



# Experiment Lifecycle Tools

## GENI Engineering Conference 15

### Houston, TX

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October 23, 2012  
[www.geni.net](http://www.geni.net)

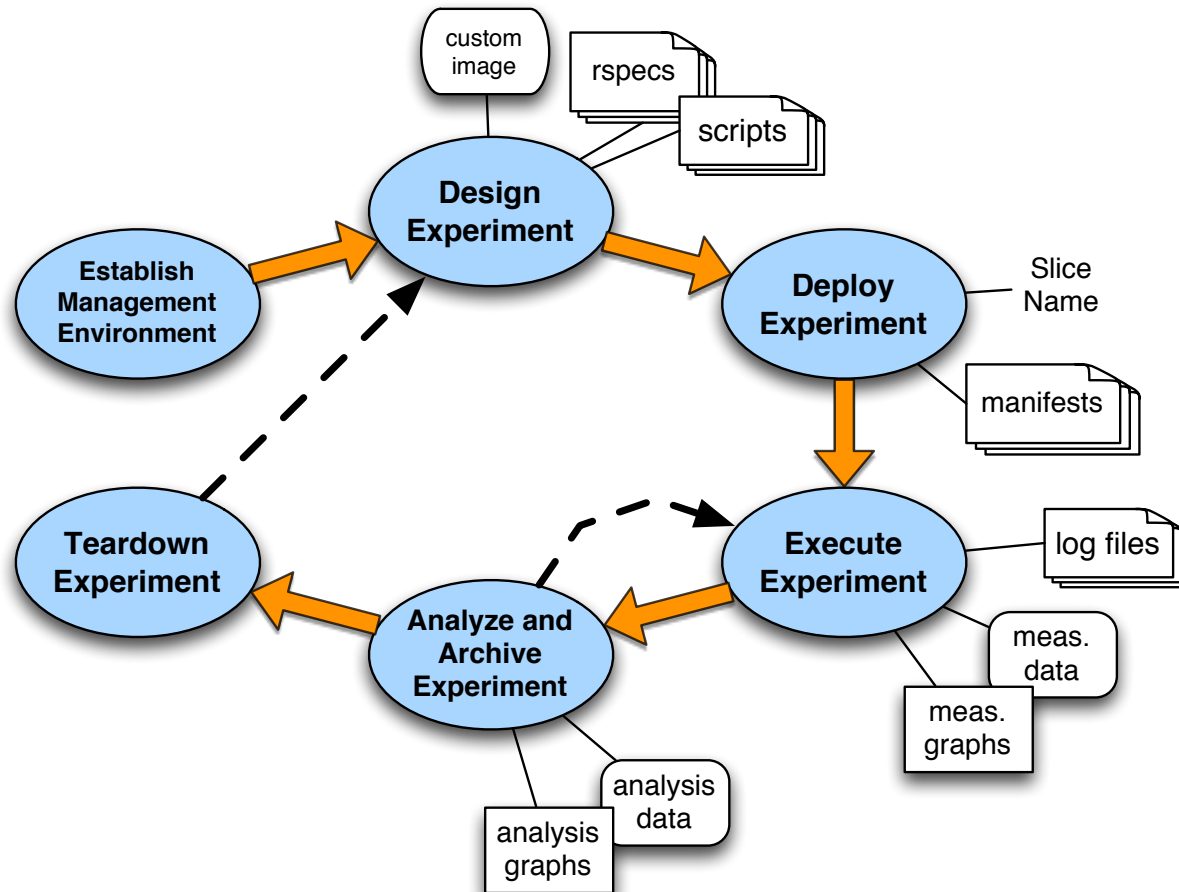


Sponsored by the National Science Foundation

- Objectives
  - Describe a general lifecycle process that can be followed when conducting GENI experiments
  - Provide guidance to experimenters on what tools are available, how and when they are best used.
  - Gather feedback on the experiment workflow and tools for future improvements
- Please contribute your thoughts and ideas!
  - The process I will describe is a strawman
  - You are the GENI experimenters and developers
  - What is your workflow?
  - What can we do to make this workflow easier?

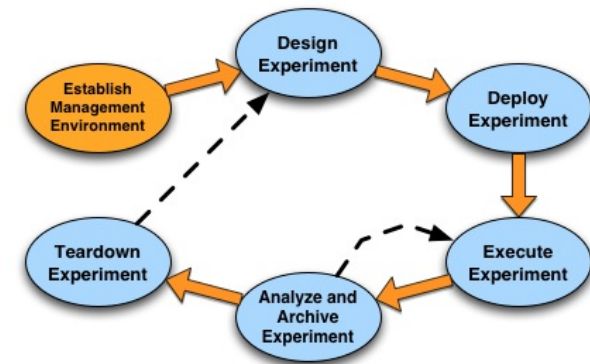
- Experiment Workflow Process
  - Broken down into 6 major steps
  - Describe each step
  - Discuss available tools
  - Discuss artifacts produced and consumed
- Upcoming tools
- Two GENI experimenters share their experience
  - Fraida Fund (Polytechnic Institute of NYU)
  - Roberto Francescangeli (Columbia University)
- Feedback
  - What tools or steps are missing?
  - What are the rough spots in the flow?

# Experiment Lifecycle

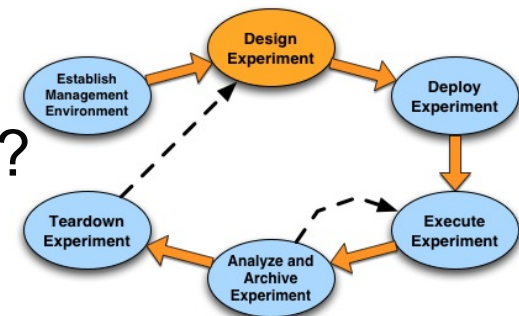



# Establish Management Environment

- Download and configure GENI credentials
  - GENI certificate
    - Download from GENI Slice Authority
    - Load into browser cache for Flack
      - Log in to Slice Authority website
  - SSH key pair
    - Download from GENI Slice Authority
    - Generate from GENI certificate
    - Add to ssh-agent
  - Archive service account
    - iRODS/CNRI-DOR
    - Obtain from service provider

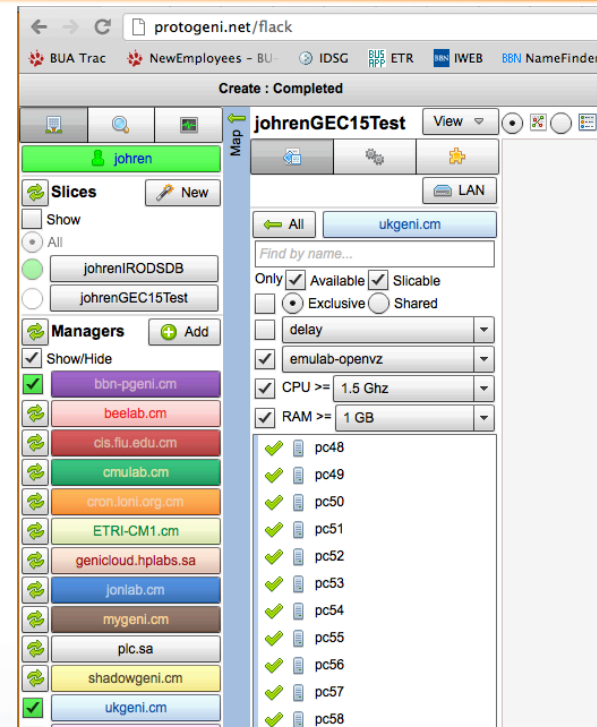


- A lot of questions to consider
  - What is the hypothesis of the experiment?
  - What is the experiment plan?
  - What resources are needed and available?
  - Are required services available? (iRODS, UNIS, etc.)
  - What is the required topology?
  - What applications are needed?
  - How will the experiment be orchestrated?
  - What measurements are needed?
  - Who needs access to the experiment?
  - Who needs access to the results?



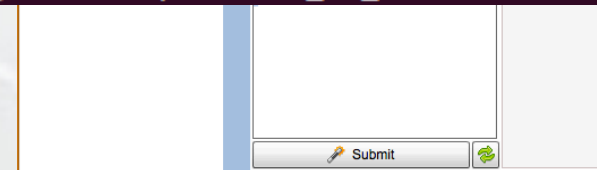
- What images are needed?
  - Generic images
    - Use install scripts to install and configure additional software
    - Easy to get started
  - Custom images
    - Configure and capture a custom image with necessary software for the experiment
    - ProtoGENI/InstaGENI
      - createimage.py
        - » <https://users.emulab.net/trac/protogeni/wiki/ImageHowTo>
      - Create Image button in Flack 
    - ExoGENI process (VMs only):
      - <https://geni-orca.renci.org/trac/wiki/virtual-machines>

- Tools
  - Flack
    - Determine what resources are available
    - Design the topology
  - OMNI
    - Determine what resources are available



```

geni@geni-VirtualBox:~$ omni.py -a pg-utah listresources -o
INFO:omni:Loading config file /home/geni/.gcf/omni_config
INFO:omni:Using control framework pg
INFO:omni:Saving output to a file.
Enter PEM pass phrase:
INFO:omni:Substituting AM nickname pg-utah with URL https://
geni/xmlrpc/am/2.0, URN unspecified_AM_URN
  
```





- Tools

- OMF/Gush

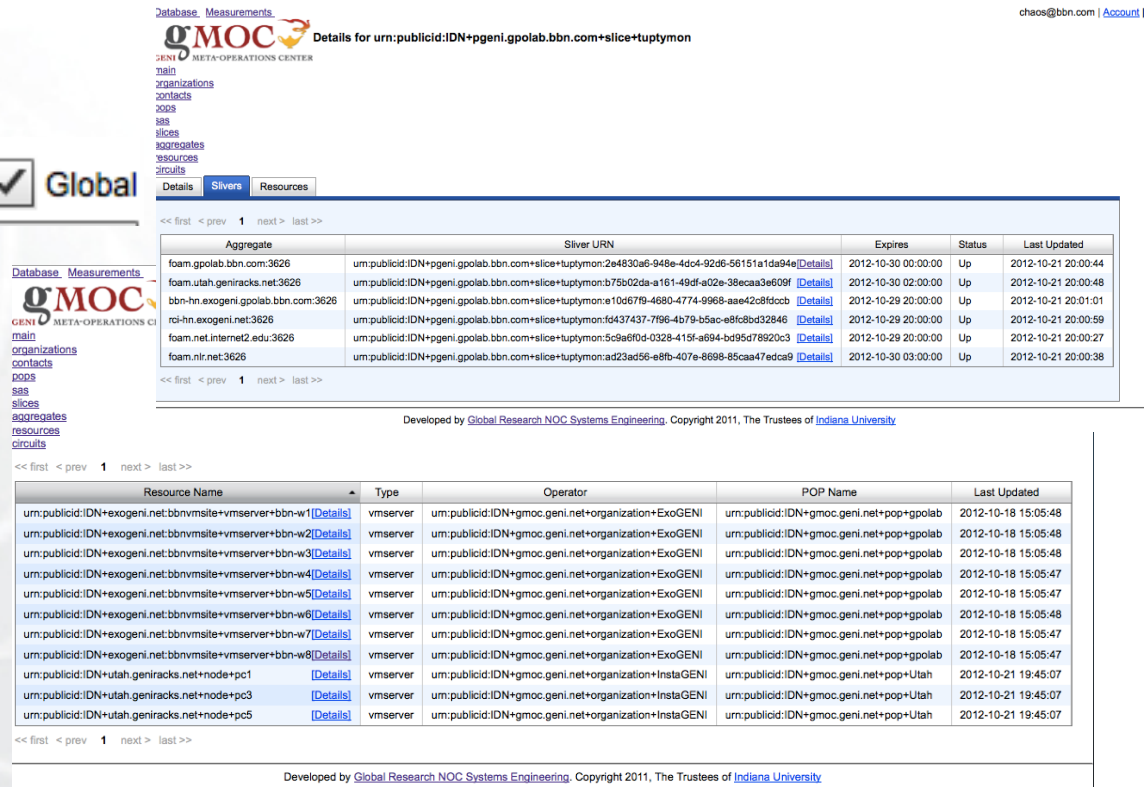
- Orchestration scripts

- Images

- Createimage.py
- Flack   Global

- Monitoring

- GMOC



Database. Measurements. **GMOC** GENI META-OPERATIONS CENTER Details for urn:publicid:IDN+pgeni.gpolab.bbn.com+slice+tuptymon chaos@bbn.com | Account |

main organizations contacts xos sas slices aggregates resources circuits

Details Silvers Resources

<< first < prev 1 next > last >>

Aggregate	Silver URN	Expires	Status	Last Updated
foam.gpolab.bbn.com:3626	urn:publicid:IDN+pgeni.gpolab.bbn.com+slice+tuptymon:2e4830a6-948e-4dc4-9246-56151a1da94e [Details]	2012-10-30 00:00:00	Up	2012-10-21 20:00:44
foam.utah.geniracks.net:3626	urn:publicid:IDN+pgeni.gpolab.bbn.com+slice+tuptymon:b75b02da-a161-49df-a02e-38ecaa3e609f [Details]	2012-10-30 02:00:00	Up	2012-10-21 20:00:48
bbn-hn.exogeni.gpolab.bbn.com:3626	urn:publicid:IDN+pgeni.gpolab.bbn.com+slice+tuptymon:a10d67f9-4680-4774-9968-aae428fdccb [Details]	2012-10-29 20:00:00	Up	2012-10-21 20:01:01
rci-hn.exogeni.net:3626	urn:publicid:IDN+pgeni.gpolab.bbn.com+slice+tuptymon:fd437437-7f96-4b79-b5ac-e8fc8bd32846 [Details]	2012-10-29 20:00:00	Up	2012-10-21 20:00:59
foam.net.internet2.edu:3626	urn:publicid:IDN+pgeni.gpolab.bbn.com+slice+tuptymon:5c9ae0d-0328-415f-a694-bd95d78920c3 [Details]	2012-10-29 20:00:00	Up	2012-10-21 20:00:27
foam.nir.net:3626	urn:publicid:IDN+pgeni.gpolab.bbn.com+slice+tuptymon:ad23ad56-e8fb-407e-8698-85caa47edca9 [Details]	2012-10-30 03:00:00	Up	2012-10-21 20:00:38

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Database. Measurements. **GMOC** GENI META-OPERATIONS CENTER

main organizations contacts xos sas slices aggregates resources circuits

<< first < prev 1 next > last >>

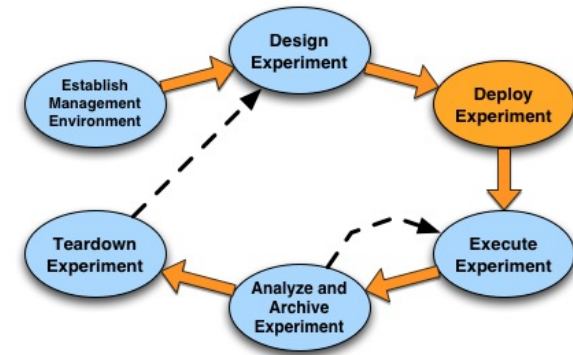
Resource Name	Type	Operator	POP Name	Last Updated
urn:publicid:IDN+exogeni.net:bbnvm-site+vmserver+bbn-w1 [Details]	vmserver	urn:publicid:IDN+gmoc.geni.net+organization+ExoGENI	urn:publicid:IDN+gmoc.geni.net+pop+gpolab	2012-10-18 15:05:48
urn:publicid:IDN+exogeni.net:bbnvm-site+vmserver+bbn-w2 [Details]	vmserver	urn:publicid:IDN+gmoc.geni.net+organization+ExoGENI	urn:publicid:IDN+gmoc.geni.net+pop+gpolab	2012-10-18 15:05:48
urn:publicid:IDN+exogeni.net:bbnvm-site+vmserver+bbn-w3 [Details]	vmserver	urn:publicid:IDN+gmoc.geni.net+organization+ExoGENI	urn:publicid:IDN+gmoc.geni.net+pop+gpolab	2012-10-18 15:05:48
urn:publicid:IDN+exogeni.net:bbnvm-site+vmserver+bbn-w4 [Details]	vmserver	urn:publicid:IDN+gmoc.geni.net+organization+ExoGENI	urn:publicid:IDN+gmoc.geni.net+pop+gpolab	2012-10-18 15:05:47
urn:publicid:IDN+exogeni.net:bbnvm-site+vmserver+bbn-w5 [Details]	vmserver	urn:publicid:IDN+gmoc.geni.net+organization+ExoGENI	urn:publicid:IDN+gmoc.geni.net+pop+gpolab	2012-10-18 15:05:47
urn:publicid:IDN+exogeni.net:bbnvm-site+vmserver+bbn-w6 [Details]	vmserver	urn:publicid:IDN+gmoc.geni.net+organization+ExoGENI	urn:publicid:IDN+gmoc.geni.net+pop+gpolab	2012-10-18 15:05:48
urn:publicid:IDN+exogeni.net:bbnvm-site+vmserver+bbn-w7 [Details]	vmserver	urn:publicid:IDN+gmoc.geni.net+organization+ExoGENI	urn:publicid:IDN+gmoc.geni.net+pop+gpolab	2012-10-18 15:05:47
urn:publicid:IDN+exogeni.net:bbnvm-site+vmserver+bbn-w8 [Details]	vmserver	urn:publicid:IDN+gmoc.geni.net+organization+ExoGENI	urn:publicid:IDN+gmoc.geni.net+pop+gpolab	2012-10-18 15:05:47
urn:publicid:IDN+utah.geniracks.net+node+pc1 [Details]	vmserver	urn:publicid:IDN+gmoc.geni.net+organization+InstaGENI	urn:publicid:IDN+gmoc.geni.net+pop+Utah	2012-10-21 19:45:07
urn:publicid:IDN+utah.geniracks.net+node+pc3 [Details]	vmserver	urn:publicid:IDN+gmoc.geni.net+organization+InstaGENI	urn:publicid:IDN+gmoc.geni.net+pop+Utah	2012-10-21 19:45:07
urn:publicid:IDN+utah.geniracks.net+node+pc5 [Details]	vmserver	urn:publicid:IDN+gmoc.geni.net+organization+InstaGENI	urn:publicid:IDN+gmoc.geni.net+pop+Utah	2012-10-21 19:45:07

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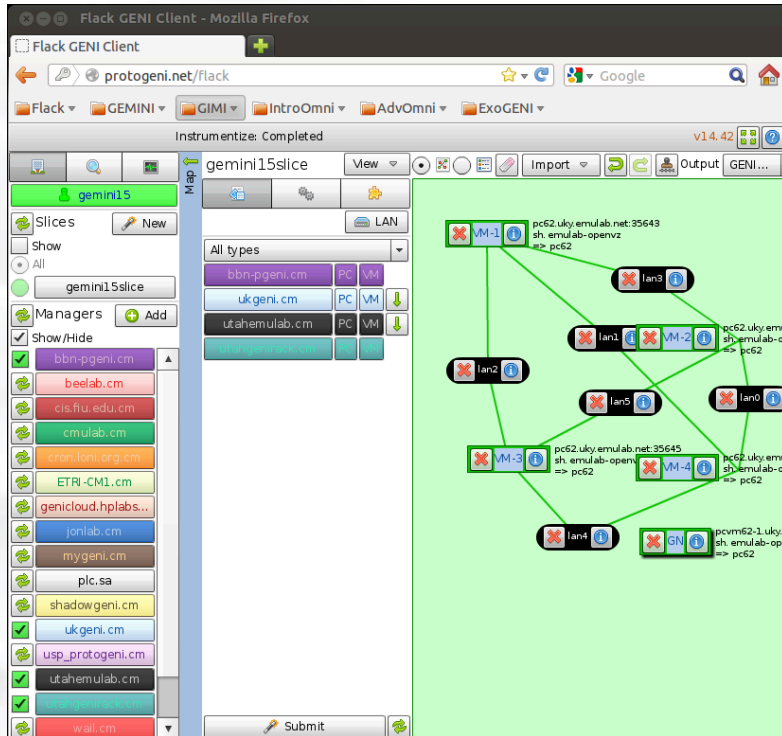
Developed by Global Research NOC Systems Engineering. Copyright 2011, The Trustees of Indiana University

- Artifacts
  - Advertisement specs (transient)
  - Request specs
  - Software package lists
  - Experiment orchestration scripts
  - Custom images
  - Install scripts

- Create slice(s)
- Create slivers
- Install and configure software
  - Experiment applications and services
  - Instrumentation and Measurement tools
- Verify Deployment
  - Node access (can I ping/login to the nodes?)
  - Connectivity (is the network topology set up correctly?)
  - Software configuration (are services running?)



- Resource Configuration Tools
  - Flack
  - Omni



```

geniuser@UserWorkspace: ~
geniuser@UserWorkspace:~$ omni.py -a insta-utah createsliver johGEC15Test insta.rspec
INFO:omni:Loading config file /home/geniuser/.gcf/omni_config
INFO:omni:Using control framework pg
INFO:omni:Slice urn:publicid:IDN+geni.gpolab.bbn.com+slice+johGEC15Test expires on 2012-10-20 19:33:21 UTC
INFO:omni:Substituting AM nickname insta-utah with URL https://boss.utah.geniracks.net/protogeni/xmlrpc/am/2.0, URN unspecified_AM_URN
INFO:omni:Substituting AM nickname insta-utah with URL https://boss.utah.geniracks.net/protogeni/xmlrpc/am/2.0, URN unspecified_AM_URN
INFO:omni:Creating sliver(s) from rspec file insta.rspec for slice urn:publicid:IDN+geni.gpolab.bbn.com+slice+johGEC15Test
INFO:omni:Got return from CreateSliver for slice johGEC15Test at https://boss.utah.geniracks.net/protogeni/xmlrpc/am/2.0:
INFO:omni:<?xml version="1.0" ?>
INFO:omni: <!-- Reserved resources for:
          Slice: johGEC15Test
          at AM:
  
```

- I&M Tools
  - GEMINI
    - Instrumentize.py
  - GIMI
    - OMF scripts
  - INSTOOLS
    - Instrumentize button in Flack

```
geni@geni-VirtualBox: ~  
geni@geni-VirtualBox:~$ instrumentize.py -f ~/ssh/myppgenicert.pem -n myGENIslice
```

INSTOOLS ▼

[? Read Tutorial](#)

[⚡ Instrumentize](#)

INSTOOLS APIV 2 ▼

INSTOOLSv Stable ▼

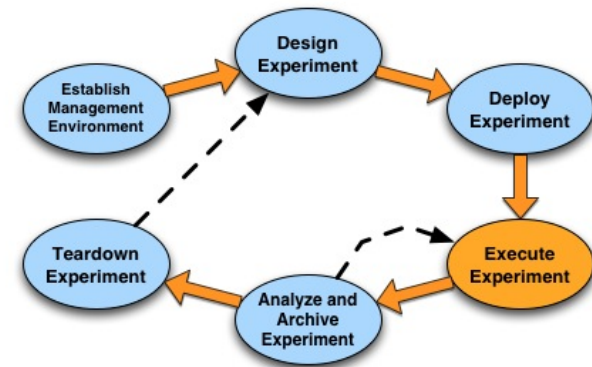
Virtual MCs  Raw MCs

[📊 Go to portal](#)

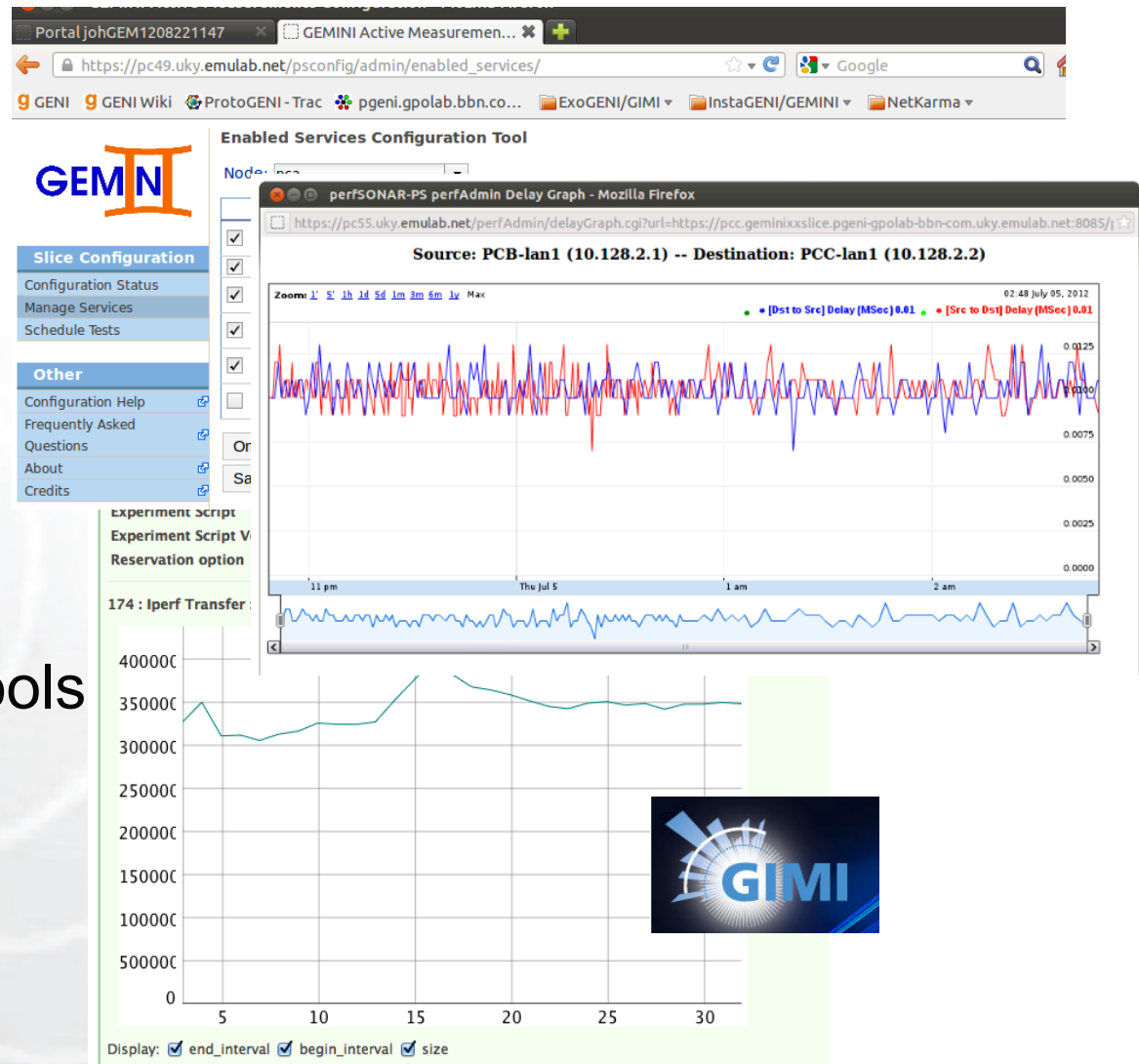
- Artifacts
  - Slice Name
  - Manifest rspec

```
<?xml version="1.0" ?>
  <!-- Reserved resources for:
        Slice: gemini17slice
        at AM:
        URN: unspecified_AM_URN
        URL: https://www.uky.emulab.net/protogeni/xmlrpc/am/2.0
  -->
  <rspec expires="2012-10-24T00:00:00Z" generated="2012-10-10T16:34:53Z" generated_b
y="Flack" type="manifest" xmlns="http://www.geni.net/resources/rspec/3" xmlns:client
="http://www.protogeni.net/resources/rspec/ext/client/1" xmlns:flack="http://www.pro
togeni.net/resources/rspec/ext/flack/1" xmlns:gemini="http://geni.net/resources/rspe
c/ext/gemini/1" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLoca
tion="http://www.geni.net/resources/rspec/3 http://www.geni.net/resources/rspec/3/ma
nifest.xsd">
  <node client_id="VM-1" component_id="urn:publicid:IDN+uky.emulab.net+node+pc73"
component_manager_id="urn:publicid:IDN+uky.emulab.net+authority+cm" exclusive="false
" sliver_id="urn:publicid:IDN+uky.emulab.net+sliver+57851" xmlns:flack="http://www.p
rotogeni.net/resources/rspec/ext/flack/1" xmlns:gemini="http://geni.net/resources/rs
pec/ext/gemini/1" xmlns:rs="http://www.protogeni.net/resources/rspec/ext/emulab/1">
    <rs:vnode name="pcvm73-7"/>
    <sliver_type name="emulab-opensvz"/>
    <interface client_id="VM-1:if0" component_id="urn:publicid:IDN+uky.emulab.ne
t+interface+pc73:lo0" mac_address="00000a800202" sliver_id="urn:publicid:IDN+uky.emu
lab.net+sliver+57861">
      <ip address="10.128.2.2" netmask="" type="ipv4"/>
      <flack:interface_info addressUnset="false"/>
    </interface>
```

- Configure and enable I&M services
- Configure and execute the experiment
- Observe real-time experiment measurements and output
- Push results to off-slice storage

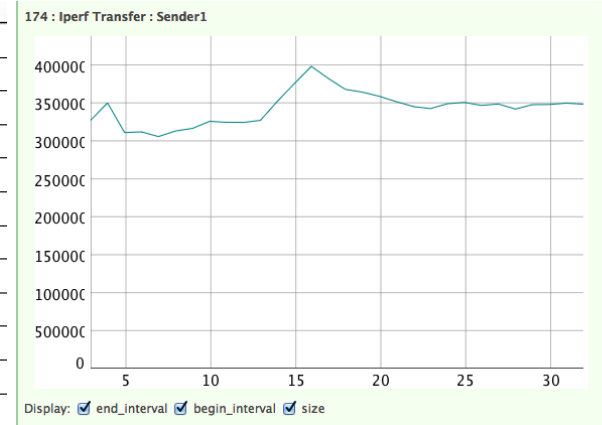
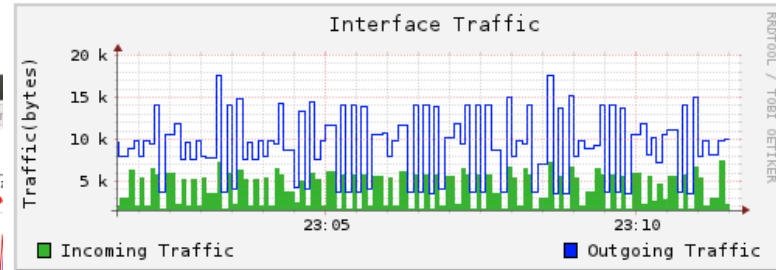
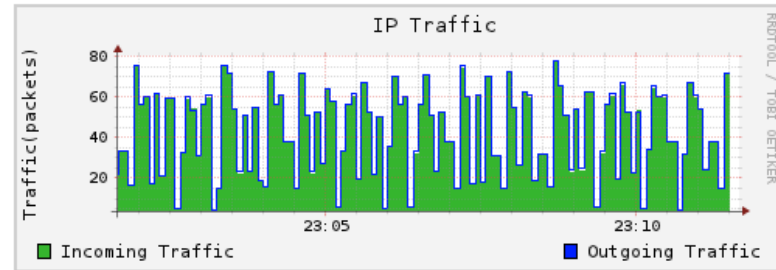
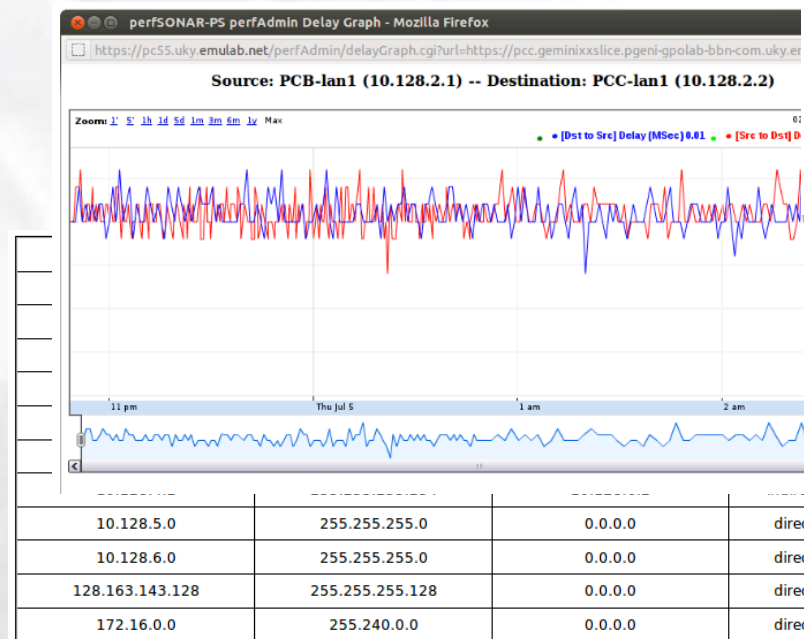


- Tools
  - I&M tools
    - GIMI
    - GEMINI
    - INSTOOLS
  - Monitoring
    - GMOC
  - Orchestration tools
    - OMF
    - Gush



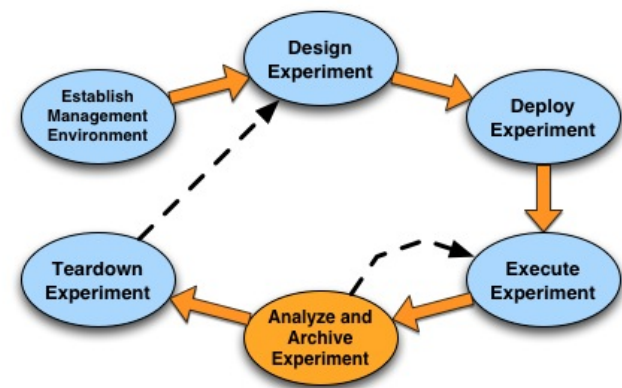


- Artifacts
  - Measurement data
  - Measurement graphs
  - Log files

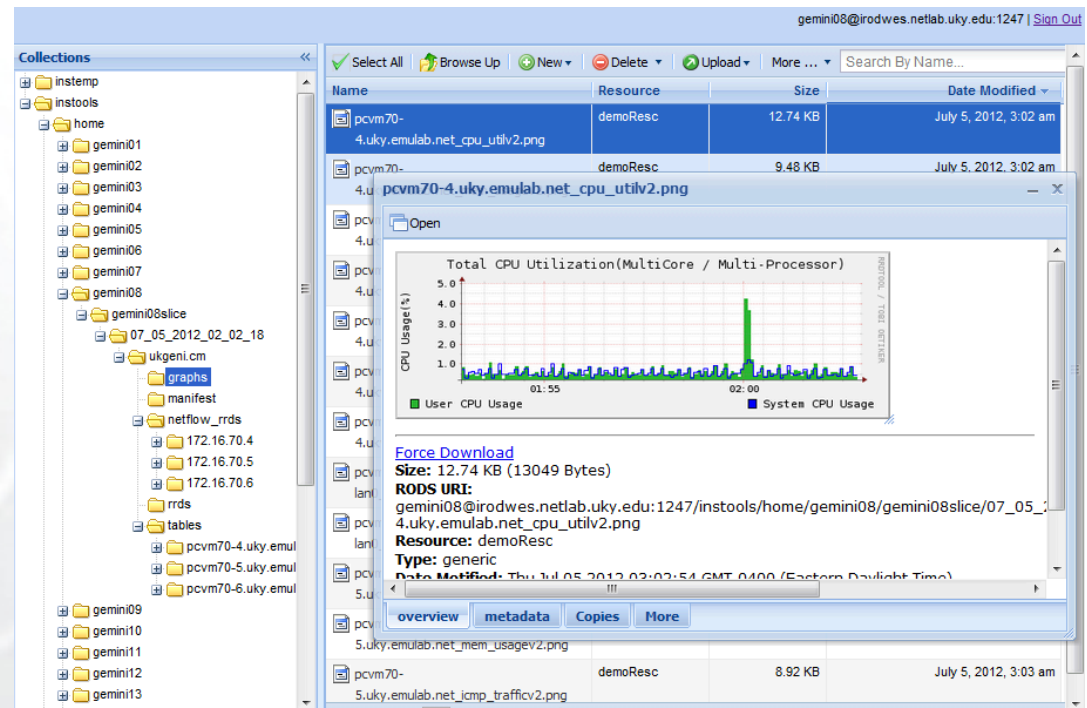


# Analyze and Archive Experiment

- Observe post-experiment measurements
- Observe experiment results
- Analyze results
- Push analysis results to off-slice storage
- Push full experiment and metadata to long-term archive



- Tools
  - I&M Tools
    - GIMI
    - GEMINI,
    - INSTOOLS
  - Analysis Software
    - Third-party tools:
      - R, gnuplot, etc.
  - Archival Services
    - iRODS
    - CNRI-DOR



The screenshot shows the iRODS web interface. On the left is a 'Collections' tree view showing a hierarchy of folders: instemp, instools, home, gemini01-08, gemini08slice, 07\_05\_2012\_02\_02\_18, ukgent.cm, graphs, manifest, netflow\_rrds, 172.16.70.4-6, rrd, tables, pcvm70-4-6.uky.emul. The main panel displays a table of resources:

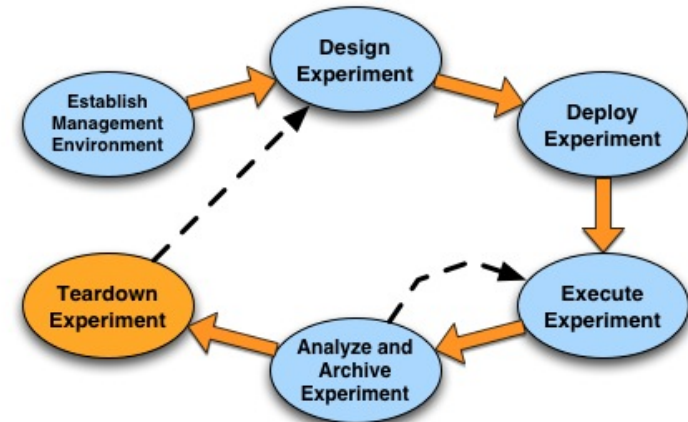
Name	Resource	Size	Date Modified
pcvm70-4.uky.emulab.net_cpu_utilv2.png	demoResc	12.74 KB	July 5, 2012, 3:02 am
pcvm70-4.uky.emulab.net_cpu_utilv2.png	demoResc	9.48 KB	July 5, 2012, 3:02 am
pcvm70-5.uky.emulab.net_icmp_trafficv2.png	demoResc	8.92 KB	July 5, 2012, 3:03 am

An 'Open' dialog box is open for the selected file, displaying a line graph titled 'Total CPU Utilization(MultiCore / Multi-Processor)'. The graph shows 'User CPU Usage' (green) and 'System CPU Usage' (blue) over time. The Y-axis is 'CPU Usage (%)' from 0 to 5.0. The X-axis shows time from 01:55 to 02:00. A significant spike in user CPU usage is visible at approximately 01:58:30.

Below the graph, the following metadata is shown:

- Force Download**
- Size:** 12.74 KB (13049 Bytes)
- RODS URI:** gemini08@irodws.netlab.uky.edu:1247/instools/home/gemini08/gemini08slice/07\_05\_2012\_02\_02\_18/ukgent.cm/graphs/manifest/netflow\_rrds/172.16.70.4/rrds/tables/pcvm70-4.uky.emulab.net\_cpu\_utilv2.png
- Resource:** demoResc
- Type:** generic
- Date Modified:** Thu Jul 05 2012 02:02:54 GMT-0400 (Eastern Daylight Time)

- Delete slivers
  - Releases resources
- Tools
  - Flack
  - OMNI



	Tools	Notes
<b>Design/Deploy</b>	Flack	not supported with ExoGENI
	OMNI	
<b>Execute/ Orchestrate</b>	OMF, Gush	
<b>Monitoring</b>	GMOC	
<b>I&amp;M</b>	GEMINI, INSTOOLS,	Currently ProtoGENI/InstaGENI only
	GIMI	Currently ExoGENI only
<b>Archival</b>	iRODS, CNRI-DOR	
<b>Image Creation</b>	Createimage.py	ProtoGENI/InstaGENI



# Upcoming GENI Tool Tutorials

<b>Tool</b>	<b>Session Time</b>
<b>Intro to OMNI</b>	Today, 3pm
<b>GEMINI (part 2)</b>	Today, 3pm
<b>Advanced OMNI</b>	Wednesday, 1pm
<b>ExoGENI</b>	Wednesday, 1pm
<b>GIMI</b>	Thursday, 8:30am
<b>WiMAX (OMF)</b>	Thursday, 8:30am

- GENI Portal

- An entry to GENI for experimenters
- A user interface to the GENI Clearinghouse services



Logged in as Aaron Helsinger

Home Projects Slices Profile Help Debug

### My Projects

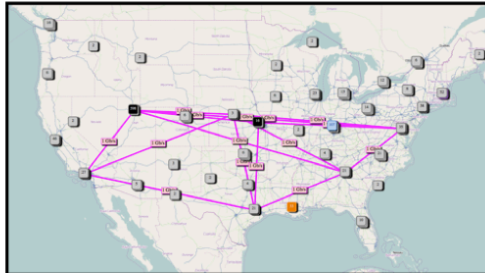
Join a Project  
Ask Someone to Create a Project  
No outstanding project join requests.

Project Name	Project Lead	Purpose	Slice Count	Create Slice
<a href="#">CS101</a>	<a href="#">Marshall Brinn</a>	teach CS	1	<a href="#">Create Slice</a>

### My Slices

Slice Name	Project	Slice Expiration	Slice Owner	Add Slivers	Sliver Status	Manifest	Delete Slivers	Flack
<a href="#">TuesdaySession</a>	<a href="#">CS101</a>	2012-06-26 21:27:44	<a href="#">Aaron Helsinger</a>	<a href="#">Add Slivers</a>	<a href="#">Sliver Status</a>	<a href="#">Manifest</a>	<a href="#">Delete Slivers</a>	<a href="#">Launch Flack</a>

### GENI Resources



### GENI Messages

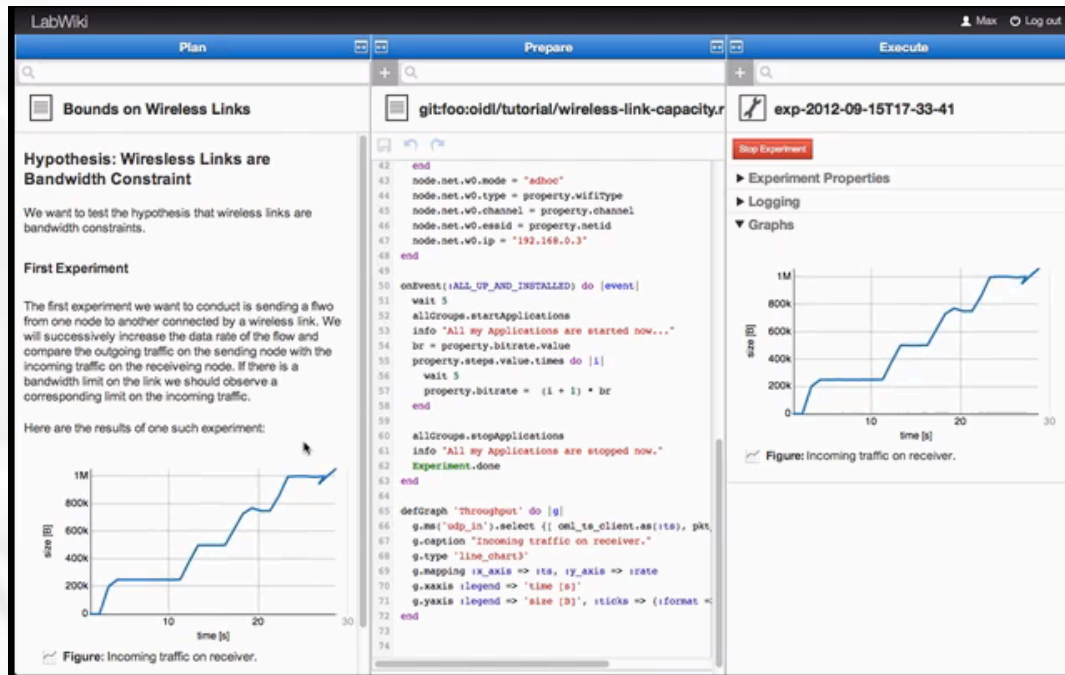
- 2012-06-26 13:24:20: Added Aaron Helsinger to project CS101 as Member
- 2012-06-26 13:22:54: Aaron Helsinger requested to join project CS101
- 2012-06-26 13:46:40: Deleted resources from slice TuesdaySession
- 2012-06-26 13:31:37: Added resources to slice TuesdaySession
- 2012-06-26 13:27:44: Created slice TuesdaySession

[Invite Someone to GENI](#)

- See **GENI Portal and Clearinghouse** session at 1pm tomorrow for more details

- LabWiki

- A web-based tool to support the experimenter throughout the entire investigative lifecycle.
- Designed as a framework with plugins



The screenshot displays the LabWiki interface with three main panels: Plan, Prepare, and Execute.

- Plan Panel:** Shows the experiment title "Bounds on Wireless Links", a hypothesis "Wireless Links are Bandwidth Constraint", and a description of the first experiment. It includes a line graph showing "Incoming traffic on receiver" over time, with data points at approximately (0,0), (5,200k), (10,400k), (15,600k), (20,800k), and (25,1M).
- Prepare Panel:** Shows a Git repository path and a code editor with a script for setting up an ad-hoc network and measuring throughput. The script includes commands for setting node properties, starting applications, and logging data.
- Execute Panel:** Shows the experiment ID "exp-2012-09-15T17-33-41", a "Stop Experiment" button, and a "Graphs" section containing the same line graph as in the Plan panel.

- See <http://labwiki.mytestbed.net> for introductory video
- See **GIMI Tutorial** at 8:30am Thursday for more details



- **Fraida Fund**
  - Polytechnic Institute of New York University
  - GENI WiMAX Project
  
- **Roberto Francescangeli**
  - Columbia University
  - NetServ Project

- Does this workflow fit your process or model of planning and executing experiments?
- What steps or tools are missing?
- What is out of order?
- What are the rough spots in the flow?
  - Places where tools can help smooth out the process

- Experiment Management BoF Dinner
  - Wednesday 6pm
  - Ninfas's (<http://www.ninfas.com>)
  - RSVP to Sarah Edwards ([sedwards@bbn.com](mailto:sedwards@bbn.com))
  - Meet at 6pm in lobby of hotel