Are you ready for the tutorial?

1. Grab instructions

2. Did you do the pre-work?
   A. Do you have an account?
   B. Have you installed the tools?
      * ssh

3. Connect to the network
   Connect to *U. Oregon's wireless network*

GENI Portal is at:

http://portal.geni.net

An Introduction to GENI and Your 1st Experiment using GENI

Violet R. Syrotiuk

Arizona State University

Based on a presentation by Sarah Edwards and Vic Thomas, GENI Project Office

Sponsored by the National Science Foundation

Outline

- What is GENI?
- How is GENI being used?
- An experimenter's view of GENI
- Two hands-on exercises
  1. Create a simple topology and experiment with it
  2. A routing exercise using an existing topology

Why GENI?

Science Issues

We cannot currently understand or predict the behavior of complex, large-scale networks

Innovation Issues

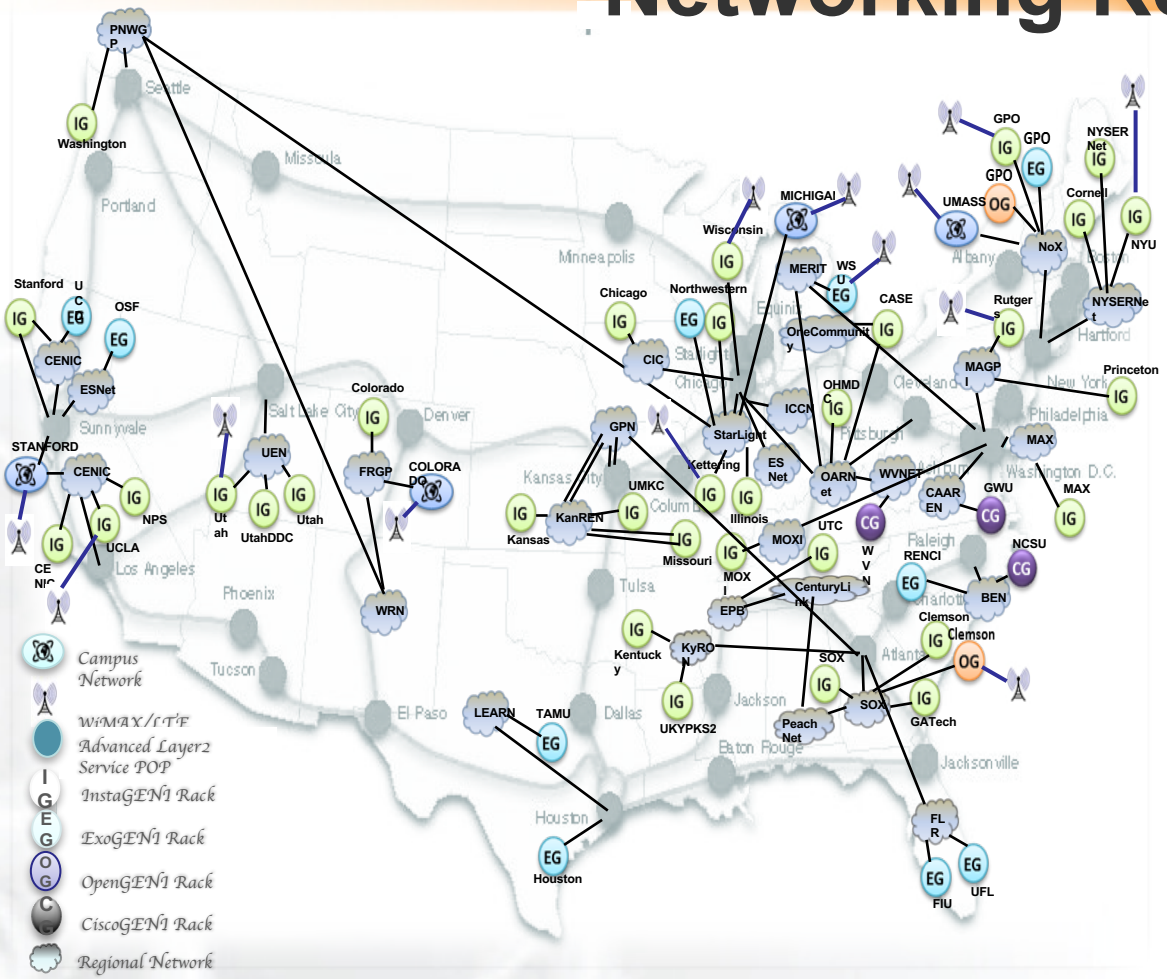
Substantial barriers to at-scale experimentation with new architectures, services, and technologies

Society Issues

We increasingly rely on the Internet but are unsure we can trust its security, privacy or resilience

These issues are becoming increasingly important with ubiquitous connectivity, IoT, cybercrime.

GENI: A Laboratory for Novel Networking Research



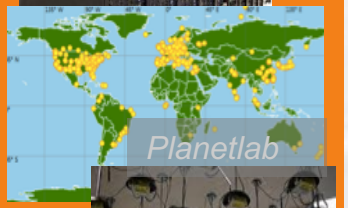
GENI provides compute resources that can be connected in experimenter specified Layer 2 topologies.

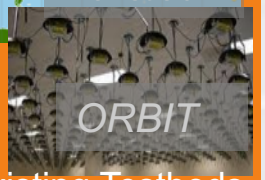
Compute Resources

GENI Racks: small clouds
Virtual Machines
Bare metal Machines

Android Phones

Wireless nodes

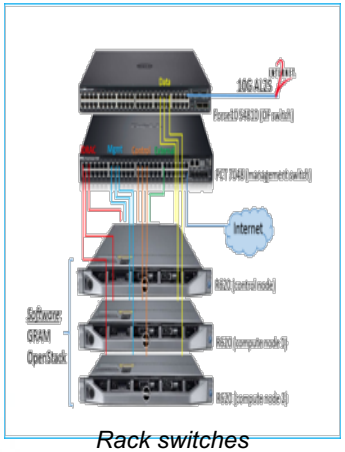




Existing Testbeds

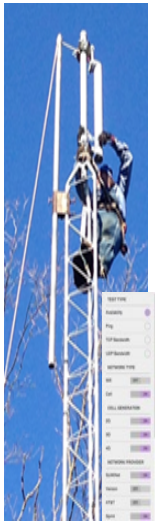
Network Resources

Layer 2 VLANS and Access to Programmable Switches

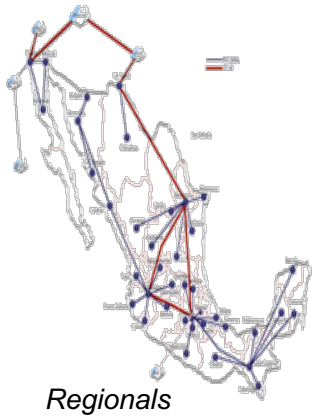


Rack switches

Internet2: US Research Backbone

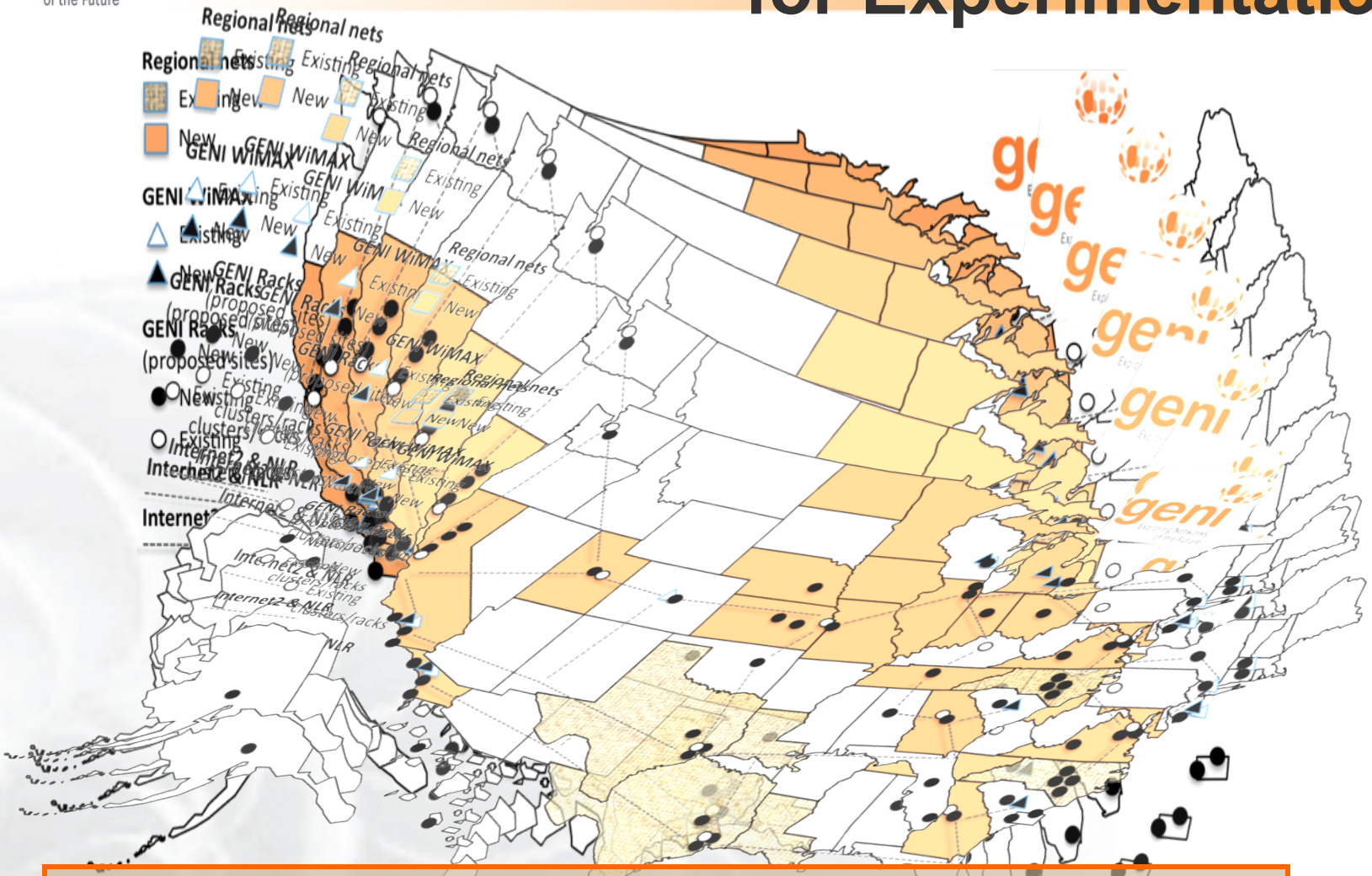


WiMAX/LTE base stations, 4G/3G Network



Regionals

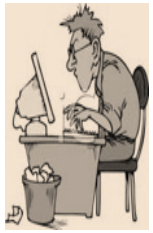
GENI: Infrastructure for Experimentation



GENI provides compute resources that can be connected in experimenter specified Layer 2 topologies.

Multiple GENI Experiments run Concurrently

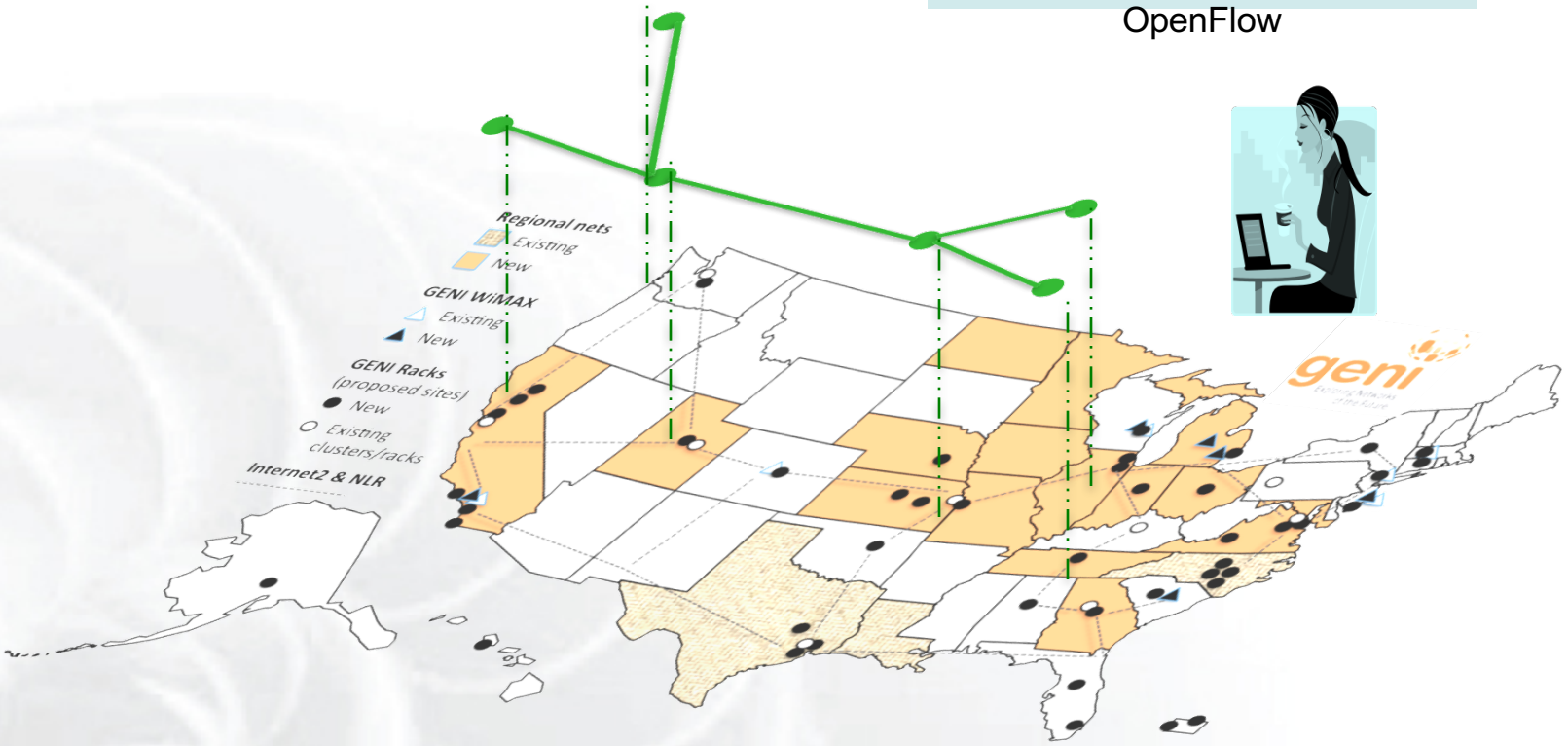
Resources may be **virtualized** and used by multiple experiments



Experiments live in **isolated** "slices"

GENI is "Deeply Programmable"

I install software I want throughout my network slice (into routers, switches, …) or control switches using OpenFlow



Everything is programmable: Experimenters create and program custom topologies, protocols and flows

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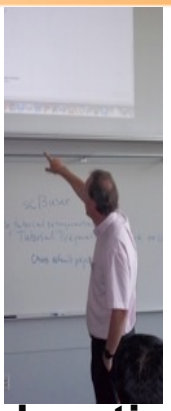
GENI for Research and Education

Research

- Future Internet Architectures
- Software defined networking
- Large scale evaluation of protocols
- Cloud networking
- Domain sciences



Education

- Classes in:
  - Computer Networking
  - Distributed systems
  - Cloud computing
  - Wireless Communications
- Undergraduate, graduate

GENI has over 10,000 users!

STEM Initiatives using GENI

K-12

PlanIT: SimCIty like game set in students' own city

Bringing scientific instruments into the classroom virtually

Immersive 3D environments for problem solving

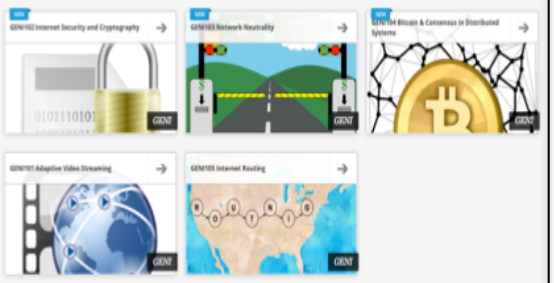
Grad/Undergrad

GENI as a remote, virtual lab for networking, distributed systems and cloud computing classes

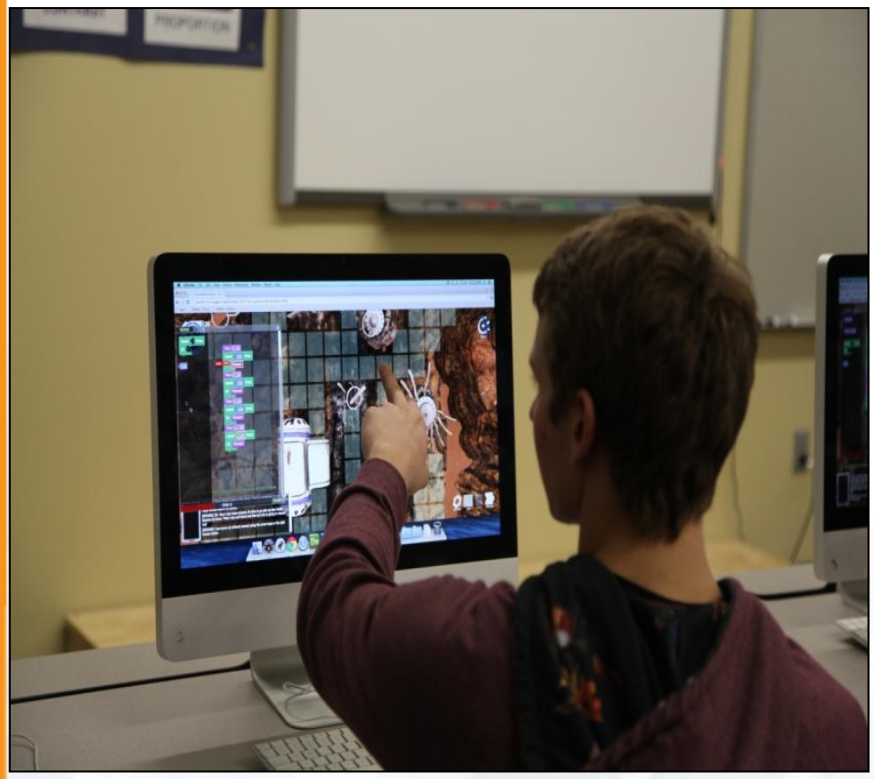
Community

GENI based Massive Open Online Courses (MOOCs) for the masses

edX



Mars Rover Game

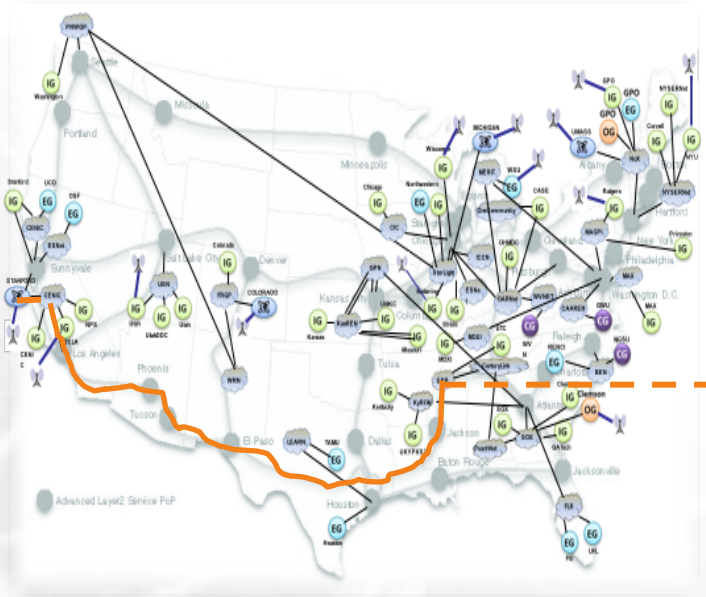


Students at a high school in Colorado learn math and programming using the Mars Rover game

The Mars Rover has crash landed and the student must help the rover repair itself, build shelter, and prepare for colonists before they arrive. The game is designed to engage high school students, effectively teach and assess their critical thinking, math, and programming skills. - *https://www.adlnet.gov/mars-game*

Bringing Science to Life

Digital cinema microscope
at the U. of Southern California



GENI network

High school student in
Chattanooga, TN

GENI as a Remote Lab

Over 4500 students have used GENI in classes taught by 73 instructors

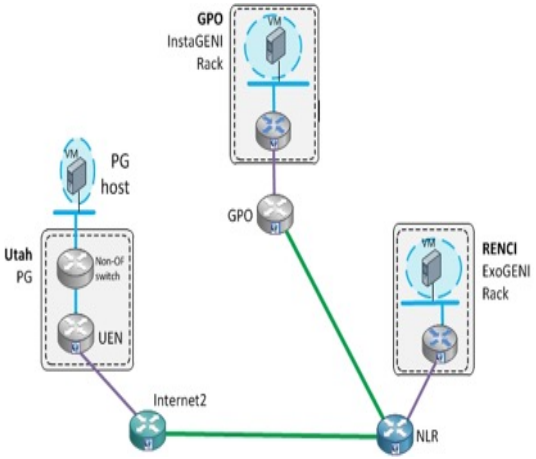
Last semester 638 students in 24 classes did labs on GENI

Jennie Albrecht teaches a distributed systems class at Williams College, MA

Students using GENI in a wireless networking class in Greece

Why use GENI for Education?

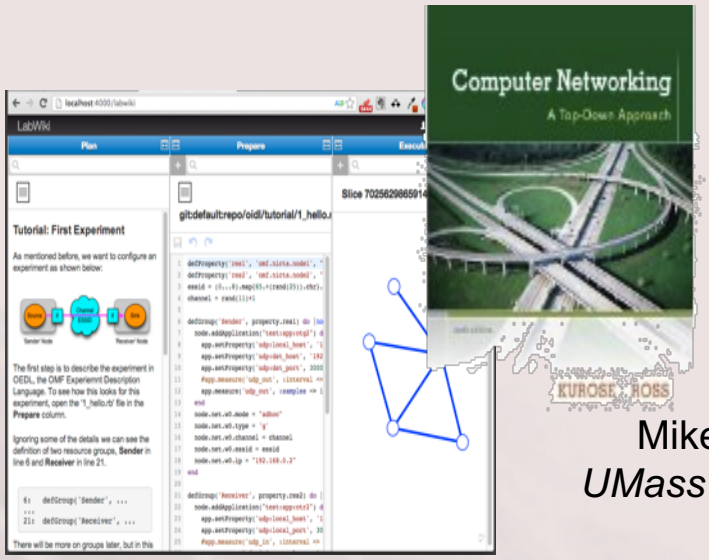
- No need to acquire and maintain expensive lab facilities
  - 24x7 access from almost anywhere
- Enables new lab exercises
  - Exercises based on expensive and uncommon resources
    - 4G wireless base stations, long haul network links, programmable switches
- Promotes exploratory learning
  - If student messes up a resource configuration, delete and start over
    - No instructor or administrator intervention needed
- Shared community resource
  - Community developed course modules
  - Community supported mailing lists



Wide area experiment on GENI

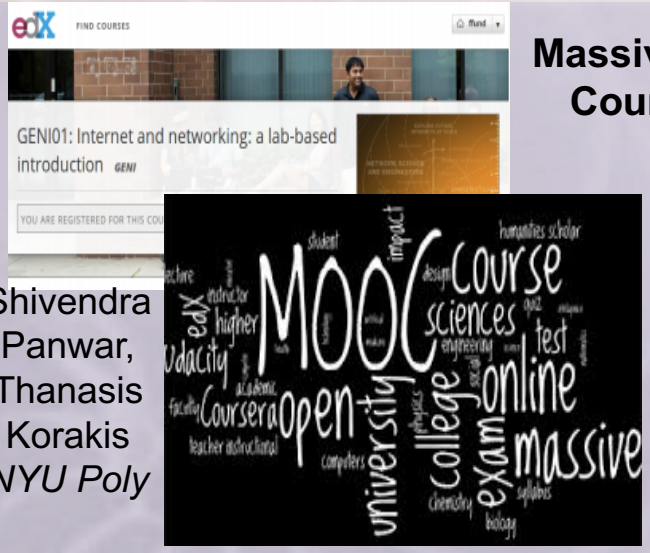
One of many wireless resources available for GENI labs

GENI-based Courseware



Labs on GENI for networking textbook

Mike Zink
UMass Amherst

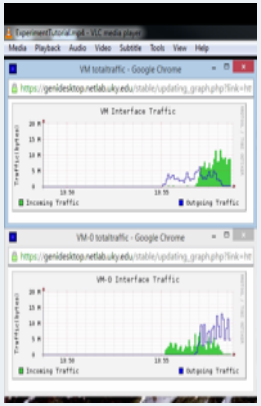


Massive Online Open Courses on GENI

Shivendra Panwar, Thanasis Korakis
NYU Poly

Use GENI to educate the Internet users, not the Internet creators.

GENI Modules to teach networking concepts

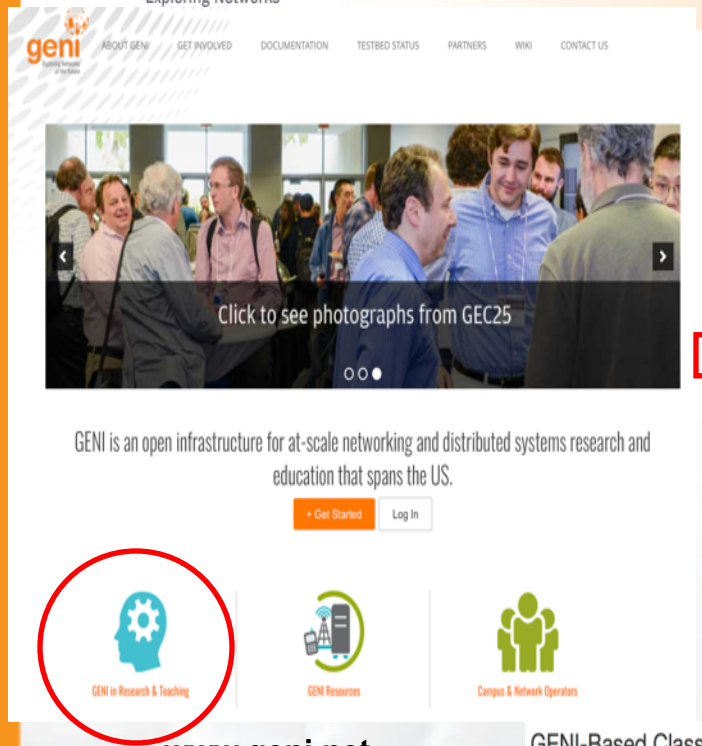


Example Demo Module

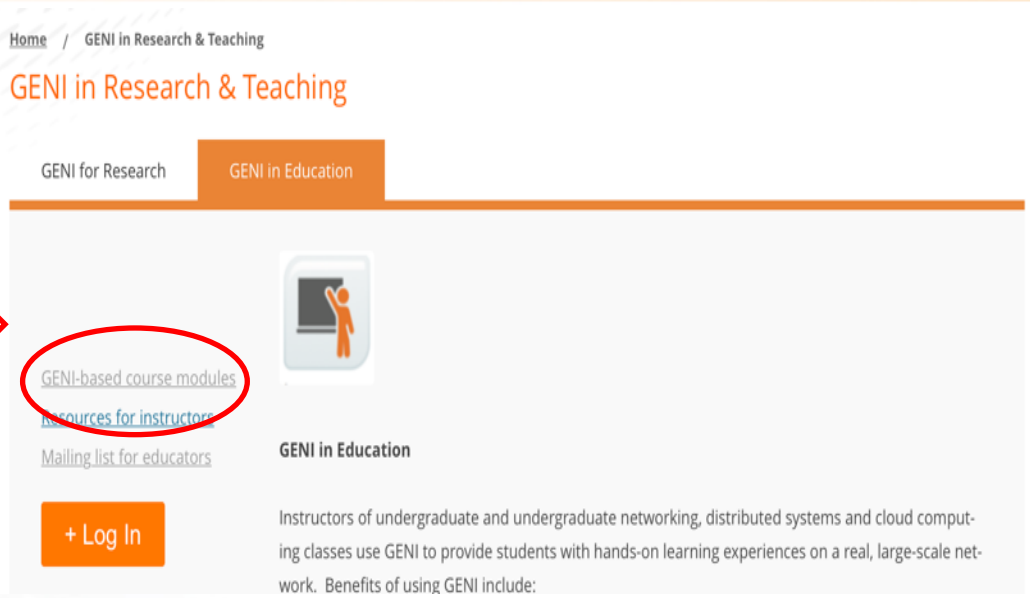
Example Assignment

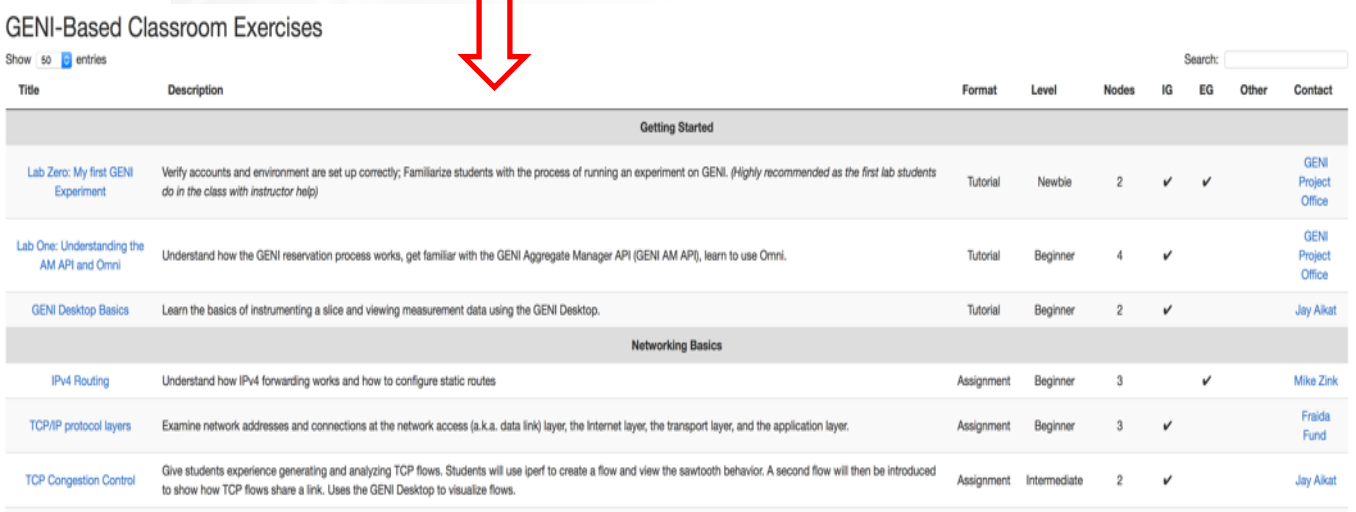
Kevin Jaffay, Jay Aikat
UNC-Chapel Hill

GENI Course Modules on www.geni.net



www.geni.net





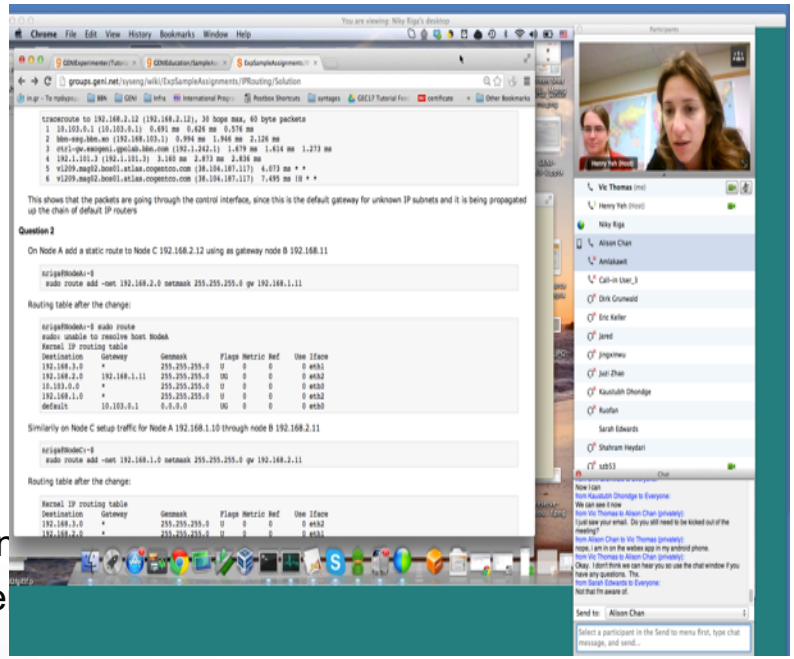
GENI-Based Classroom Exercises

Show 50 entries Search:

Title	Description	Format	Level	Nodes	IG	EG	Other	Contact
Getting Started								
Lab Zero: My first GENI Experiment	Verify accounts and environment are set up correctly; Familiarize students with the process of running an experiment on GENI. *(Highly recommended as the first lab students do in the class with instructor help)*	Tutorial	Newbie	2	✔	✔		GENI Project Office
Lab One: Understanding the AM API and Omni	Understand how the GENI reservation process works, get familiar with the GENI Aggregate Manager API (GENI AM API), learn to use Omni.	Tutorial	Beginner	4	✔			GENI Project Office
GENI Desktop Basics	Learn the basics of instrumenting a slice and viewing measurement data using the GENI Desktop.	Tutorial	Beginner	2	✔			Jay Aikat
Networking Basics								
IPv4 Routing	Understand how IPv4 forwarding works and how to configure static routes	Assignment	Beginner	3		✔		Mike Zink
TCP/IP protocol layers	Examine network addresses and connections at the network access (a.k.a. data link) layer, the Internet layer, the transport layer, and the application layer.	Assignment	Beginner	3	✔			Fraida Fund
TCP Congestion Control	Give students experience generating and analyzing TCP flows. Students will use iperf to create a flow and view the sawtooth behavior. A second flow will then be introduced to show how TCP flows share a link. Uses the GENI Desktop to visualize flows.	Assignment	Intermediate	2	✔			Jay Aikat

Train-the-TA Webinar

- Offered start of every semester
- Attended by instructors and TAs
- Two 3-hour sessions on two afternoons
  - Session 1: Introduction to GENI
    - Simple hands-on exercise
    - (you can skip this)
  - Session 2: Tips for running a class on GENI
    - Timeline
    - Setup needed (GENI Project, accoun
    - Tips for debugging student experime



Join the community mailing list for educators for announcements:
geni-educators@googlegroups.com

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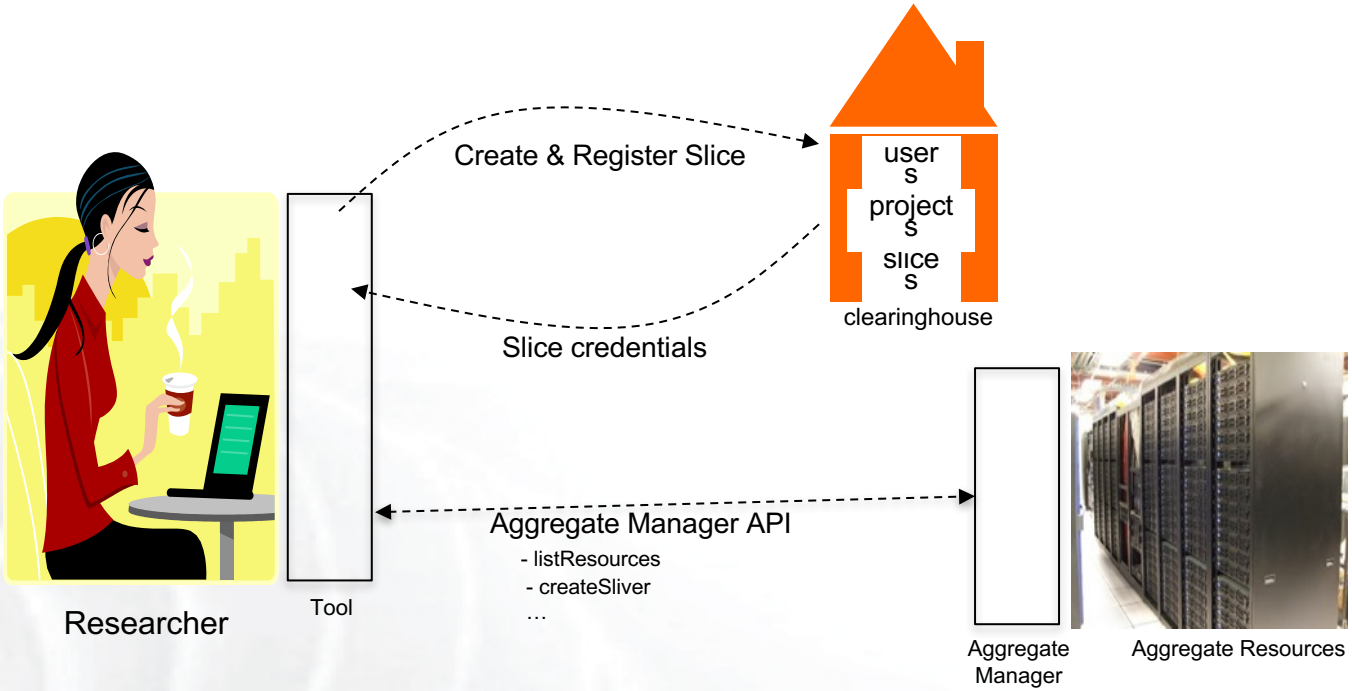
Clearinghouse and Aggregates



- Clearinghouse: Manages users, projects and slices
  - Standard credentials shared via custom API or new Common CH API
  - GENI supported accounts: GENI Portal/CH, PlanetLab CH, ProtoGENI CH
- Aggregate: Provides resources to GENI experimenters
  - Typically owned and managed by an organization
  - Speaks the GENI AM API
  - Examples: PlanetLab, Emulab, GENI Racks on various campuses

RSpecs

- **RSpecs:** Lingua franca for describing and requesting resources
  - **"Machine language"** for negotiating resources between experiment and aggregate
  - Experimenter tools eliminate the need for most experimenters to write or read RSpec

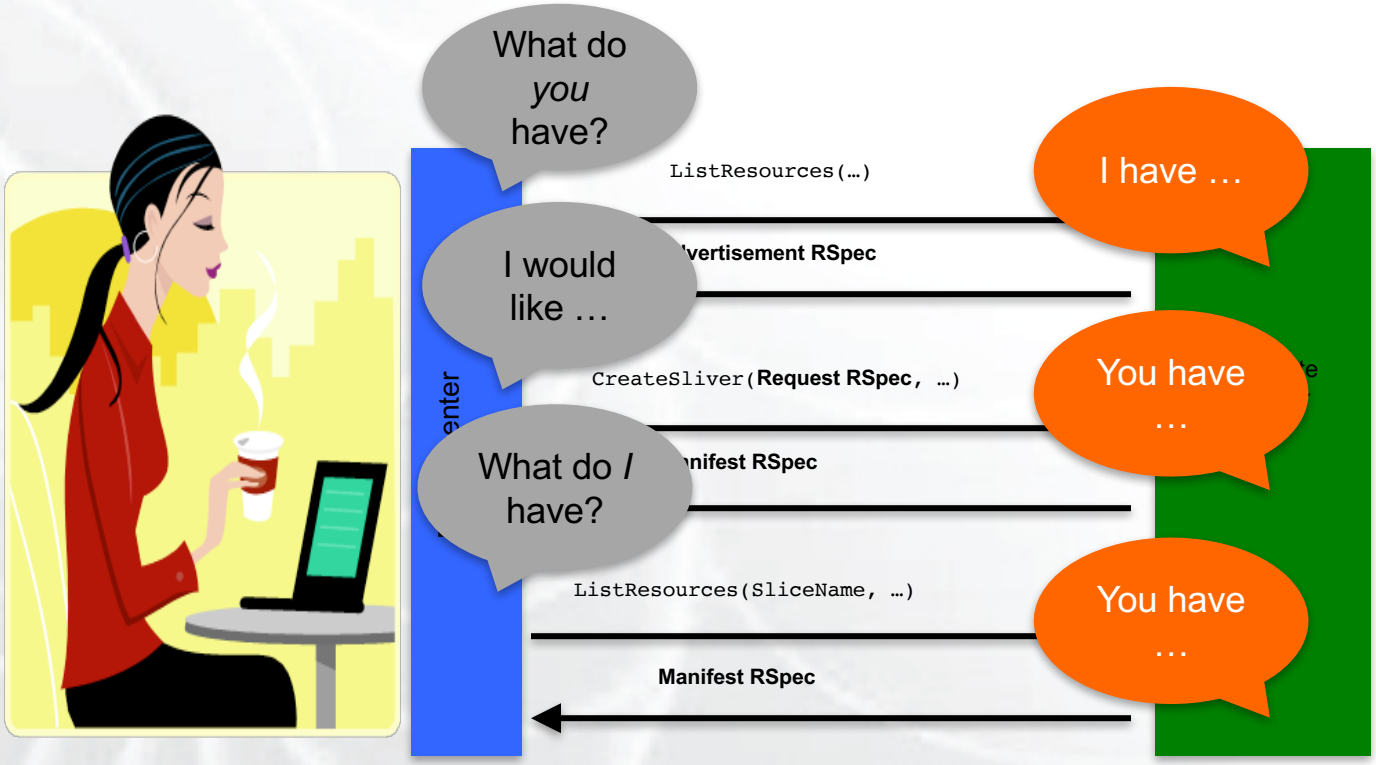
```
<?xml version="1.0" encoding="UTF-8"?>
<rspec xmlns="http://www.protogeni.net/resources/rspec/2"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xsi:schemaLocation="http://www.protogeni.net/resources/rspec/2
                           http://www.protogeni.net/resources/rspec/2/request.xsd"
       type="request" >
  <node client_id="my-node"
        exclusive="true">
    <sliver_type name="raw-pc" />
  </node>
</rspec>
```

RSpec for requesting a single node

Reserving Resources using RSpecs and the AM API

Experimenter **tools** and **aggregates talk** to each other **using** resource specifications (**RSpecs**) and the GENI Aggregate Manager API (**GENI AM API**)

- **Advertisement RSpec:** What does an aggregate have?
- **Request RSpec:** What does the experimenter want?
- **Manifest RSpec:** What does the experimenter have?



Outline

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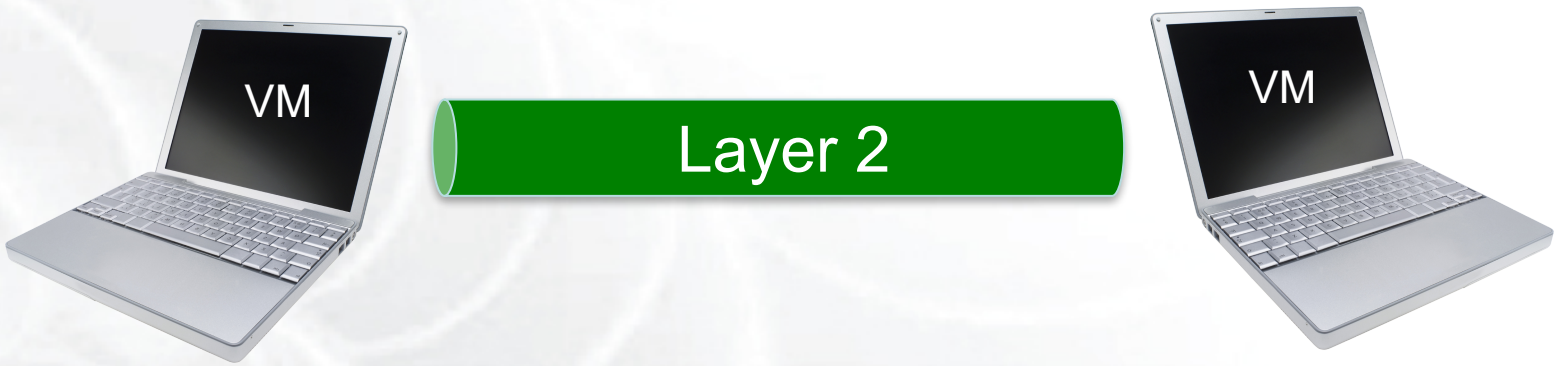
  2. A routing exercise

Hands On Exercises

Experiment #1 in GENI

Reserve two VMs connected at Layer 2



Use the GENI Portal and Jacks

geni
Exploring Networks of the Future

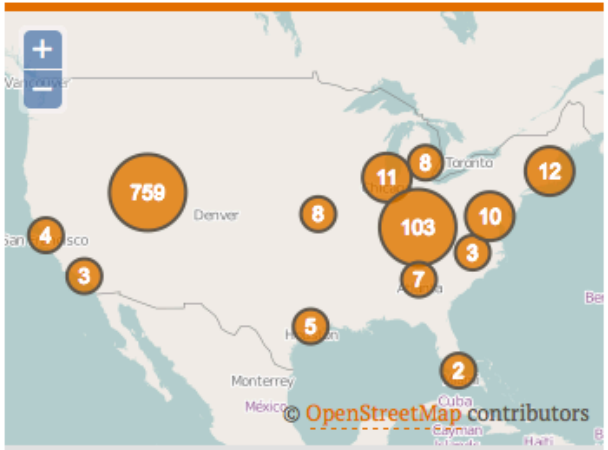
WELCOME TO GENI

GENI is a new, nationwide suite of infrastructure supporting "at scale" research in networking, distributed systems, security, and novel applications. It is supported by the National Science Foundation, and available without charge for research and classroom use.

Use GENI

Find out more about using GENI

- Information for GENI experimenters
- Published research that used GENI resources
- Get help using GENI



These are some of the many resources being used in GENI experiments across the country.

http://portal.geni.net

The GENI Portal is…

A web-based tool for experimenters to manage **experimenters**, **projects**, and **slices**.

Includes simple tools to reserve **resources**.

Among other things!

Establish Management Environment

1 Design the experiment

2. Establish the environment

2.1 Pre-work: Create a GENI account

2.2 Pre-work: Ask to join a project

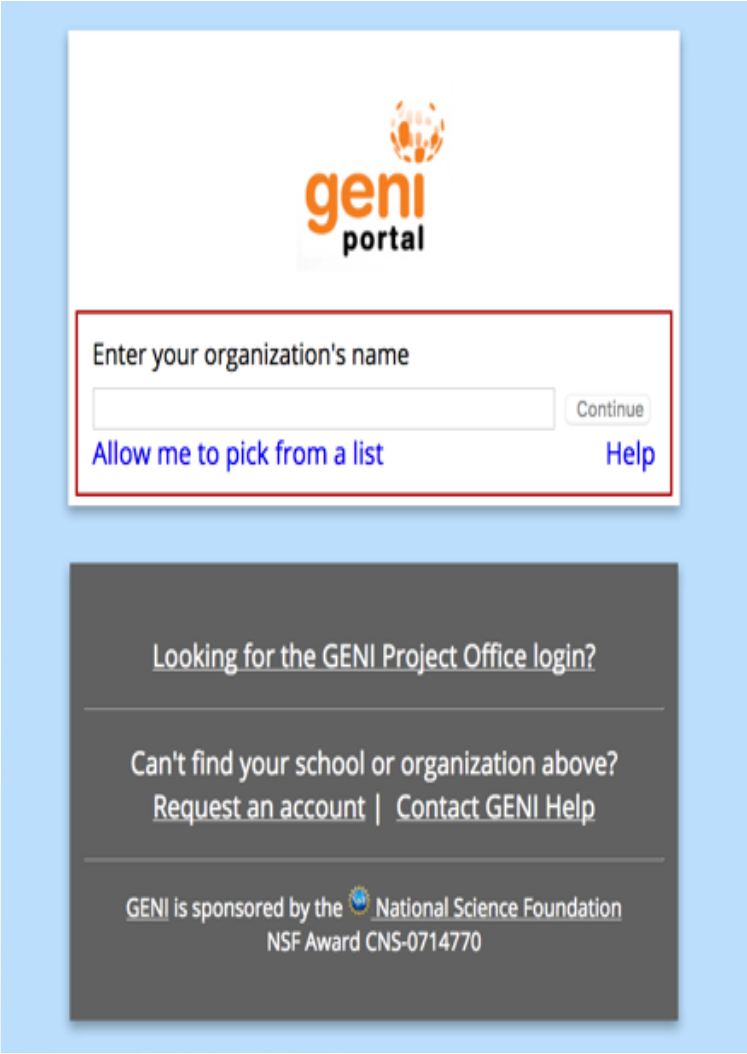
Project Name: GRW-UOregon

2.3 Generate and download ssh keypair

Click on SSH Keys drop-down under “Your Name”

Ready?

- Have you logged into the GENI Portal?
  - Check if your institution is listed on the Portal
    - If so, log in using your university username/pw
  - Otherwise
    - Request an account from the NCSA
- Have you joined the GENI project for the workshop?
  - Click Home➔Projects➔Join a Project



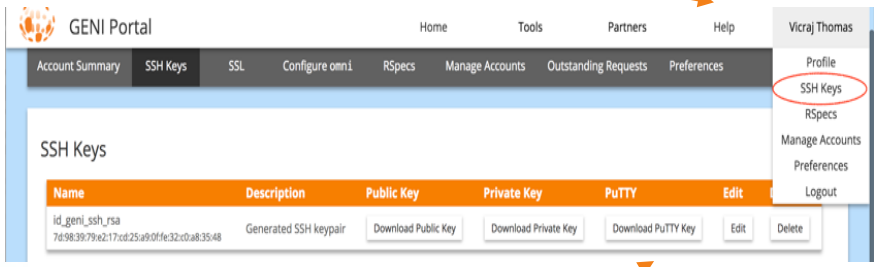
Set?

- Create your ssh keys
  - Look for SSH Keys under your name

- Download your ssh private key
  - Mac/Linux:
    - Move key to .ssh folder
    - Change permission so only you can read it

```
chmod 600 ~/.ssh/id_geni_ssh_rsa
```

  - Windows:
    - Download your PuTTY key



Generate and download ssh keypair

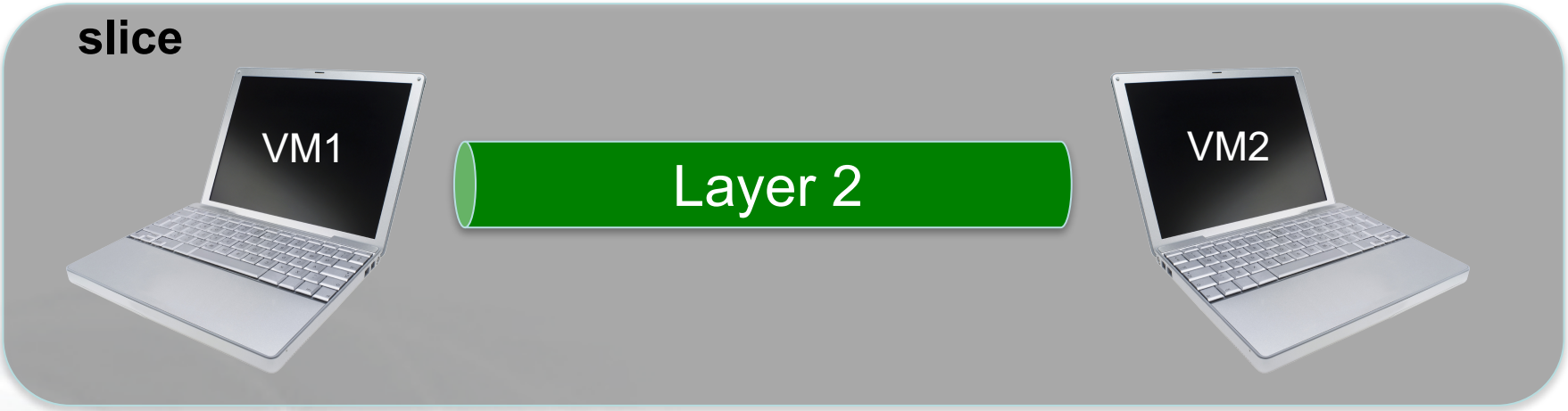
For Windows users:
PuTTY is recommended

PuTTY download:
http://www.putty.org

Mac OS X/Linux users:
On your local machine

```
> mv ~/Downloads/id_geni_ssh_rsa ~/.ssh/.
> chmod 600 ~/.ssh/id_geni_ssh_rsa
> ssh-add ~/.ssh/id_geni_ssh_rsa
```

Obtain Resources



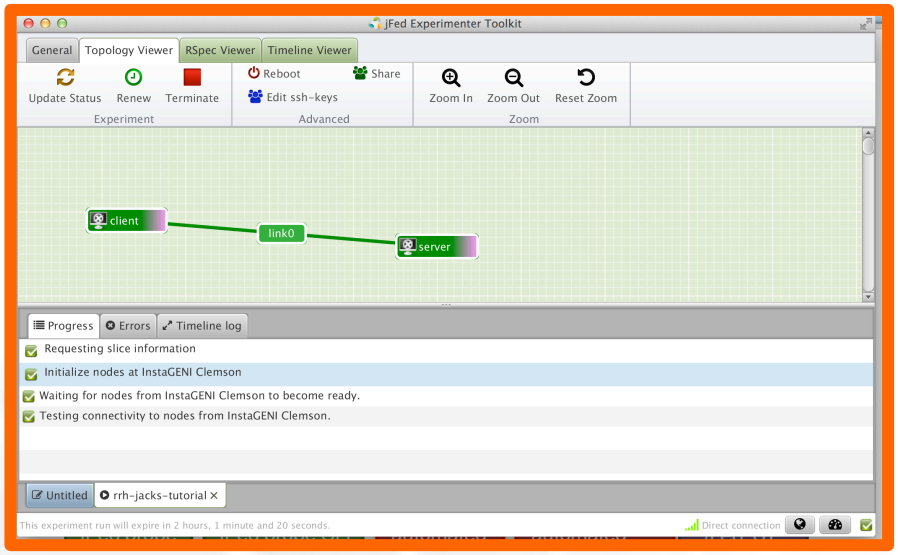
3.1 Create a slice

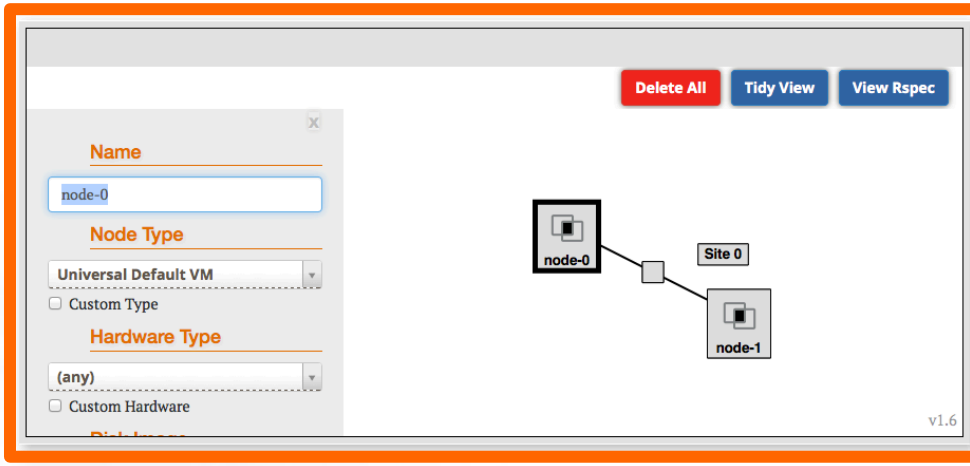
Call it “exp1-xy” where “xy” are your initials

3.3 Reserve two VMs at one aggregate using Jacks

3.4 Check whether VMs are ready to be used

Jacks and jFed are …



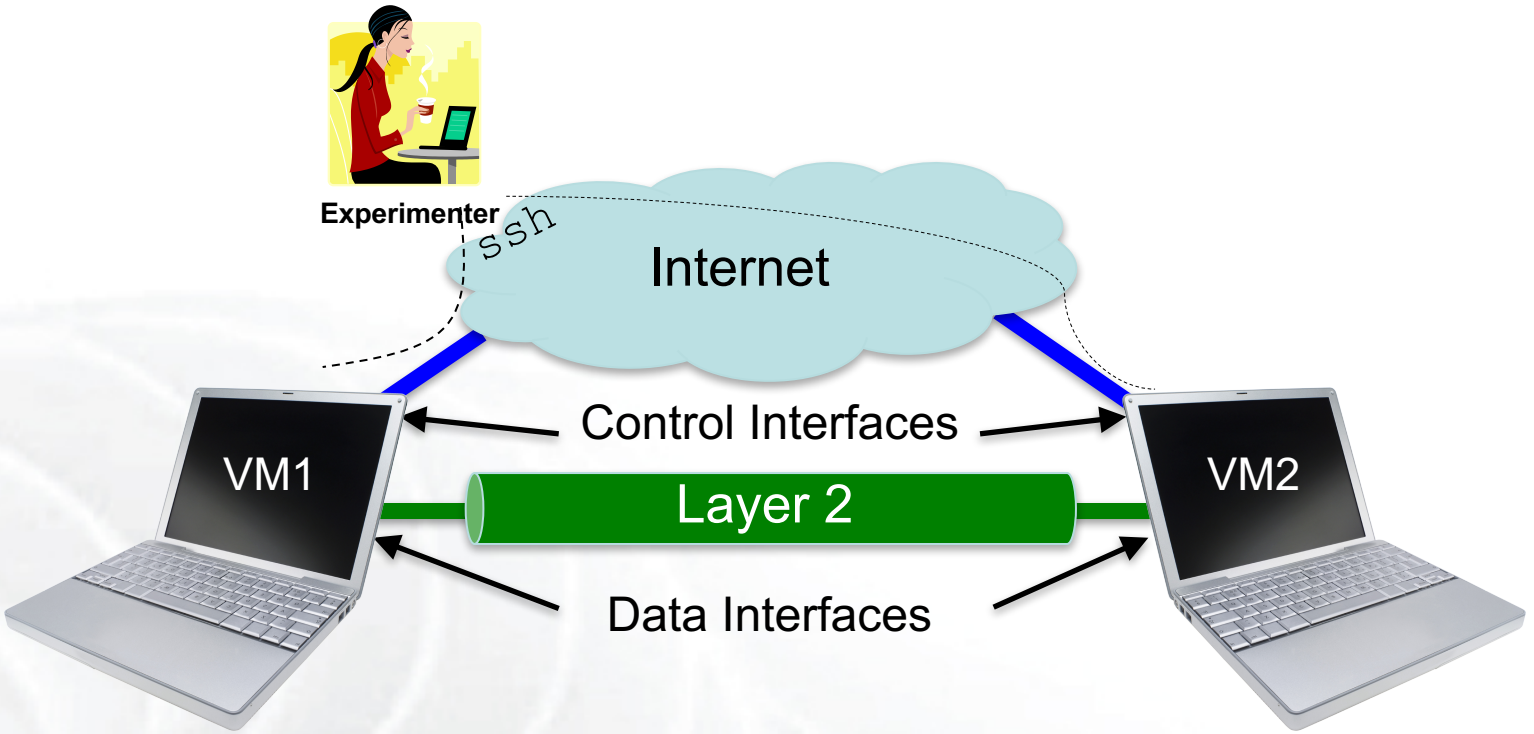


Graphical user interfaces (GUIs) for:

– **designing topologies** in GENI

– **reserving resources** in GENI

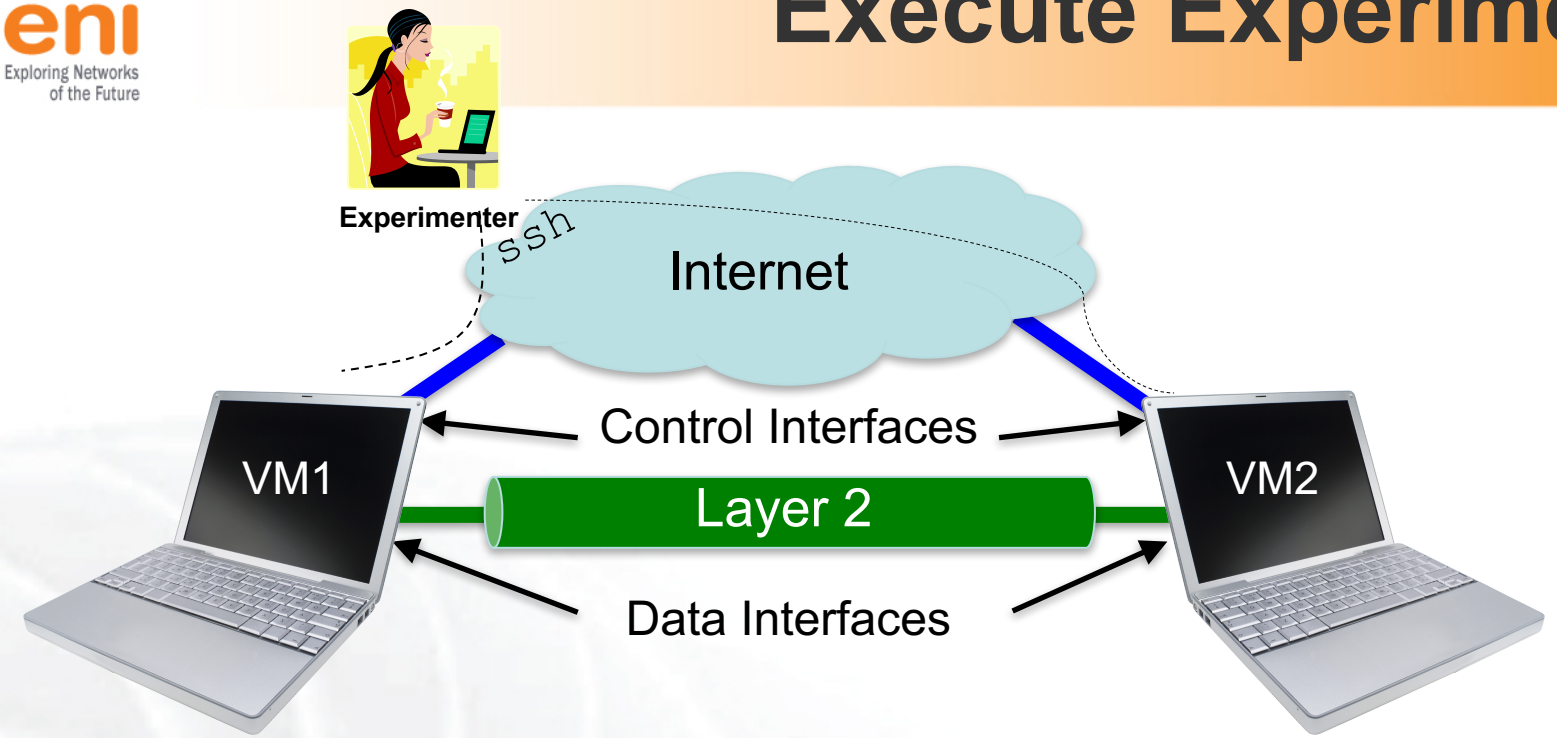
Execute Experiment



4. Configure and initialize

    4.1 Login to the VM1 and VM2 nodes

Execute Experiment



5. Execute experiment
    - 5.1 Test connectivity: ping interfaces
    - 5.2 Logout of your nodes
6. Teardown experiment
    - 6.1 Delete your resources
7. Archive experiment

Finish Experiment

project
resource
experimenter
aggregate
slice

When your experiment is done, you should always release your resources.

- Normally this is when you would archive your data and the experiment
- Delete your resources at **each** aggregate

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Hands on Exercise #2

- The IP routing exercise developed by Prof. Mike Zink of UMass, Amherst
- You will learn to set up static IP routes using the Linux `route` command

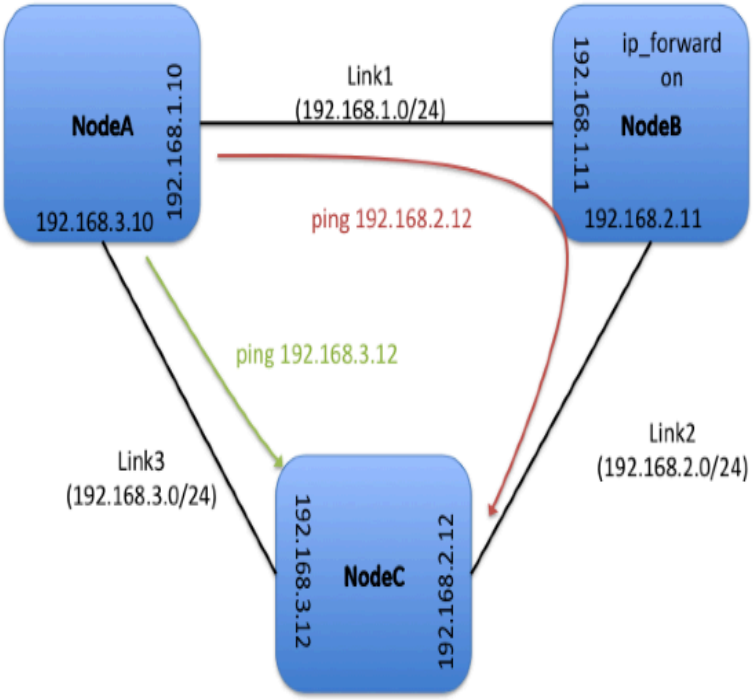


Figure 1 Topology and routing

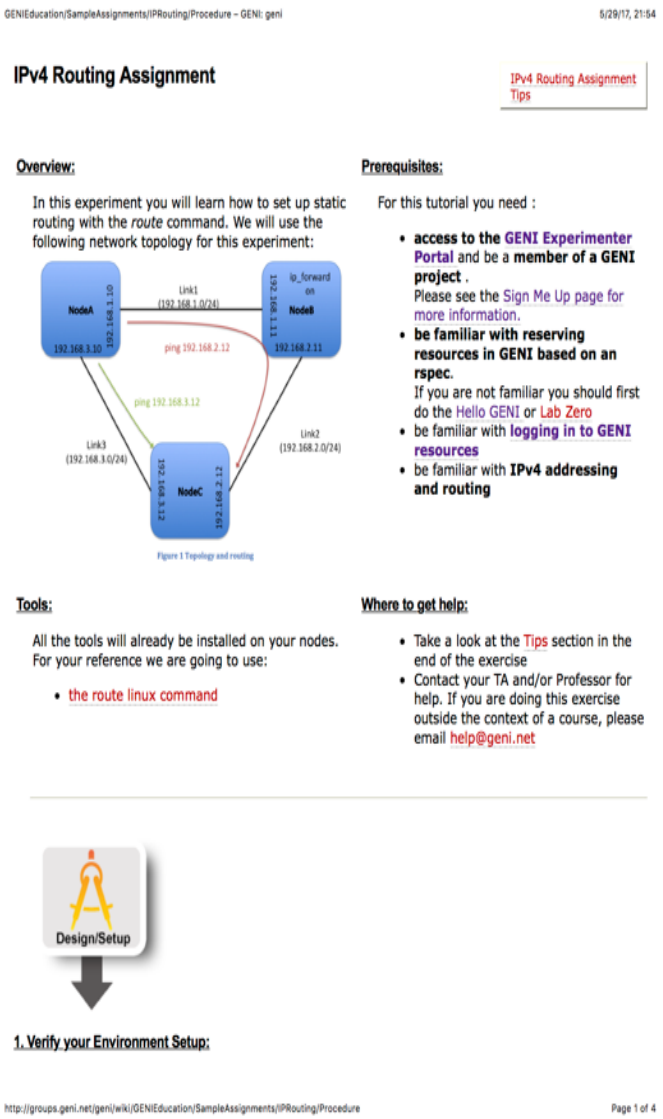
Go!

Follow instructions in the handout!

You will not draw your topology; you will load one created for you.

Use any ExoGENI rack

```
FIU ExoGENI
Texas A&M ExoGENI
WVNet ExoGENI
StarLight ExoGENI
```



GENIEducation/SampleAssignments/IPRouting/Procedure – GENI: geni 5/29/17, 21:54

IPv4 Routing Assignment

IPv4 Routing Assignment Tips

Overview:

In this experiment you will learn how to set up static routing with the *route* command. We will use the following network topology for this experiment:

Figure 1 Topology and routing

Prerequisites:

For this tutorial you need :

- **access to the GENI Experimenter Portal** and be a **member of a GENI project** .
  Please see the Sign Me Up page for more information.
- **be familiar with reserving resources in GENI based on an rspec.**
  If you are not familiar you should first do the Hello GENI or Lab Zero
- be familiar with **logging in to GENI resources**
- be familiar with **IPv4 addressing and routing**

Tools:

All the tools will already be installed on your nodes. For your reference we are going to use:

- the route linux command

Where to get help:

- Take a look at the Tips section in the end of the exercise
- Contact your TA and/or Professor for help. If you are doing this exercise outside the context of a course, please email help@geni.net

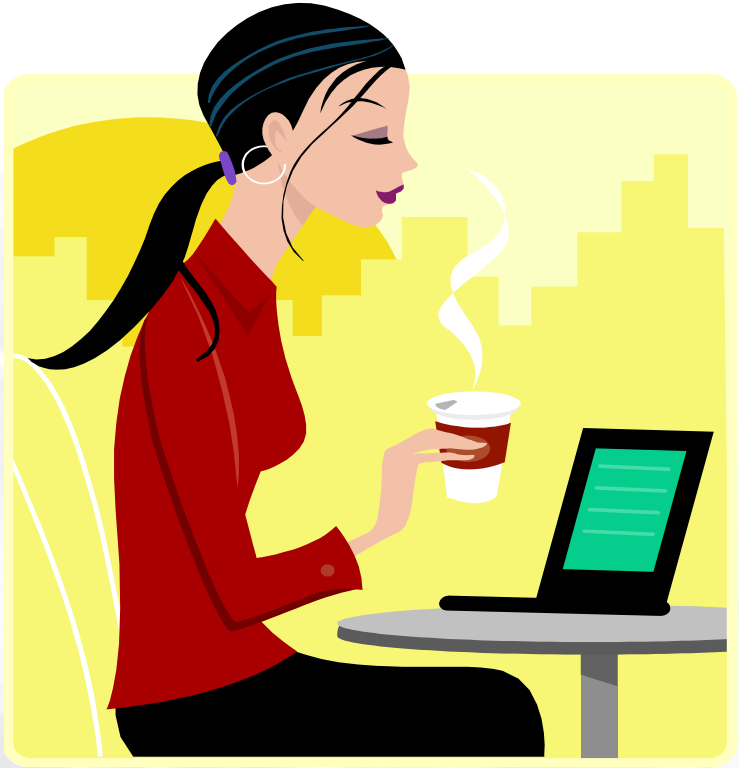
1. Verify your Environment Setup:

http://groups.geni.net/geni/wiki/GENIEducation/SampleAssignments/IPRouting/Procedure Page 1 of 4

Congratulations!

You have…

- Run your first GENI experiments!
- Exercised your knowledge of GENI terminology
- Used the GENI Portal and Jacks



Welcome to GENI!