



**Tutorial on OnTimeMeasure-GENI**  
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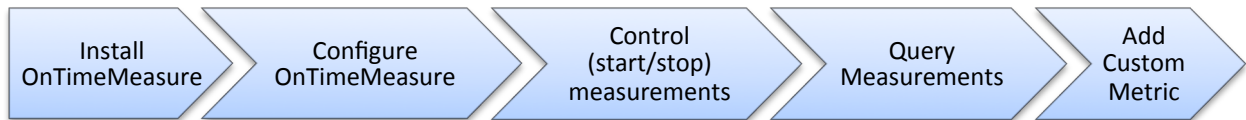
**Purpose of the Tutorial**

This tutorial provides step-by-step instructions for GENI experimenters to learn about the main Instrumentation and Measurement (I&M) capabilities of OnTimeMeasure software/service. Configuration involves ‘Node Beacons’ at measurement points, and a ‘Root Beacon’ that acts as a central intelligence module. Schedule measurements from the Root Beacon and query/visualize performance between two compute nodes that host Node Beacons. Performance data collection comprises of network health metrics such as round trip delay, loss, jitter and throughput. Add Custom metrics related to enabling performance intelligence for meeting application-specific needs.

**References to guide lab work**

- [1] OnTimeMeasure Tutorial: <http://groups.geni.net/geni/wiki/OnTimeMeasure>
- [2] OnTimeControl: <http://groups.geni.net/geni/wiki/OTM-Control>
- [3] OnTimeMeasure Custom Metric Integration: <http://groups.geni.net/geni/wiki/OTM-CustomMetric>
- [4] OnTimeMeasure Paper: [http://faculty.missouri.edu/~calyamp/publications/fi-ontimemeasure-vdcloud\\_jcn11.pdf](http://faculty.missouri.edu/~calyamp/publications/fi-ontimemeasure-vdcloud_jcn11.pdf)
- [5] Miscellaneous OnTimeMeasure demo videos: <http://ontime.rnet.missouri.edu/demo>

**Tutorial Organization**



**Figure 1: Tutorial Steps Overview**

Figure 1 shows the required steps to successfully complete the tutorial with OnTimeMeasure [1] in GENI. You will need to install the OnTimeMeasure Node and Root Beacon software, and configure them with ‘network path measurement tasks’ between two compute nodes in your GENI slice. You will control and query active measurements as part of your experiment and monitor the network path status using common network health metrics such as round trip delay, loss, jitter and throughput [2]. You will also experiment with adding a custom metric [3] i.e., CPU usage and schedule ‘host-based measurement tasks’ with OnTimeMeasure and understand programmability and extensibility concepts in meeting application-specific monitoring requirements.

The OnTimeMeasure-GENI architecture is shown in Figure 2, for details refer to [4].

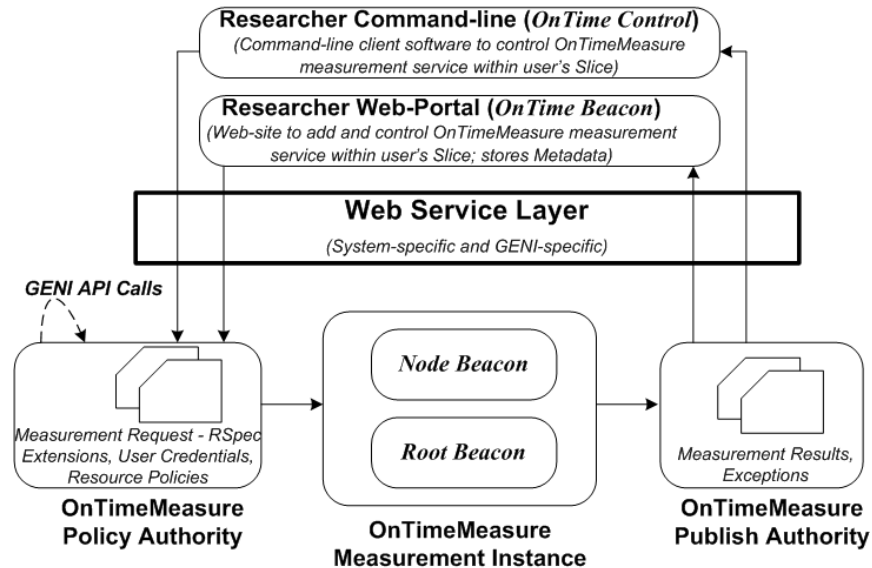


Figure 2: OnTimeMeasure-GENI Architecture

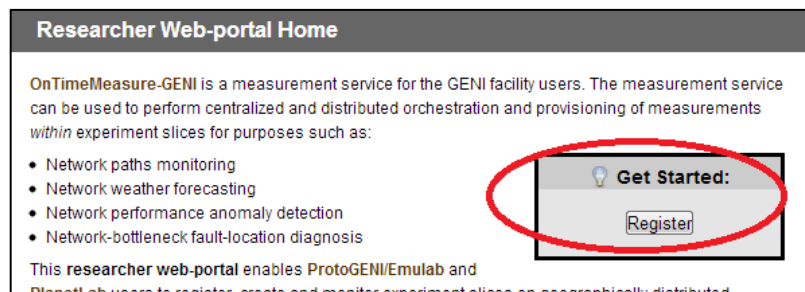
### Pre-work for GENI

If you wish to run the hands-on demo yourself, please complete the following pre-work:

- ✓ Ensure you can login to portal.geni.net (instructions, step 1 [here](#))
- ✓ Join a project. Use the project named "OnTimeMeasure-GENI-Webinar" unless you have access to another project which you prefer to use.
- ✓ Ensure you have generated and can use a key pair. You must:
  - have your private key on your machine
  - know your passphrase
  - if you are using Windows, have an SSH client installed and tested.
- ✓ Become familiar with the GENI Portal

### Pre-work for OnTimeMeasure

Register and create an account on the OnTimeMeasure portal at: <http://ontime.rnet.missouri.edu> (OnTimeBeacon instance installed at University of Missouri-Columbia)



- a. The 'Register' button will take you to the User Registration page. Provide your user information and give the Project Name as 'GENI\_Tutorial' and click 'Register'.

- b. Once the Instructor approves your registration, you can login to the portal to perform OnTimeMeasure related experiments in GENI.

Note: You will start using the OnTimeMeasure portal in Section 2.2 of this tutorial.



## 1. Install OnTimeMeasure Software Packages

### 1.1 Create Slice

Log in into GENI Portal and create a new slice

### 1.2 Specify Topology

Click on the 'Add Resources' button.

A graphical description of the following steps is shown in Figure 3.

- a. Select URL option and paste the following url:  
[http://ontime.rnet.missouri.edu/download/Ubuntu/Sample\\_RSPEC.rspec](http://ontime.rnet.missouri.edu/download/Ubuntu/Sample_RSPEC.rspec)
- b. The RSpec will reserve 3 compute nodes in your slice with 2 Node Beacons and 1 Root Beacon.
- c. Select "site" icon and choose an InstaGENI Aggregate Manager amongst options: Illinois InstaGENI, NPS InstaGENI, Rutgers InstaGENI, etc. and then click on "Reserve Resources".

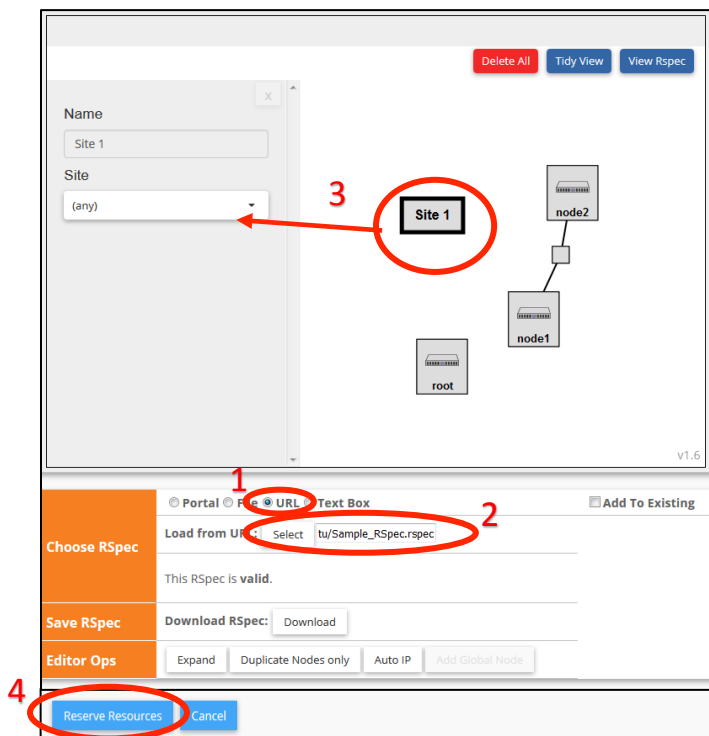


Figure 3: Steps to specify OnTimeMeasure topology



Wait for the 'Finished' status to pop up, then come back to your slice and wait for the nodes to turn green (**The time for this steps ranges from 10 to 15 minutes**).

Home → Project *Calyam\_UMissouri\_Spring2016* → Slice *Test2* → Add Resources to *Test2* (Results)

### Add Resources to GENI Slice *Test2* (Results)

Total run time: 19 seconds  
Status: **Finished**

Started at: Tue, 23 Feb 2016 05:26:35 -0500  
Finished at: Tue, 23 Feb 2016 05:26:54 -0500

Results | Detailed Progress | Request RSpec | Manifest RSpec | Send Problem Report | Advanced

#### Results

Resources requested from RSpec:

Note that the results are current as of the finish time. Your resource allocation may have changed after this time if resources expired or were deleted. Check the [slice page](#) for the most up-to-date results about your slice's current allocated resources.

Node #1 (at Illinois InstaGENI):

### 1.3 OnTimeMeasure Installation

Manage Resources

Resources on Illinois InstaGENI are ready. [View RSpec](#)

Name	Node Type	Hardware Type
root	Other...	emulab-openvz
SSH to mhn2n8@pcvm4-3.instageni.illinois.edu:22		
calyamp@pcvm4-3.instageni.illinois.edu:22		

Copy SSH info from here or by hitting SSH button below like you did in Lab1

SSH Restart Snapshot Details Add Resources Expand

Use the 'SSH' button as showed in the figure above or any other method to login to your resources. e.g. (putty, linux terminal).

FireSSH is also a good Add-on to use if you are using the Mozilla Firefox browser.

*Please note that the login and network information can be different for every user (and not necessarily the same as shown in the screenshot).*

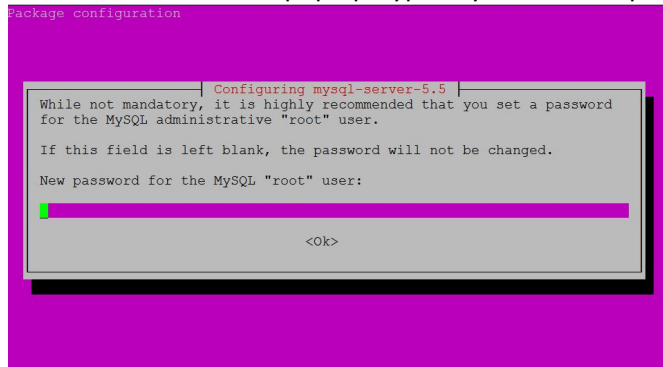


Once the nodes are reserved successfully, SSH to 'Root' and type in (or just copy and paste below lines):

```
cd /tmp/  
wget http://ontime.rnet.missouri.edu/download/Ubuntu/RootBeaconAndControl.tar.gz  
tar xzf *.gz  
tar xzf RootBeacon.tar.gz  
tar xzf OnTimeControl.tar.gz  
cd RootBeacon/InstallScript  
./ontime_software_install_ubuntu10.sh
```

**Note:** During the installation, you will be prompt to setup password several times. To avoid potential problems with password setup, please use any **ONE** password that you can remember for this whole tutorial.

Wait until this window pop up, type in your familiar password.



In this step, type in 'yes':

```
Creating table django_admin_log  
Creating table django_content_type  
  
You just installed Django's auth system, which means you don't have any superusers defined.  
Would you like to create one now? (yes/no): yes
```

Then, enter the information:

Username: root (type in 'root', not blank)

Email: The email that you provided for OnTimeMeasure register process

Password: <Your unique password> (you cannot see it when you type it, as it is show in below figure)



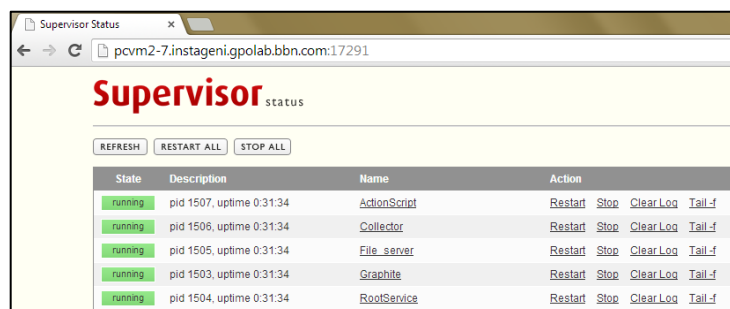
```
Creating table auth_user_groups
Creating table auth_user
Creating table auth_message
Creating table django_session
Creating table django_admin_log
Creating table django_content_type

You just installed Django's auth system, which means you don't have any superusers defined.
Would you like to create one now? (yes/no): yes
Username (Leave blank to use 'root'): root
E-mail address: admin@ontime.oar.net
Password:
Password (again):
```

You will be prompted to set a supervisor account during the installation, and also will be prompted to set a password of an automatically created database user: *collector*. Once again, use a password that you can remember. (**NOTE:** It is better to use one password from beginning to end)

```
You just installed Django's auth system, which means you don't have any superusers defined.
Would you like to create one now? (yes/no): yes
Username (Leave blank to use 'root'): root
E-mail address: admin@ontime.oar.net
Password:
Password (again):
Superuser created successfully.
Installing custom SQL ...
Installing indexes ...
No fixtures found.
Please set Root password for Database initialization
```

After the installation has finished, if your ROOT login is xyz99@[pcvm2-7.instageni.gpolab.bbn.com](http://pcvm2-7.instageni.gpolab.bbn.com), open a browser and type in: <http://pcvm2-7.instageni.gpolab.bbn.com:17291>). You should see your supervisor running as below:

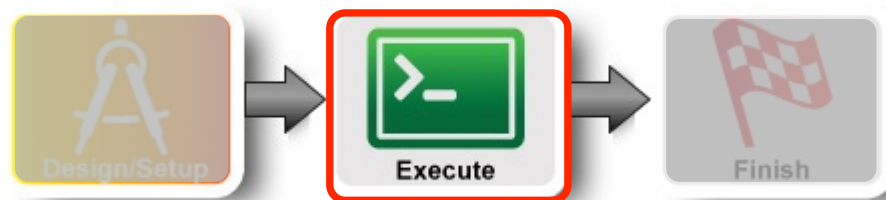
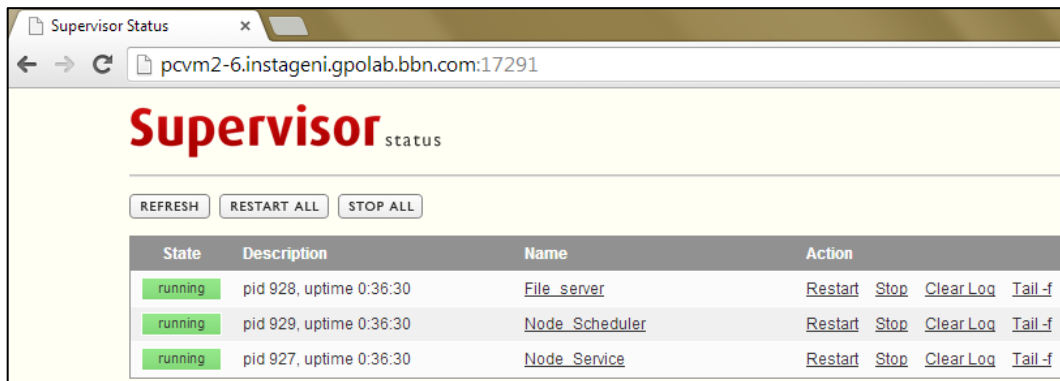




Next, SSH to 'node1' beacon and type in:

```
cd /tmp/  
wget http://ontime.rnet.missouri.edu/download/Ubuntu/NodeBeacon.tar.gz  
tar xzf NodeBeacon.tar.gz  
cd NodeBeacon/InstallScript  
./ontime_software_install_ubuntu10.sh
```

Similarly, install OnTimeMeasure on 'node2' beacon, and once the installation process is finished, confirm the installation of Node Beacons in the web-browser URL of each Node Beacon as shown below:



## 2. Configure OnTimeMeasure

### 2.1 Identify the IP addresses of all 3 nodes

Open a terminal on your local machine, Ping all the three nodes to see if they are accessible, and note down the IP addresses in the Ping tool output.

If your login for the Root and Node Beacons are pvcvm2-7.instageni.gpolab.bbn.com, pvcvm2-5.instageni.gpolab.bbn.com and pvcvm2-6.instageni.gpolab.bbn.com, type for e.g.:

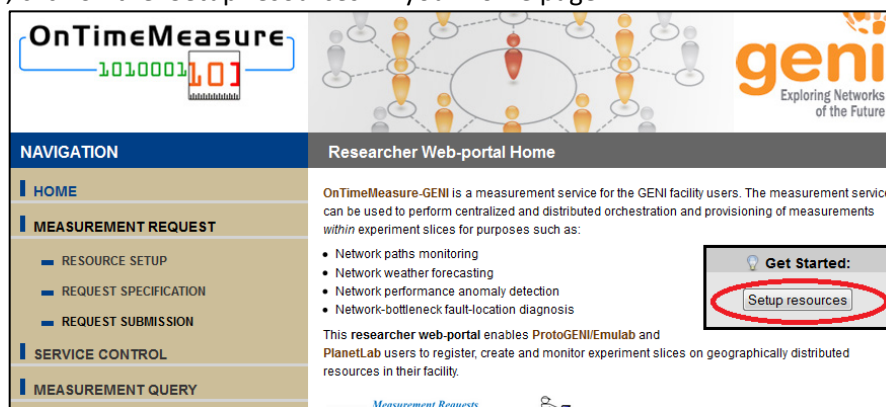
```
ping pvcvm2-7.instageni.gpolab.bbn.com
```

### 2.2 Resource Setup

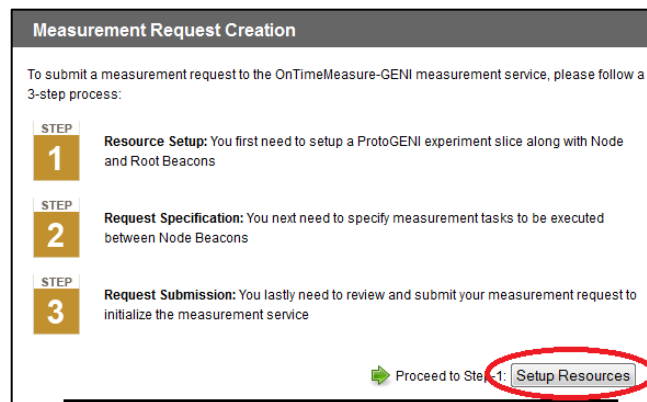
Login to the portal at: <http://ontime.rnet.missouri.edu>



Once you login, click on the 'Setup resources' in your home page



This will take you to another page, 'Measurement Request Creation' page, please read the steps involved for measurement request creation, and then select the 'Setup Resources' button.



The 'Measurement Request Setup' page comes up. Retain the desired topology as 'Centralized'. Enter the Root and Node Beacon information and IP addresses noted down in the previous step. Also enter the database username and password as collector and your familiar password.





1 2 3 **Measurement Request Setup**

Please select the desired measurement topology architecture:

Centralized  Distributed

Please input the nodes information:

Slice name:

Root Beacon:

Machine name:

IP address:

Database user name:

Database password:

Node Beacon: delete ↓

Machine name:

IP address:

Node Beacon: delete ↓

Machine name:

IP address:

Once the information is entered, select the 'Specify Request' button. You should observe the status changing to 'Measurement Request Specification' as shown below:

The screenshot shows a web form titled "Measurement Request Setup" with three tabs (1, 2, 3). The form is divided into two main sections. The first section, "Please select the desired measurement topology architecture:", contains two radio buttons: "Centralized" (selected) and "Distributed". The second section, "Please input the nodes information:", contains several input fields. A "Slice name" field is filled with "Lab2xyz". Under "Root Beacon", there are fields for "Machine name" (root), "IP address" (155.98.38.94), "Database user name" (collector), and "Database password" (otm\_slice\_password). Below this, there are two "Node Beacon" sections. The first has "Machine name" (node1) and "IP address" (155.98.38.99). The second has "Machine name" (node2) and "IP address" (155.98.38.97). A "One more node" button is located below the second node section. At the bottom of the form, a status message reads: "Status: ✓ Your resource has been updated. Going to Measurement Request Specification in 1 second. Cancel". A red oval highlights the "One more node" button and the status message.

### 3. Control (start/stop) measurement

You should be transferred to the 'Measurement Request Specification' page. In case you do not see the metric options in the drop down menu of Metric field, logout of the portal and login again and click the 'Manage Measurements' button in the home page.

The screenshot shows the "Researcher Web-portal Home" page. It features a header, a main text block, a bulleted list of services, and a "Get Started:" section with a "Manage measurements" button. A red oval highlights the "Get Started:" section and the "Manage measurements" button.

**Researcher Web-portal Home**

**OnTimeMeasure-GENI** is a measurement service for the GENI facility users. The measurement service can be used to perform centralized and distributed orchestration and provisioning of measurements *within* experiment slices for purposes such as:

- Network paths monitoring
- Network weather forecasting
- Network performance anomaly detection
- Network-bottleneck fault-location diagnosis

This **researcher web-portal** enables **ProtoGENI/Emulab** and **PlanetLab** users to register, create and monitor experiment slices on geographically distributed resources in their facility.

**Get Started:**  
Manage measurements

Add the following tasks for network path measurement metrics: Round-trip Delay, Jitter, Loss and Throughput from Node2 to Node1 by selecting the metrics from the drop down menu of Metric field and click 'AddTask' button. Also retain the pattern as periodic. Do the same again with source as Node1 and Destination as Node 2.

Also, do 'Add Task' for the Memory Free metric on both Node1 and Node2 as shown below.



1 2 3 Measurement Request Specification

Specify a measurement task using the following options:

Path based measurement:

Source:  Metric:

Destination:  Pattern:

Host based measurement:

Host:  Metric:

Pattern:

The tasks added to the measurement service are as follows:

Source	Destination	Metric	Pattern	Action
node2(155.98.38.97)	node1(155.98.38.99)	Loss	Periodic	<input type="button" value="Remove"/>
node2(155.98.38.97)	node1(155.98.38.99)	Jitter	Periodic	<input type="button" value="Remove"/>
node2(155.98.38.97)	node1(155.98.38.99)	Round-trip Delay	Periodic	<input type="button" value="Remove"/>
node2(155.98.38.97)	node1(155.98.38.99)	Throughput	Periodic	<input type="button" value="Remove"/>
node1(155.98.38.99)	node2(155.98.38.97)	Throughput	Periodic	<input type="button" value="Remove"/>
node1(155.98.38.99)	node2(155.98.38.97)	Round-trip Delay	Periodic	<input type="button" value="Remove"/>
node1(155.98.38.99)	node2(155.98.38.97)	Jitter	Periodic	<input type="button" value="Remove"/>
node1(155.98.38.99)	node2(155.98.38.97)	Loss	Periodic	<input type="button" value="Remove"/>

Host	Metric	Pattern	Action
node1(155.98.38.99)	Memory Free	Periodic	<input type="button" value="Remove"/>
node2(155.98.38.97)	Memory Free	Periodic	<input type="button" value="Remove"/>

Proceed to Step-3:

Once the above steps are complete, select the Step3 'Review Request' button.



This will take you to the Step 3 'Measurement Request Submission' page. Review the tasks information and select the 'Submit Request' button:

**1 2 3 Measurement Request Submission**

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

**Resource Setup** Modify  
Status: Complete

Measurement topology architecture selected is: Centralized  
Measurement topology is as follows:  
**Slice name:** Lab2xyz  
**Root Beacon:** root(155.98.38.94)  
**Node Beacon 1:** node2(155.98.38.97)  
**Node Beacon 2:** node1(155.98.38.99)

**Request Specification** Modify  
Status: Complete

The tasks added to the measurement service are as follows:

Source	Destination	Metric	Pattern
node2(155.98.38.97)	node1(155.98.38.99)	Loss	Periodic
node2(155.98.38.97)	node1(155.98.38.99)	Jitter	Periodic
node2(155.98.38.97)	node1(155.98.38.99)	Round-trip Delay	Periodic
node2(155.98.38.97)	node1(155.98.38.99)	Throughput	Periodic
node1(155.98.38.99)	node2(155.98.38.97)	Throughput	Periodic
node1(155.98.38.99)	node2(155.98.38.97)	Round-trip Delay	Periodic
node1(155.98.38.99)	node2(155.98.38.97)	Jitter	Periodic
node1(155.98.38.99)	node2(155.98.38.97)	Loss	Periodic

Host	Metric	Pattern
node1(155.98.38.99)	Memory Free	Periodic
node2(155.98.38.97)	Memory Free	Periodic

**Request Submission**  
Submit the request to initialize the measurement service. Submit Request

Once, you select the 'Submit Request', the 'Service Control' page comes up, initiate the measurement collection by selecting the 'Start' button. The status changes to 'Running'.

**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 & Data Collector	✔ OK
Publish Authority	✔ OK
Measurement Data Visualization	✔ OK

Proceed to query measurements data collected. Query Data



#### 4. Query Measurements

Select the 'Query Data' button to visualize the results. This will take you to the 'Measurement Query' page. Allow some time for the results to be generated (**at least 30 minutes or more depending on how you setup the measurement data sampling frequency**). Scroll down to the end of page and select the 'View Dashboard' button. You can also download the measurement data by selecting the 'Submit Query' button and clicking 'View Result' as shown below:

Measurement Query

Please select from the following query options:

User: xyz99 Metric: Memory Free

Start time(UTC): 2013-09-06 16:39:41 Host: node2(192.1.242.194)

End time(UTC): 2013-09-13 17:39:41

Results type:

Raw Files  Time Series with Anomalies

Time Series  Time Series with Forecasts

[Submit Query](#)

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


Measurement graph:

in query.js\_generate graphite request to proxy MemFree" query

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

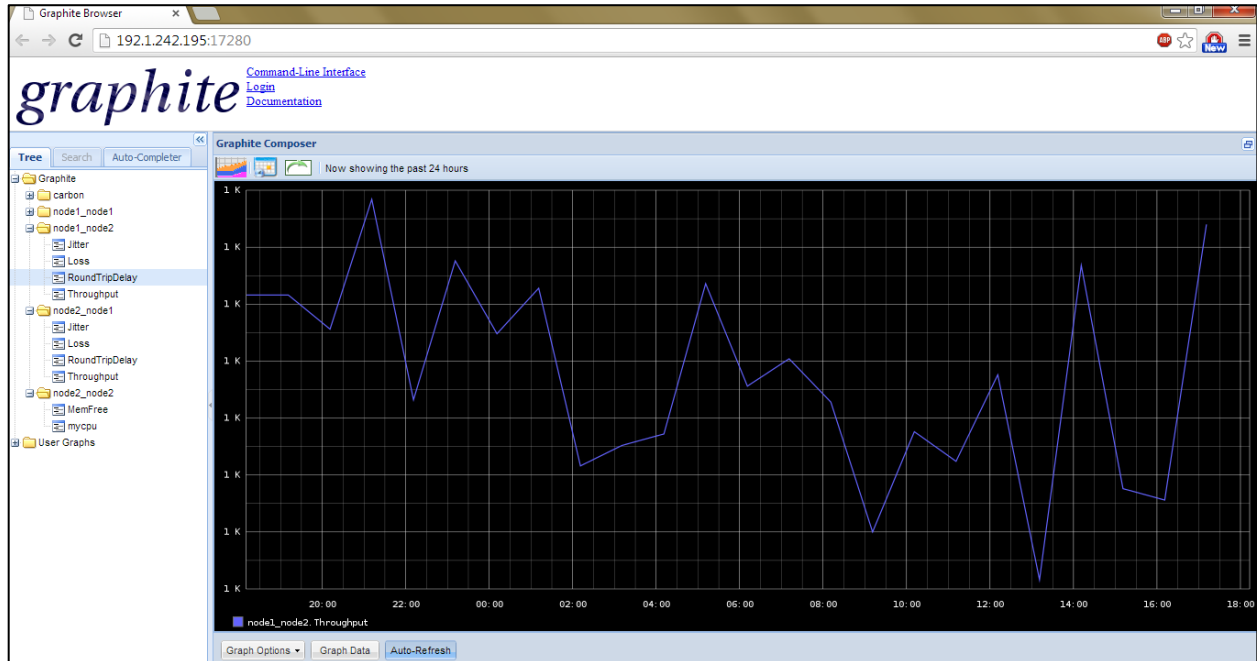
Download entire slice measurement archive: [Query Archive](#)

Proceed to control measurement service status: [Service Control](#)

The 'View Dashboard' button will take you to a new page called the Graphite Browser. You can visualize all the measurement metrics data by navigating the left hand folder structure. At any moment, in order to visualize a new metric, de-select the current metric and highlight the desired metric to view the results at any given time. You can also change the measurement data period by clicking third icon  in the top left corner of the graph.

For more details, see the OnTimeMeasure demo video on Graphite:

<http://ontime.rnet.missouri.edu/demo/dashboard.htm>



*Note: Measurement graphs in Graphite can vary for every user.*

## 5. Add Custom Metric (Using Command Line Interface)

In this step we will add a custom metric i.e., CPU usage and schedule ‘host-based measurement tasks’ and understand programmability and extensibility concepts in meeting application-specific monitoring requirements.

### 5.1 Configure IP address and database password

Login to your ROOT node using the SSH information. Enter OnTimeControl folder by entering the following command:

```
sudo mv /tmp/OnTimeControl /opt/OnTimeMeasure/  
sudo chmod u+rwx /opt/OnTimeMeasure/OnTimeControl  
cd /opt/OnTimeMeasure/OnTimeControl
```

Copy the given config\_example.yaml under the directory to config.yaml

```
sudo cp config_example.yaml config.yaml
```

Open the config.yaml file and edit the IP addresses of ‘root\_beacon’, ‘node1’ and ‘node2’, change the ‘root\_hostname’ to localhost and also change the ‘db\_pwd’ to your familiar password and change <http://ontime.oar.net/xmlrpc.php> to <http://ontime.rnet.missouri.edu/xmlrpc.php>. Your config.yaml should look similar to below.



```
sudo nano config.yaml
```

**Note:** Please make sure you do not give extra spaces or unnecessary quotes anywhere in the file.

```
#####
connection: direct
#####
# Setup for direct connection
#####
root_beacon: 192.1.242.205
root_hostname: localhost
db_user: collector
db_pwd: <Your familiar password>

nodes:
- name: node1
  IP: 192.1.242.206
- name: node2
  IP: 192.1.242.207
#####
# Setup for portal connection
#####
portal: http://ontime.rnet.missouri.edu/xmlrpc.php
web_user: demo
web_pwd: password
```

## 5.2 Install custom metric CPU on to the OnTimeMeasure Framework

Run the following commands to download a custom CPU metric which gives CPU utilization of the nodes.

```
sudo wget http://ontime.rnet.missouri.edu/INSTALL/metric/CPU.tgz
sudo tar -xzf CPU.tgz
```

You will get custom metric specification file CPUSpecs.yaml and parser file CPUParser.pm. Add custom metric specifications file and parser file into your OnTimeMeasure framework instance.

```
python add_metric.py -c CPUSpecs.yaml -p CPUParser.pm
```

Edit the measurement configuration file (measurement.yaml) to add the new metric on both nodes

```
sudo nano measurement.yaml
```

Configure the two nodes CPU metric at the end of the file as shown below:

```
- source: node1
  metric: [MemFree, Mycpu]
```



```
- source: node2
  metric: [MemFree, Mycpu]
```

### 5.3 Restart the measurement service

Run command "task\_manage.py" to manage the measurement tasks with custom metric (i.e., requests), which are configured in the measurement.yaml file and restart the measurements

```
python task_manage.py -c measurement.yaml
python service_control.py restart
```

Allow sometime for results to be generated (**at least 30 minutes**).

You can go back to your graphite page to visualize the new metric or download the results from the OnTimeBeacon portal page as shown previously. You can also download the results from command line. For example to download the data for the Throughput metric for a certain start and end time, run:

```
python query.py -f "2016-03-01 18:00:00" -t "2015-03-01 20:00:00" -s
node2 -d node1 -m Throughput -r TimeSeries
```

You can change the `-m`, `-f`, `-t` and `-r` parameter accordingly.



### Release Resources.

When you are done with your experiment it is always good to clean up and release your resources so other people can use them.

You can delete the resources by using Jacks by simply clicking delete button, then confirm OK.

