

Technical Report for the project of “Integrating a CRON (Cyberinfrastructure of Reconfigurable Optical Network) Testbed into ProtoGENI” (GENI Proposal 1794)

Period: September 2011 – December 2011

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I. Major Accomplishments

Scope

This effort provides a reconfigurable optical network emulator aggregate connected to the GENI backbone over Louisiana Optical Network Initiative (LONI). The role of optical network emulation in GENI is to provide a predictable environment for repeatable experiments, and to perform early tests of network research experimentation prior to acquiring real network resources. The tools and services developed by this project will integrate with the ProtoGENI suite of tools. The aggregate manager and network connections between LONI and GENI for this project will also allow other LONI sites to participate in GENI.

For the second year from 2010 to 2011, the scope of work includes

- (1) implementation of GENI AM API,
- (2) trusting all four GENI Clearinghouses,
- (3) finding experimenters and providing supports for experimenters,
- (4) performing demos with experimenters at GECs,
- (5) exporting the status of CRON to the GMOC, and
- (6) hosting tutorials at GECs.

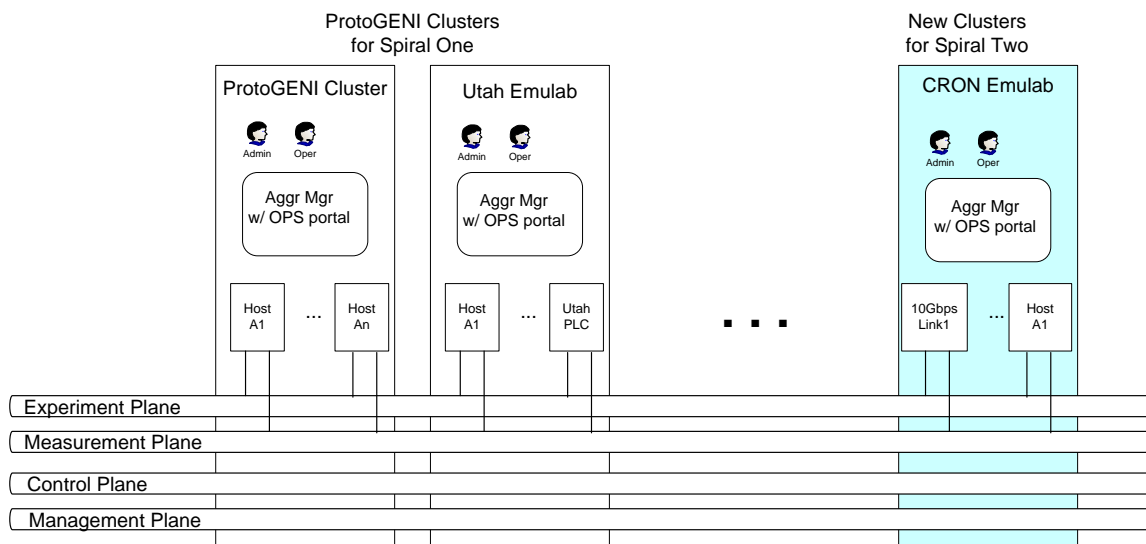


Figure 1. Implementation of Federation of CRON into ProtoGENI Cluster C at the Spiral 3

A. Milestones Achieved Between Sept 2011- December 2011

Note: (6mo) means activity that completes by the 6th month after start of project. Also, (7-12mo) means activity that starts in the 7th month and continues through the 12th month.

Milestone 1: Demonstrate semi-autonomous network stitching between MAX and CRON using the Internet2 ION service. Due 11/07/2011

Status: Accomplished

At GEC 12, PIs have demonstrated semi-autonomous network stitching between MAX and CRON using the Internet2 ION service.

Milestone2: Agree to the GENI Aggregate Provider Agreement. Due 11/07/2011

Status: Accomplished

The agreement has been negotiated between GPO and LSU. The signed agreement has been sent to GPO by LSU at mid December 2011.

Milestone3: CRON resources discoverable using Flack . Due 11/07/11

Status: Ongoing

CRON testbed including the CRON aggregate manager has been operated based on the GENI API. After CRON testbed had been moved to new domain (www.cron.loni.org), the Flack website cannot recognize the CRON testbed at the new domain. PIs and collaborators (led by Robert Ricci) at University of Utah have discussed about the problem and tried to solve it.

B. Deliverable Made

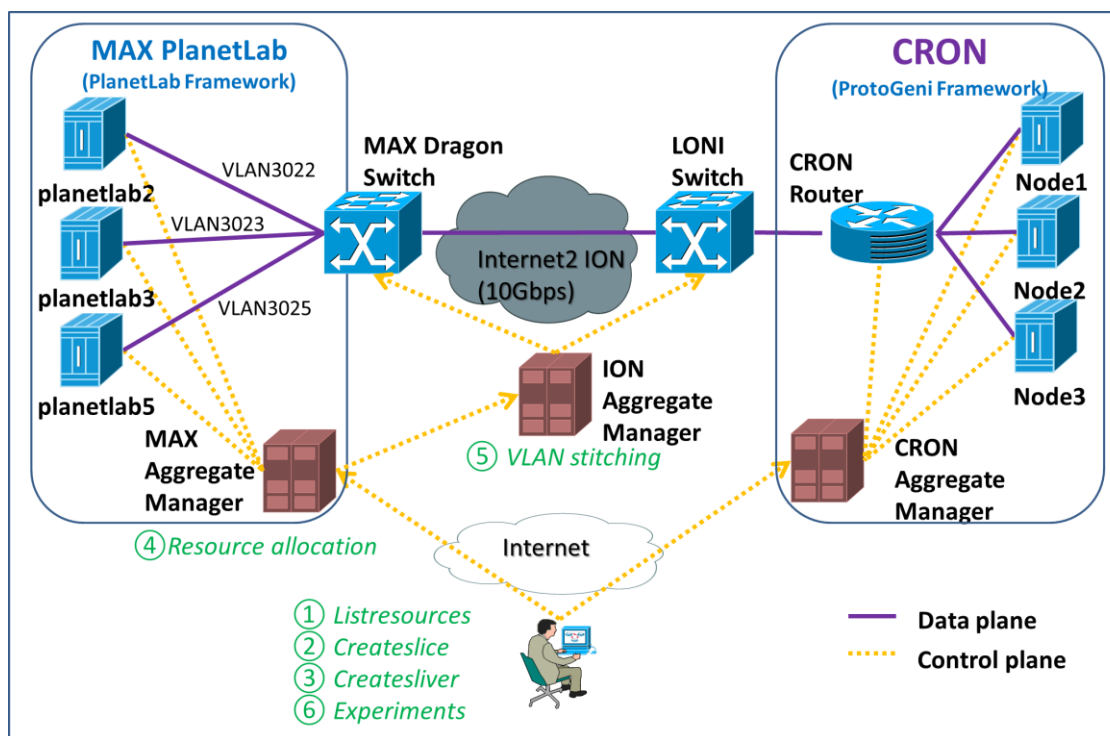
Tutorials and Demonstration videos have been uploaded to CRON website.
(<http://www.cron.loni.org>)

II. Description of work performed during last quarter

A. Activities and Findings

1) Federation of CRON through Internet2 in GENI framework

To aggregate CRON with GENI PlanetLab framework, a GENI *clearinghouse* authenticates experimenters and issues them credentials. And GENI *aggregates* provide resources to experimenters with GENI credentials. A GENI *slice* holds a collection of computing and communications resources capable of running an experiment or a wide area service. Since CRON uses the GENI Aggregate Manager API, including Flack and Omni, CRON can be federated with other GENI Aggregates without any technical issue. GENI Manager API provides a common interface to Aggregate Managers, including PlanetLab and ProtoGENI. Also, network stitching will be provided for CRON to connect into GENI through Internet2.



This report describes how to connect those two federated aggregates (CRON and MAX) through Internet2 ION service. First, an experimenter will get slivers including several machines from CRON at cron.loni.org (ProtoGeni Framework) and several machines from MAX (PlanetLab Framework) based on the following steps.

First install OMNI tool, which is GENI API in the GCF package:

1. get gcf <http://trac.gpolab.bbn.com/gcf/wiki/GettingGcf>
2. gcf quickstart <http://trac.gpolab.bbn.com/gcf/wiki/QuickStart>

OMNI command examples:

Typical workflow is: -request sliver on MAX AM, wait to see what vlan you get -modify ION AM request to use the VLAN that MAX returned on one end and whatever VLAN is needed on the other end -ION can do VLAN translation -you will also need to modify the timestamps in the ION request rspec, a script is included below to do that just prior to submit.

```
./src/omni.py listresources -a http://alpha.east.isi.edu:12346 ./src/omni.py listresources -  
a http://max-myplc.dragon.maxgigapop.net:12346
```

```
./src/omni.py createslice -n demo1
```

```
./src/omni.py createsliver -a http://alpha.east.isi.edu:12346 -n demo1 ion-  
request.xml ./src/omni.py createsliver -a http://max-  
myplc.dragon.maxgigapop.net:12346 -n demo1 max-request.xml
```

```
./src/omni.py sliverstatus -a http://alpha.east.isi.edu:12346 -n demo1 ./src/omni.py  
sliverstatus -a http://max-myplc.dragon.maxgigapop.net:12346 -n demo1
```

```
./src/omni.py listresources -a http://alpha.east.isi.edu:12346 -n demo1 ./src/omni.py  
listresources -a http://max-myplc.dragon.maxgigapop.net:12346 -n demo1
```

```
./src/omni.py deletesliver -a http://alpha.east.isi.edu:12346 -n demo1 ./src/omni.py  
deletesliver -a http://max-myplc.dragon.maxgigapop.net:12346 -n demo1
```

```
./src/omni.py deleteslice -n demo1
```

uopdatetime.sh-----

1. !/bin/bash
2. command line usage
3. ./updatetime.sh <duration-in-seconds> <filename.rspec>

```
start=`perl -e 'print `date +%s`'` end=$((($start+$1)) sed -i "s/time-[^\"]*/time-$start-$end/g" $2 sed -i "s/>[0-9]*<VCtrlPlane:start/>$start<VCtrlPlane:start/g" $2 sed -i "s/>[0-9]*<VCtrlPlane:end/>$end<VCtrlPlane:end/g" $2
```

uopdatetime.sh-----

The rspec example

```
<rspec id="maxpl_lsutestslice1"
xmlns="http://geni.maxgigapop.net/aggregate/rspec/20100412/"
xmlns:CtrlPlane="http://ogf.org/schema/network/topology/ctrlPlane/20080828/">
```

```

    <aggregate>geni.maxgigapop.net</aggregate>
    <description>LSU GEC12 Demo Request RSPEC</description>
    <lifetime id="time-1319569918-1319573518">
      <CtrlPlane:start
type="CtrlPlane:TimeContent">1319569918</CtrlPlane:start>
      <CtrlPlane:end type="CtrlPlane:TimeContent">1319573518</CtrlPlane:end>
    </lifetime>
    <user email="lxue2@tigers.lsu.edu"/>
    <computeResource
id="urn:aggregate=geni.maxgigapop.net:rspec=maxpl_lsutestslice1">
      <planetlabNodeSliver
id="urn:aggregate=geni.maxgigapop.net:rspec=maxpl_lsutestslice1:domain=dragon
.maxgigapop.net:node=planetlab2">
        <address>206.196.176.133</address>
        <computeCapacity>
          <cpuType>generic</cpuType>
          <cpuSpeed>2.0GHz</cpuSpeed>
          <numCpuCores>1</numCpuCores>
          <memorySize>256MB</memorySize>
          <diskSize>16GB</diskSize>
        </computeCapacity>
        <networkInterface
id="urn:aggregate=geni.maxgigapop.net:rspec=maxpl_lsutestslice1:domain=dragon
.maxgigapop.net:node=planetlab2:interface=eth1.3022_stitching">
```

```

        <deviceType>Ethernet</deviceType>
        <deviceName>eth1</deviceName>
        <capacity>100Mbps</capacity>
        <ipAddress>192.168.42.2/24</ipAddress>
        <vlanRange>3022</vlanRange>

<attachedLinkUrn>urn:ogf:network:domain=dragon.maxgigapop.net:node=MAX:port=1
-0-9:link=*</attachedLinkUrn>
    </networkInterface>
</planetlabNodeSliver>
<planetlabNodeSliver
id="urn:aggregate=geni.maxgigapop.net:rspec=maxpl_lsutestslicel:domain=dragon
.maxgigapop.net:node=planetlab3">
    <address>206.196.176.55</address>
    <computeCapacity>
        <cpuType>generic</cpuType>
        <cpuSpeed>2.0GHz</cpuSpeed>
        <numCpuCores>1</numCpuCores>
        <memorySize>256MB</memorySize>
        <diskSize>16GB</diskSize>
    </computeCapacity>
    <networkInterface
id="urn:aggregate=geni.maxgigapop.net:rspec=maxpl_lsutestslicel:domain=dragon
.maxgigapop.net:node=planetlab3:interface=eth1.3023_stitching">
        <deviceType>Ethernet</deviceType>
        <deviceName>eth1</deviceName>
        <capacity>100Mbps</capacity>
        <ipAddress>192.168.43.2/24</ipAddress>
        <vlanRange>3023</vlanRange>

<attachedLinkUrn>urn:ogf:network:domain=dragon.maxgigapop.net:node=CLPK:port=
1-0-4:link=*</attachedLinkUrn>
    </networkInterface>
</planetlabNodeSliver>
<planetlabNodeSliver
id="urn:aggregate=geni.maxgigapop.net:rspec=maxpl_lsutestslicel:domain=dragon
.maxgigapop.net:node=planetlab5">
    <address>206.196.176.138</address>
    <computeCapacity>
        <cpuType>generic</cpuType>
        <cpuSpeed>2.0GHz</cpuSpeed>
        <numCpuCores>1</numCpuCores>
        <memorySize>256MB</memorySize>
        <diskSize>16GB</diskSize>
    </computeCapacity>

```

```

        <networkInterface
id="urn:aggregate=geni.maxgigapop.net:rspec=maxpl_lsutestslicel1:domain=dragon
.maxgigapop.net:node=planetlab5:interface=eth1.3025_stitching">
        <deviceType>Ethernet</deviceType>
        <deviceName>eth1</deviceName>
        <capacity>100Mbps</capacity>
        <ipAddress>192.168.45.2/24</ipAddress>
        <vlanRange>3025</vlanRange>

<attachedLinkUrn>urn:ogf:network:domain=dragon.maxgigapop.net:node=MAX:port=1
-0-8:link=*</attachedLinkUrn>
        </networkInterface>
    </planetlabNodeSliver>
</computeResource>
    <stitchingResource
id="urn:aggregate=geni.maxgigapop.net:rspec=maxpl_lsutestslicel1:stitching=302
2" type="p2pvlan">

<networkInterfaceUrn>urn:aggregate=geni.maxgigapop.net:rspec=maxpl_lsutestsli
cel1:domain=dragon.maxgigapop.net:node=planetlab2:interface=eth1.3022_stitchin
g</networkInterfaceUrn>
        <networkInterfaceUrn>urn:ogf:network:domain=loni.org:node=lsu-
dcn:port=0-2-3:link=*</networkInterfaceUrn>

<externalResourceId>urn:aggregate=ion.internet2.edu:rspec=maxpl_lsutestslicel
_3022</externalResourceId>
        </stitchingResource>
    <stitchingResource
id="urn:aggregate=geni.maxgigapop.net:rspec=maxpl_lsutestslicel1:stitching=302
3" type="p2pvlan">

<networkInterfaceUrn>urn:aggregate=geni.maxgigapop.net:rspec=maxpl_lsutestsli
cel1:domain=dragon.maxgigapop.net:node=planetlab3:interface=eth1.3023_stitchin
g</networkInterfaceUrn>
        <networkInterfaceUrn>urn:ogf:network:domain=loni.org:node=lsu-
dcn:port=0-2-3:link=*</networkInterfaceUrn>

<externalResourceId>urn:aggregate=ion.internet2.edu:rspec=maxpl_lsutestslicel
_3023</externalResourceId>
        </stitchingResource>
    <stitchingResource
id="urn:aggregate=geni.maxgigapop.net:rspec=maxpl_lsutestslicel1:stitching=302
5" type="p2pvlan">

<networkInterfaceUrn>urn:aggregate=geni.maxgigapop.net:rspec=maxpl_lsutestsli

```



```

cel:domain=dragon.maxgigapop.net:node=planetlab5:interface=eth1.3025_stitchin
g</networkInterfaceUrn>
  <networkInterfaceUrn>urn:ogf:network:domain=loni.org:node=lsu-
dcn:port=0-2-3:link=*</networkInterfaceUrn>

<externalResourceId>urn:aggregate=ion.internet2.edu:rspec=maxpl_lsutestslicel
_3025</externalResourceId>
  </stitchingResource>

```

```
</rspec>
```

An example to require PlanetLab resource:

1. createsliver

```

linxue@ubuntu:~/work/omni/gcf-1.4$ ./src/omni.py createsliver -ahttp://max-
myplc.dragon.maxgigapop.net:12346 -n lsu_demo_test lsu-test1.rspec
INFO:omni:Loading config file omni_config INFO:omni:Using control framework plc
INFO:omni.sfa:SFA Registry: http://max-
myplc.dragon.maxgigapop.net:12345 INFO:omni.sfa:SFA Slice Manager: http://max-
myplc.dragon.maxgigapop.net:12347 Enter PEM pass phrase: Enter PEM pass phrase:
INFO:omni:Slice urn:publicid:IDN+maxpl:maxpl+slice+lsu_demo_test expires on 2011-
11-09 10:55:11 UTC INFO:omni:Creating sliver(s) from rspec file lsu-test1.rspec for
slice urn:publicid:IDN+maxpl:maxpl+slice+lsu_demo_test Enter PEM pass phrase:
INFO:omni:Asked http://max-myplc.dragon.maxgigapop.net:12346 to reserve resources.
Result: INFO:omni:<?xml version="1.0" ?> INFO:omni: INFO:omni:< RSpec
type="SFA">

```

```

<network name="maxpl">
  <computeResource

```

```
id="urn:aggregate=geni.maxgigapop.net:rspec=maxpl_lsu_demo_test">
```

```
<computeNode
```

```
id="urn:ogf:geni:domain=dragon.maxgigapop.net:node=planetlab2">
```

```
<networkInterface
```

```
id="urn:aggregate=geni.maxgigapop.net:rspec=physical_crdb:domain=dragon.maxgiga
pop.net:node=planetlab2:interface=eth1">
```

```

    <deviceType>
      ethernet
    </deviceType>
    <deviceName>
      eth1
    </deviceName>
    <capacity>
      100.0Mbps
    </capacity>
    <ipAddress>
      192.168.42.2/24
    </ipAddress>
    <vlanRange>
      3022
    </vlanRange>
    <attachedLinkUrn>
      urn:ogf:network:domain=dragon.maxgigapop.net:node=MAX:port=1-0-
9:link=*
    </attachedLinkUrn>
    <peerNetworkInterface>
      p2pvlan-0:interface=dst
    </peerNetworkInterface>
  </networkInterface>
</computeNode>
<computeNode
```

```
id="urn:ogf:geni:domain=dragon.maxgigapop.net:node=planetlab3">
```

```
<networkInterface
```

```
id="urn:aggregate=geni.maxgigapop.net:rspec=physical_crdb:domain=dragon.maxgiga
pop.net:node=planetlab3:interface=eth1">
```

```

    <deviceType>
      ethernet
    </deviceType>
    <deviceName>
```

```

    eth1
  </deviceName>
  <capacity>
    100.0Mbps
  </capacity>
  <ipAddress>
    192.168.43.2/24
  </ipAddress>
  <vlanRange>
    3023
  </vlanRange>
  <attachedLinkUrn>
    urn:ogf:network:domain=dragon.maxgigapop.net:node=CLPK:port=1-0-
4:link=*
  </attachedLinkUrn>
  <peerNetworkInterface>
    p2pvlan-0:interface=dst
  </peerNetworkInterface>
</networkInterface>
</computeNode>
<computeNode

```

```
id="urn:ogf:geni:domain=dragon.maxgigapop.net:node=planetlab5">
```

```
<networkInterface
```

```
id="urn:aggregate=geni.maxgigapop.net:rspec=physical_crdp:domain=dragon.maxgiga
pop.net:node=planetlab5:interface=eth1">
```

```

  <deviceType>
    ethernet
  </deviceType>
  <deviceName>
    eth1
  </deviceName>
  <capacity>
    100.0Mbps
  </capacity>
  <ipAddress>
    192.168.45.2/24
  </ipAddress>
  <vlanRange>
    3025
  </vlanRange>

```

```

      <attachedLinkUrn>
        urn:ogf:network:domain=dragon.maxgigapop.net:node=MAX:port=1-0-
8:link=*
      </attachedLinkUrn>
      <peerNetworkInterface>
        p2pvlan-0:interface=dst
      </peerNetworkInterface>
    </networkInterface>
  </computeNode>
  <computeSlice id="maxpl_lsu_demo_test">
    <node_ids>
      7, 6, 4
    </node_ids>
    <user_ids>
      20
    </user_ids>
    <expires>
      1320854111
    </expires>
  </computeSlice>
  <stitchingResource id="p2pvlan-0" type="p2pvlan">
    <networkInterface id="p2pvlan-0:interface=dst">
      <deviceType>
        ethernet
      </deviceType>
      <deviceName/>
      <capacity>
        100.0Mbps
      </capacity>
      <ipAddress/>
      <vlanRange>
        3022
      </vlanRange>
      <attachedLinkUrn>
        urn:ogf:network:domain=loni.org:node=lsu-dcn:port=0-2-3:link=*
      </attachedLinkUrn>
      <peerNetworkInterface>

urn:aggregate=geni.maxgigapop.net:rspec=physical_crdb:domain=dragon.maxgigapo
p.net:node=planetlab2:interface=eth1
      </peerNetworkInterface>
    </networkInterface>
  </stitchingResource>
  <stitchingResource id="p2pvlan-0" type="p2pvlan">
    <networkInterface id="p2pvlan-0:interface=dst">
      <deviceType>

```

```

        ethernet
    </deviceType>
    <deviceName/>
    <capacity>
        100.0Mbps
    </capacity>
    <ipAddress/>
    <vlanRange>
        3023
    </vlanRange>
    <attachedLinkUrn>
        urn:ogf:network:domain=loni.org:node=lsu-dcn:port=0-2-3:link=*
    </attachedLinkUrn>
    <peerNetworkInterface>

urn:aggregate=geni.maxgigapop.net:rspec=physical_crdb:domain=dragon.maxgigapo
p.net:node=planetlab3:interface=eth1
    </peerNetworkInterface>
</networkInterface>
</stitchingResource>
<stitchingResource id="p2pvlan-0" type="p2pvlan">
    <networkInterface id="p2pvlan-0:interface=dst">
        <deviceType>
            ethernet
        </deviceType>
        <deviceName/>
        <capacity>
            100.0Mbps
        </capacity>
        <ipAddress/>
        <vlanRange>
            3025
        </vlanRange>
        <attachedLinkUrn>
            urn:ogf:network:domain=loni.org:node=lsu-dcn:port=0-2-3:link=*
        </attachedLinkUrn>
        <peerNetworkInterface>

urn:aggregate=geni.maxgigapop.net:rspec=physical_crdb:domain=dragon.maxgigapo
p.net:node=planetlab5:interface=eth1
    </peerNetworkInterface>
</networkInterface>
</stitchingResource>
</computeResource>
</network>

```

</RSpec>

INFO:omni: ----- INFO:omni: Completed
createsliver:

```
Options as run:
    aggregate: http://max-myplc.dragon.maxgigapop.net:12346
    framework: plc
    native: True
Args: createsliver lsu_demo_test lsu-test1.rspec
Result Summary: Slice
```

urn:publicid:IDN+maxpl:maxpl+slice+lsu_demo_test expires on 2011-11-09 10:55:11
UTC Reserved resources on <http://max-myplc.dragon.maxgigapop.net:12346>.

INFO:omni:
=====

2. sliverstatus

```
linxue@ubuntu:~/work/omni/gcf-1.4$ ./src/omni.py sliverstatus -ahttp://max-myplc.dragon.maxgigapop.net:12346 -n lsu_demo_test
INFO:omni:Loading config file omni_config
INFO:omni:Using control framework plc
INFO:omni.sfa:SFA Registry: http://max-myplc.dragon.maxgigapop.net:12345
INFO:omni.sfa:SFA Slice Manager: http://max-myplc.dragon.maxgigapop.net:12347
Enter PEM pass phrase: Enter PEM pass phrase:
INFO:omni:Slice urn:publicid:IDN+maxpl:maxpl+slice+lsu_demo_test expires on 2011-11-09 10:55:11 UTC
INFO:omni:Status of Slice urn:publicid:IDN+maxpl:maxpl+slice+lsu_demo_test: Enter PEM pass phrase:
INFO:omni:Sliver status for Slice urn:publicid:IDN+maxpl:maxpl+slice+lsu_demo_test at AM URL http://max-myplc.dragon.maxgigapop.net:12346
INFO:omni: {'geni_resources': [ {'geni_error': ,
```

```
    'geni_status': 'ready',
    'geni_urn':
```

'urn:publicid:IDN+maxpl:maxpl+sliver+lsu_demo_test_plc_slice'},

```
    {'geni_error': ,
    'geni_status': 'ready',
```

```
'geni_urn':
```

```
'urn:publicid:IDN+maxpl:maxpl+sliver+lsu_demo_test_vlan_dragon.maxgigapop.net-2048'},
```

```
{'geni_error': ,
  'geni_status': 'ready',
  'geni_urn':
```

```
'urn:publicid:IDN+maxpl:maxpl+sliver+lsu_demo_test_vlan_dragon.maxgigapop.net-2049'},
```

```
{'geni_error': ,
  'geni_status': 'ready',
  'geni_urn':
```

```
'urn:publicid:IDN+maxpl:maxpl+sliver+lsu_demo_test_vlan_dragon.maxgigapop.net-2050'}]],
```

```
'geni_status': 'ready',
'geni_urn': 'urn:publicid:IDN+maxpl:maxpl+slice+lsu_demo_test'}
```

INFO:omni: ----- INFO:omni: Completed
sliverstatus:

```
Options as run:
  aggregate: http://max-myplc.dragon.maxgigapop.net:12346
  framework: plc
  native: True
Args: sliverstatus lsu_demo_test
Result Summary: Slice
```

urn:publicid:IDN+maxpl:maxpl+slice+lsu_demo_test expires on 2011-11-09 10:55:11 UTC
Returned status of slivers on 1 of 1 possible aggregates. INFO:omni:

=====

3. ssh to the resource

```
linxue@ubuntu:~/work/omni/gcf-1.4$ ssh -i ~/work/keys/id_rsa
maxpl_lsu_demo_test@planetlab2.dragon.maxgigapop.net
[maxpl_lsu_demo_test@planetlab2 ~]$ [maxpl_lsu_demo_test@planetlab2
~]$ [maxpl_lsu_demo_test@planetlab2 ~]$ [maxpl_lsu_demo_test@planetlab2
~]$ [maxpl_lsu_demo_test@planetlab2 ~]$ [maxpl_lsu_demo_test@planetlab2
~]$ [maxpl_lsu_demo_test@planetlab2 ~]$ [maxpl_lsu_demo_test@planetlab2
~]$ [maxpl_lsu_demo_test@planetlab2 ~]$ [maxpl_lsu_demo_test@planetlab2
~]$ [maxpl_lsu_demo_test@planetlab2 ~]$ ifconfig bash: ifconfig: command not found
[maxpl_lsu_demo_test@planetlab2 ~]$ uname -a Linux
planetlab2.dragon.maxgigapop.net 2.6.22.19-vs2.3.0.34.49.planetlab #1 SMP Mon Jul
26 16:10:52 EDT 2010 x86_64 x86_64 x86_64 GNU/Linux
[maxpl_lsu_demo_test@planetlab2 ~]$ [maxpl_lsu_demo_test@planetlab2
~]$ [maxpl_lsu_demo_test@planetlab2 ~]$ [maxpl_lsu_demo_test@planetlab2
~]$ [maxpl_lsu_demo_test@planetlab2 ~]$ ping 192.168.43.2 PING 192.168.43.2
(192.168.43.2) 56(84) bytes of data. From 65.120.78.45 icmp_seq=1 Destination Net
Unreachable

--- 192.168.43.2 ping statistics --- 16 packets transmitted, 0 received, +1 errors, 100%
packet loss, time 15016ms

[maxpl_lsu_demo_test@planetlab2 ~]$ ping 192.168.45.2 PING 192.168.45.2
(192.168.45.2) 56(84) bytes of data. From 65.120.78.45 icmp_seq=6 Destination Net
Unreachable From 65.120.78.45 icmp_seq=7 Destination Net Unreachable From
65.120.78.45 icmp_seq=8 Destination Net Unreachable

--- 192.168.45.2 ping statistics --- 10 packets transmitted, 0 received, +3 errors, 100%
packet loss, time 9008ms

[maxpl_lsu_demo_test@planetlab2 ~]$ ping 206.196.176.55 PING 206.196.176.55
(206.196.176.55) 56(84) bytes of data. 64 bytes from 206.196.176.55: icmp_seq=1
ttl=63 time=0.299 ms 64 bytes from 206.196.176.55: icmp_seq=2 ttl=63 time=0.244 ms
64 bytes from 206.196.176.55: icmp_seq=3 ttl=63 time=0.233 ms 64 bytes from
206.196.176.55: icmp_seq=4 ttl=63 time=0.235 ms
```



```
--- 206.196.176.55 ping statistics --- 4 packets transmitted, 4 received, 0% packet loss,  
time 3000ms rtt min/avg/max/mdev = 0.233/0.252/0.299/0.033 ms  
[maxpl_lsu_demo_test@planetlab2 ~]$ exit logout
```

B. Project Participants

PI: Seung-Jong Park

co-PI: Rajgopal Kannan

Graduate Students: Cheng Cui, Lin Xue, Chui-Hui

C. Publications

N/A

D. Outreach Activity

N/A

E. Collaborations

ProtoGENI Project Group at University of Utah

OnTimeMeasure Project Group at Ohio State University

GMOC Project Group at Indiana University

MAX project at PlanetLab Control Framework

Openflow Switch Project Group at Stanford University

F. Other Contributions