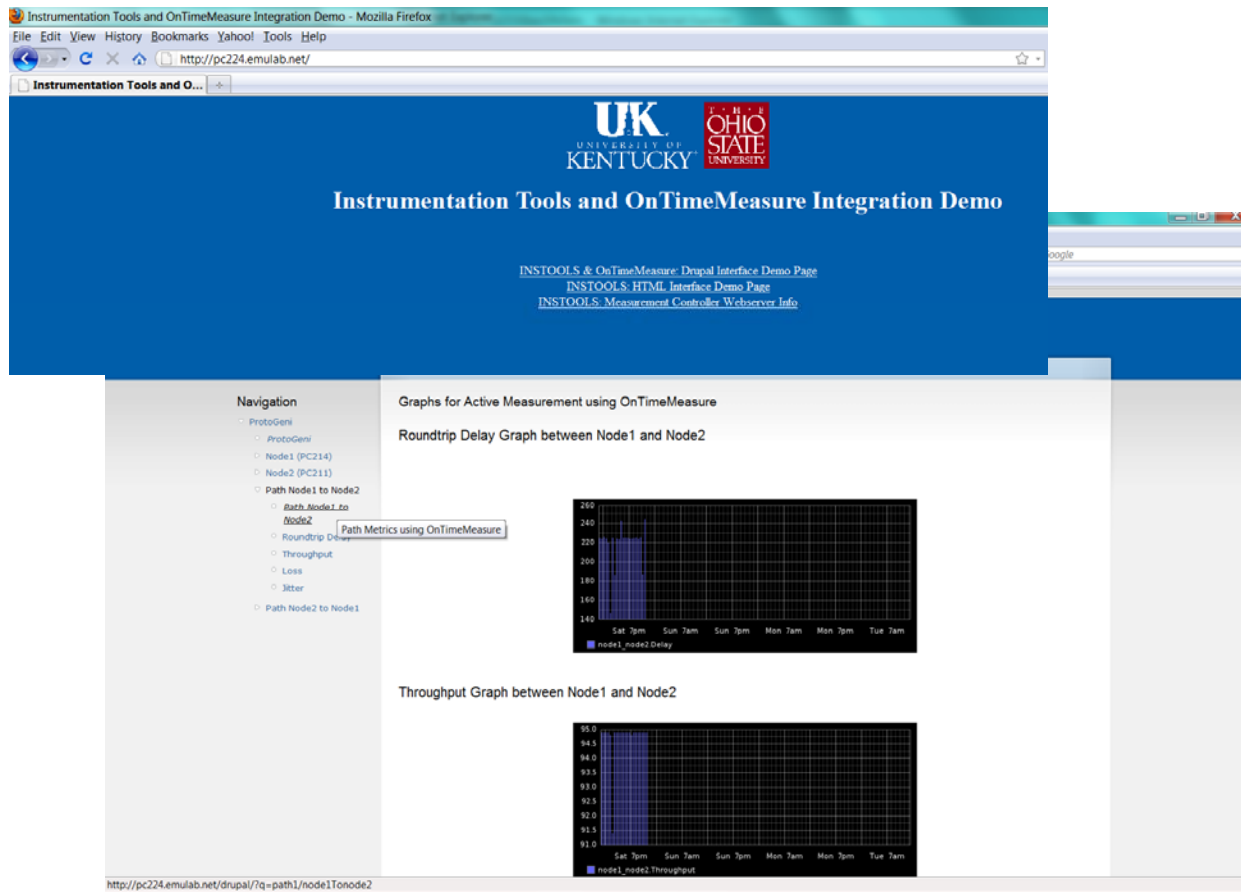
User Customizable Dashboard

# 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

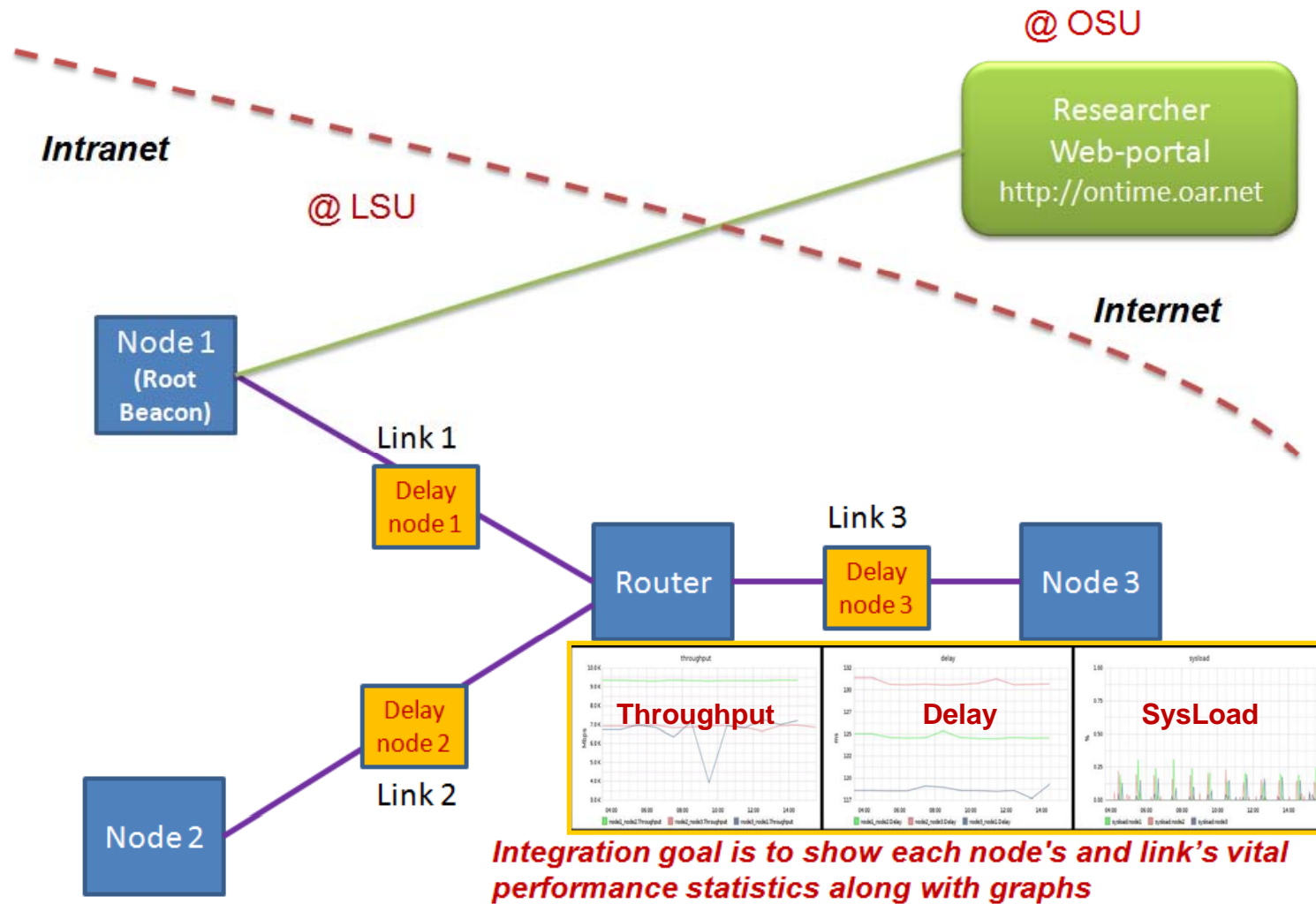
See details at - <http://groups.geni.net/geni/wiki/OTM-InsToolsDemo>



*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>



# 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 ! 😊

*This material is based upon work supported by the National Science Foundation under Grant No. CNS-0940805. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of BBN Technologies, Corp., the GENI Project Office, or the National Science Foundation.*