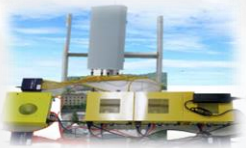


GENI

Train the TA – Session 2

Ben Newton, Jay Aikat, and Kevin Jeffay

University of North Carolina at Chapel Hill

Sponsored by the National Science Foundation

- Hands-on – Named Data Networking Experiment
  - Using Omni, the GENI AM API and Rspecs
- Tips for running a class on GENI
- Wrap-up

geni
Exploring Networks of the Future

Behind the Scenes of GENI Experimentation

featuring Named Data Networking

Sponsored by the National Science Foundation

Hands-On Exercise*

- Reinforce new concepts using a Named Data Networking (NDN) based experiment*
  - New concepts: RSpecs and AM API
- Named Data Networking (NDN)
  - A Future Internet Architecture (FIA) project**

* Based on a classroom exercise developed by Sonia Fahmy, Ethan Blanton & Sriharsha Gangam of Purdue U.; Christos Papadopoulos & Susmit Shannigrahi of Colorado State U.

** http://named-data.net

Named Data Networking
… also known as Content Centric Networking

PRINCIPLE

Focus on **what** you need; **not on where** you find it

TODAY

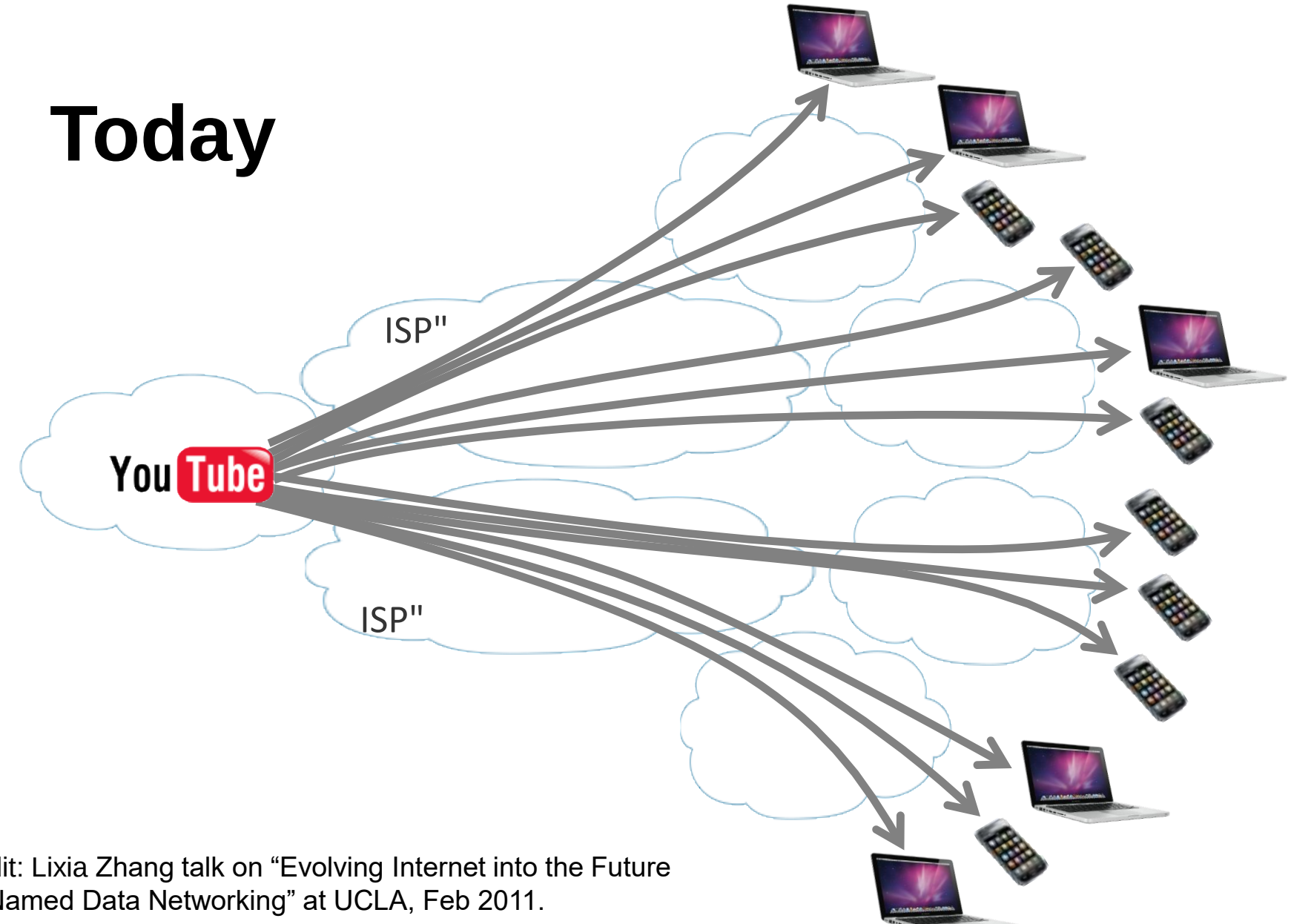
Must know the **location** of information (aka URL)

- Search engines map the *what* to the *where*
- Most Internet information look-ups start with search engines

CCN (NDN)

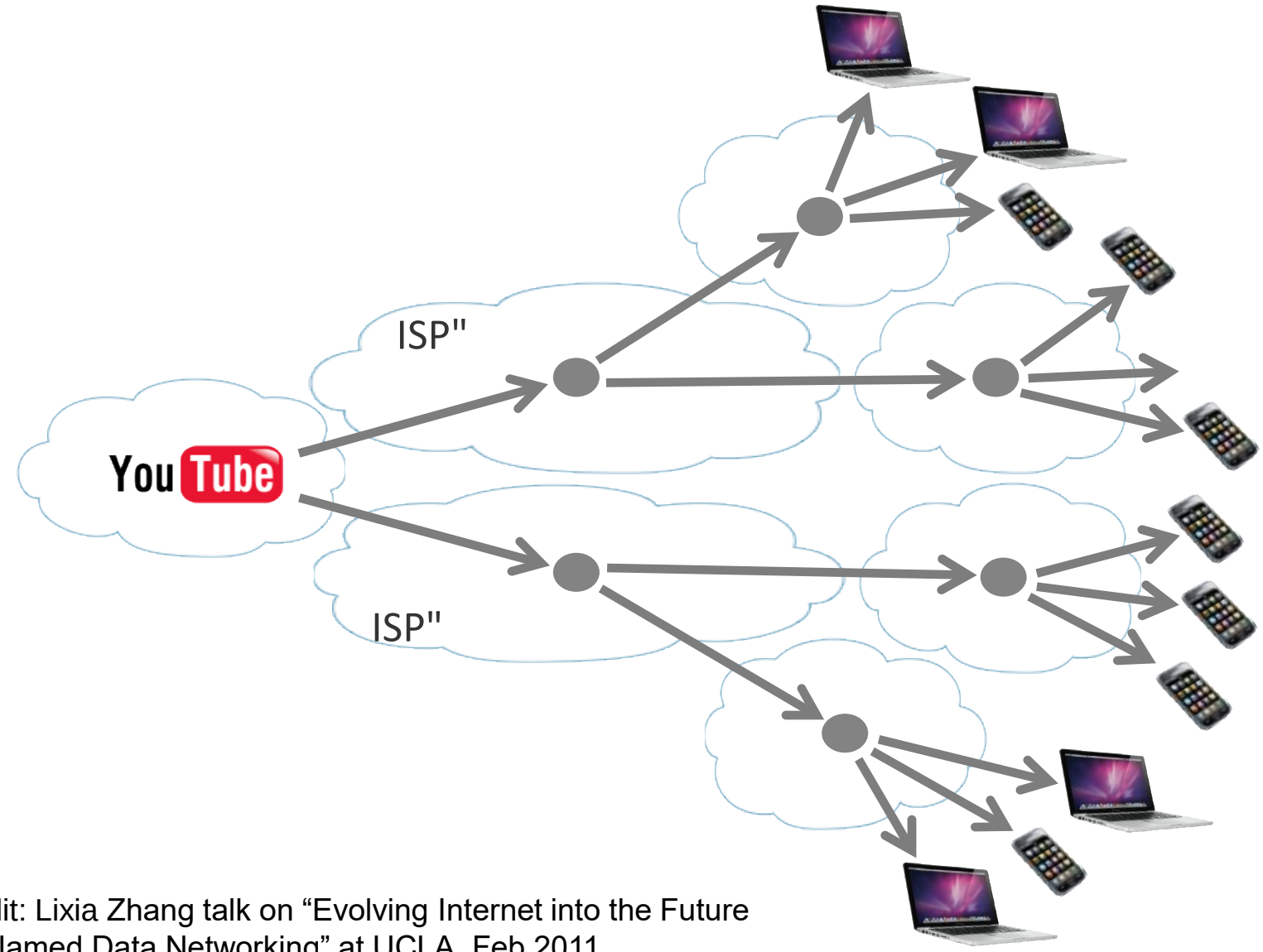
- New network architecture reflects Internet usage
- CCN protocols cache data at all network levels
  - routers, hosts

Point-to-point for data distribution



Credit: Lixia Zhang talk on “Evolving Internet into the Future via Named Data Networking” at UCLA, Feb 2011.

NDN: Scalable Data Dissemination



Credit: Lixia Zhang talk on “Evolving Internet into the Future via Named Data Networking” at UCLA, Feb 2011.

CCNX

- An implementation of NDN by Xerox PARC

- Our exercise uses CCNX software
  - Software runs on all nodes in our experiment
  - All nodes cache information that passes through them
  - When a node gets a data request it:
    - Returns data from local cache, if available
    - Passes request to neighbor if data not in cache
    - Caches data returned by neighbor

http://www.ccnx.org

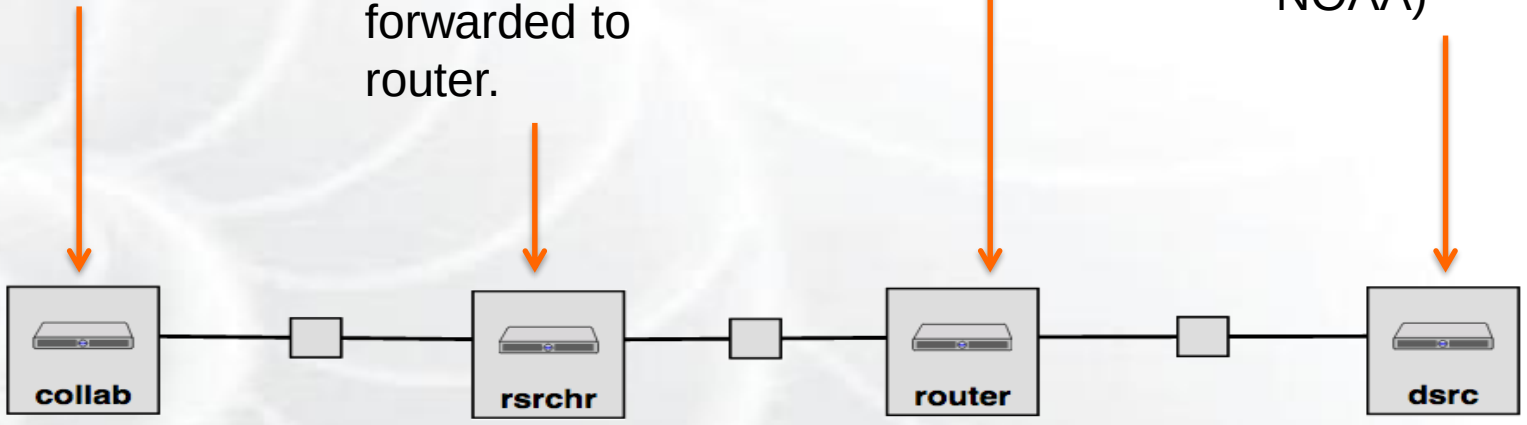
Experiment Setup

Collaborator (`collab`) fetches data by name. Requests not in cache forwarded to researcher.

Researcher (`rschr`) fetches data by name (e.g. precip data from 1901/01/01 to 1901/01/02). Requests not in cache forwarded to router.

Intermediate node (`router`). Requests not in local cache forwarded to data source.

Data Source (`dsrc1`): Holds precipitation data from 1 Jan 1901 to 31 Jan 1902 (data from NOAA)



Experiment Execution

- Log into the researcher node (`rsrchr`) and fetch data
  - Use a client program already installed on the node
    - Installed using an install script in the RSpec
- Note how long it takes to get data
- Fetch same data again and note time
- If time permits
  - Repeat the above at the collaborator node (`collab`)
    - Data is not in local cache but in `rsrchr` node cache
  - Fetch new data at the collaborator node (`collab`)
    - Data is not in local cache or in `rsrchr` node cache
- Later: Use GENI Desktop/GEMINI to view graphs of traffic on links
  - Helps visualize when data comes from a local cache and when it comes from a neighbor

Tutorial Structure

- Configure Omni (Step 2.2 of instructions)
- View and edit an RSpec using Jacks (Steps 3.2 – 3.5)
- Request resources specified in RSpec using Omni (Step 3.6)
- When resources are ready, log into a node to run the CCN application (Step 5)
- (Later) Visualize the experiment using the GENI Desktop and GEMINI
  - GENI Instrumentation and Measurement system

Tutorial Tips

- Cut-and-paste is your friend!
  - Cut-and-paste URLs, commands, etc. from instructions into text boxes, terminal windows, etc
- If at any step you don't understand why you are doing something, ask!
- If you fall behind, let us know!
  - We will help you catch up

Running a Class in GENI

GENI Accounts and Projects

Resources for Instructors

Tips

Wrap Up

Access to GENI

Leverage InCommon for single sign-on authentication

InCommon®

Experimenters from 304 educational and research institutions have InCommon accounts

For many experimenters:

- no new passwords
- familiar login screens

GENI Project Office runs a federated IdP to **provide accounts** for non-federated organizations.

Authenticating as a user

Asymmetric encryption

Asymmetric cryptography, a.k.a. public-key cryptography is based on using **different keys** for encryption and decryption

Private key

Public key

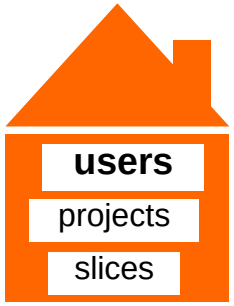
Only the private key can decrypt challenges created with the public key. Private key is usually protected with a passphrase.

http://en.wikipedia.org/wiki/Public-key_cryptography

Authenticating as a user

SSL Certs

Researcher



clearinghouse

User certificate (includes public key) signed by CH

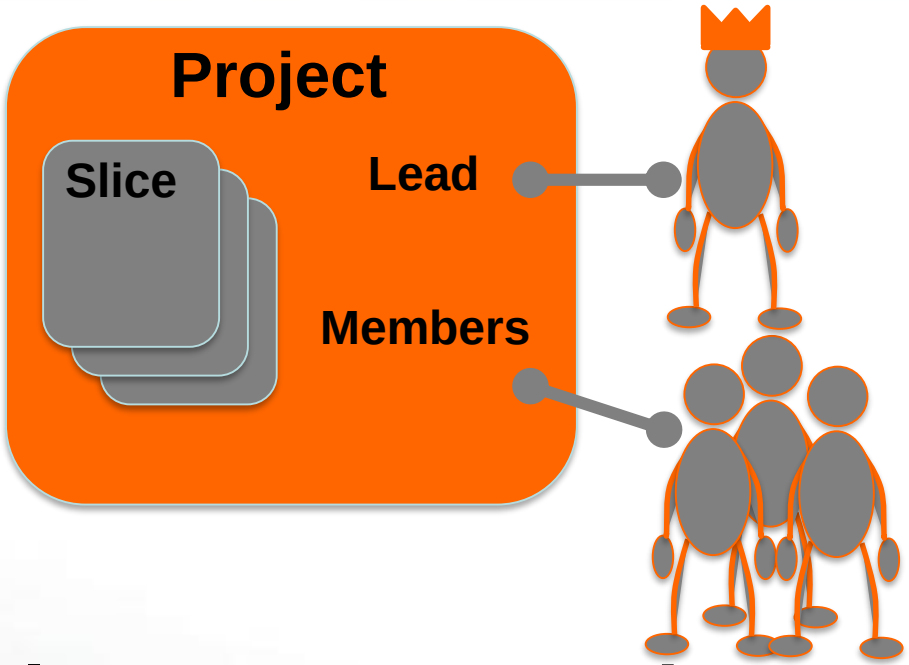
AM uses Public key to authenticate user

ggregate
lanager

Aggregate Resources

Projects

Projects organize research in GENI

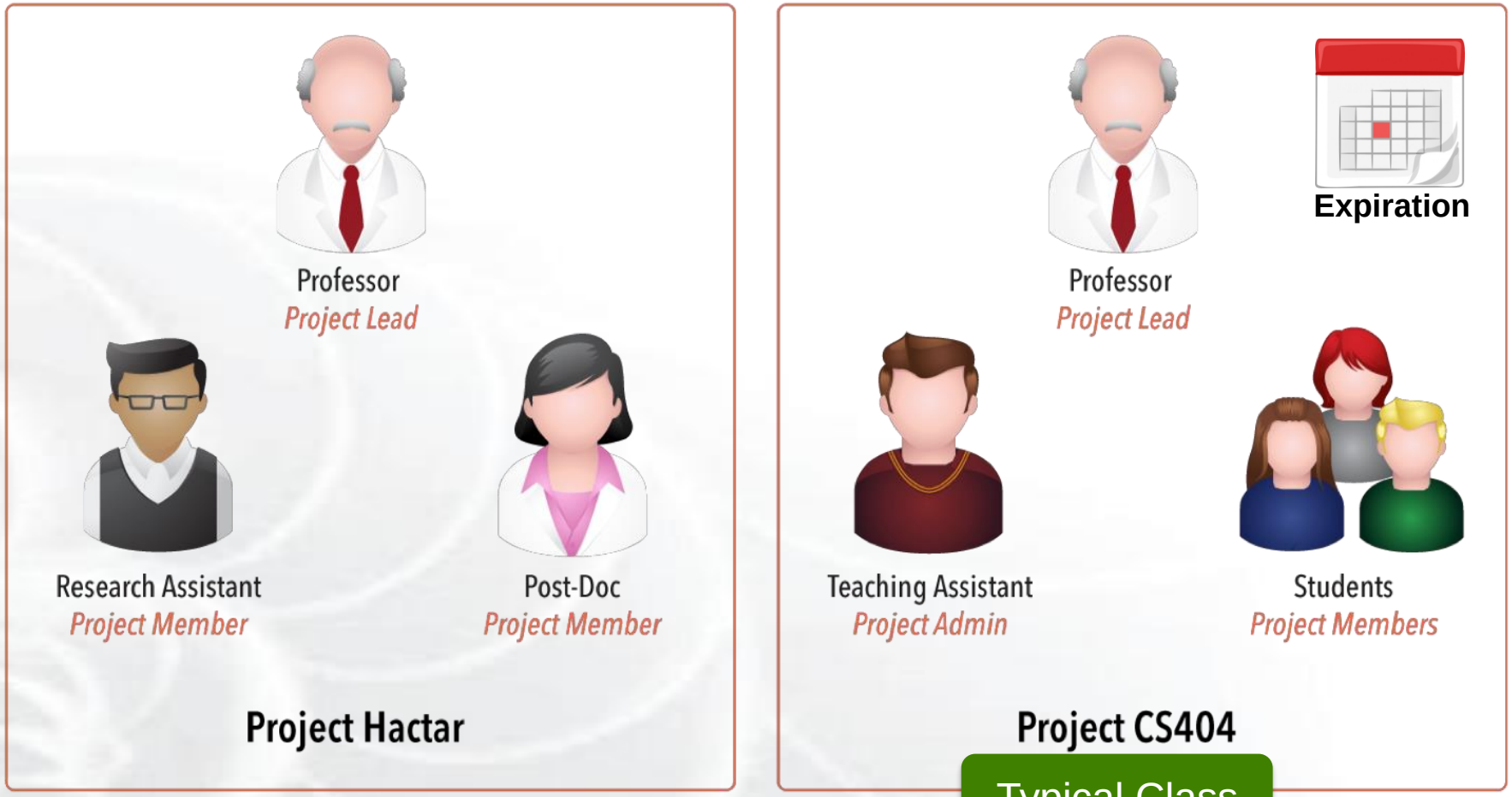


Projects contain both **people** and their **experiments**

A project is led by a single responsible individual: the **project lead**

Project Membership example

Projects have 1 **Lead** and any number of **Admins**, **Members**, and **Auditors**



http://groups.geni.net/geni/wiki/GENIConcepts#Project

Populating a Project

1. Member-initiated

Each experimenter asks to join a project, approval needed

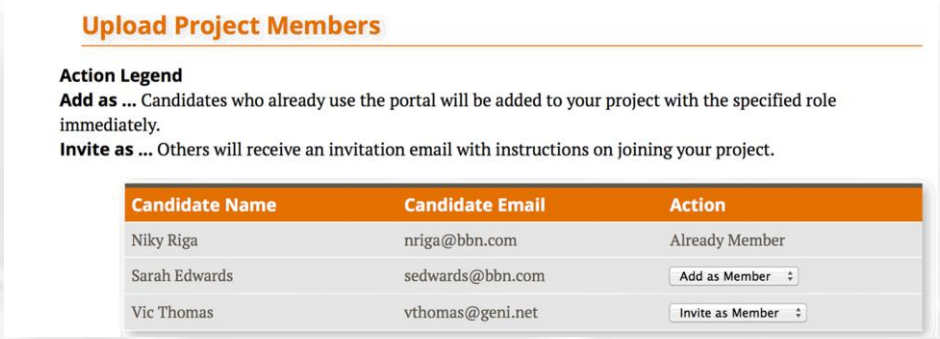
- Typical for Research projects

Project	Purpose	Project Lead	Join
ADAMANT	Use GENI to demonstrate use in data-driven computational workflows	Ilya Baldin	Join
ASU-GREE-Summer-Camp-2013		Violet Syrotiuk	Join

1. Admin-initiated

Project Lead/Admin bulk-adds experimenters

- Typical for Classrooms or Tutorials



Upload Project Members

Action Legend
Add as ... Candidates who already use the portal will be added to your project with the specified role immediately.
Invite as ... Others will receive an invitation email with instructions on joining your project.

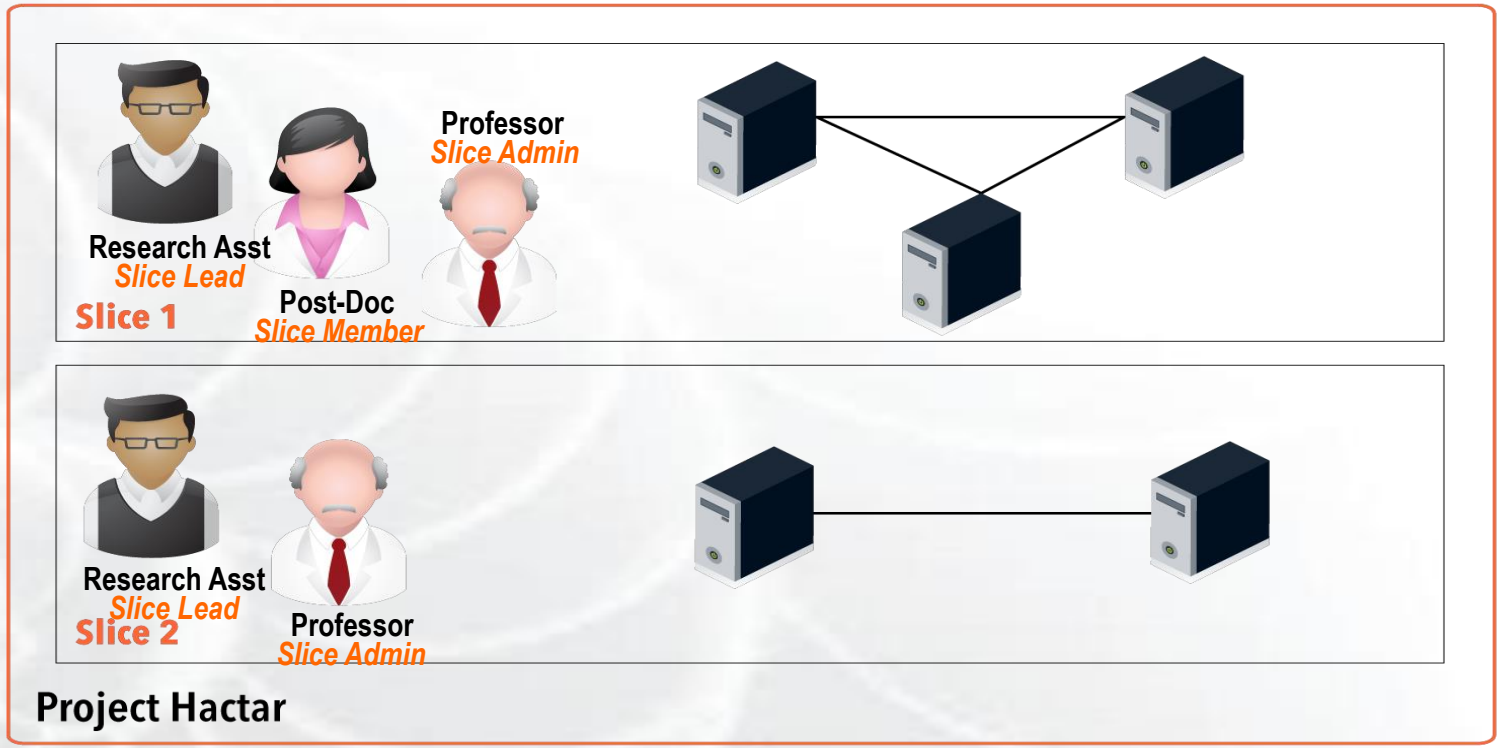
Candidate Name	Candidate Email	Action
Niky Riga	nriga@bbn.com	Already Member
Sarah Edwards	sedwards@bbn.com	Add as Member
Vic Thomas	vthomas@geni.net	Invite as Member

Live Demo

Slice Membership example

Slices have:

- 1 **Lead** (person who **created** the slice)
- any number of **Admins**, **Members**, and **Auditors**
- **Project Lead/Admins** added as slice Admins



http://groups.geni.net/geni/wiki/GENIConcepts#Slice

Project and Slice Roles

		Create project	Modify project & manage membership	Create slice	View project
Project	Lead	✓	✓	✓	✓
	Admin		✓	✓	✓
	Member			✓	✓
	Auditor				✓

		Manage slice membership	Act on slice	View slice	Account/ keys loaded on slice
Slice	Lead	✓	✓	✓	✓
	Admin	✓	✓	✓	✓
	Member		✓	✓	✓
	Auditor			✓	✓

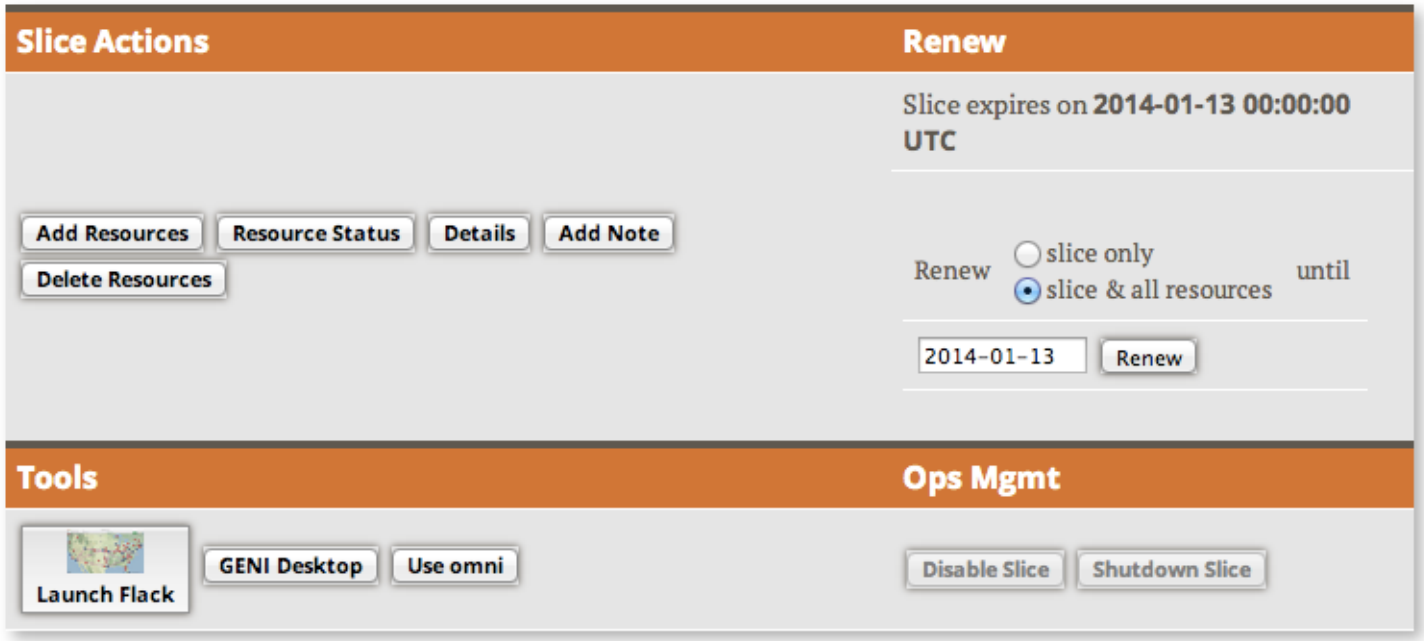
http://groups.geni.net/geni/wiki/ProjectSlicesRoles

Slice Access

Being a member of a slice means you can act on a slice:

- Add resources
- Check status
- Delete resources
- Renew resources

With any tool!



Slice Access: Logging in to resources

Slice membership does *not always* guarantee ability to login to resources!

To ensure access in student's resources:

Option 1: Reserve resources from Portal/Jacks/Omni [recommended]

- fix the membership of the slice before reserving resources

Option 2: Ensure common public key is loaded

- distribute common public key to students
- ask students to upload it in their profile
- use corresponding private key to login

Ability to login can help in debugging!

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GENI Accounts and Projects

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Tips

Wrap Up

Instructor Checklist

TIP: *Start early!*

Class Prep:
- ☐ GENI Access
- ☐ Project for the Class
- ☐ Test Exercises
- ☐ Notify GMOC
- ☐ Figure Student setup
- ☐ Email help@geni.net

Email Prework:
- ☐ GENI account
- ☐ Computer setup*
- ☐ Other?

- ☐ Bulk-add students to project

* Include steps for testing the setup

Full checklist at: *http://groups.geni.net/geni/wiki/GENIEducation/Resources*

Our Advice for Novice Experimenters

Creating Repeatable Computer Science and Networking Experiments on Shared, Public Testbeds

by S. Edwards, X. Liu, N. Riga

In *Operating Systems Review*, Jan '15

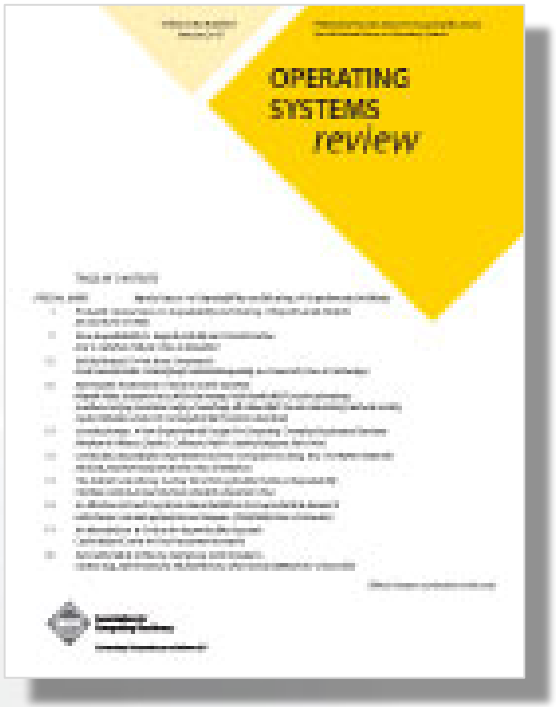
For students designing their own experiments

Concise advice for novices on designing experiments to run on a testbed:

1. Formulate a clear plan
2. Automate the execution/analysis of your experiment using best practices
3. Build scalable experiments

   a.k.a. Start small. *Then* scale up

Plus a case study created by a PhD student.



Link to ACM Library

Available Exercises

- **List of sample assignments and tutorials:**
  - Use as they are
  - Modify to meet your needs
- **Annotated:**
  - Type
  - Purpose
  - Resources needed
  - Difficulty/Duration

Available Exercises

- **Each sample exercise has:**
  - Handouts / Instructions for students
  - Further information about the instructors
  - For solutions email help@geni.net
- **Instruction format:**
  - 3 Steps based on standard experiment lifecycle

Popular Samples

Tutorials:

- **Lab Zero**
  Basic GENI understanding, ensures students setup their environment

- **Intro To OpenFlow**
  Basic OpenFlow introductory tutorial, students learn how to setup OVS and write simple controllers

Assignments:

- **IPv4 Routing**
  Students understand IPv4 forwarding and how to configure static routes

- **TCP Network Awareness**
  Students explore different TCP flavors and TCP parameters

Tutorials: *http://groups.geni.net/geni/wiki/GENIExperimenter/Tutorials*
Assignments: *http://groups.geni.net/geni/wiki/GENIEducation/SampleAssignments*

GENI Education Modules

geni.web.unc.edu

Migrate an Assignment to GENI

1. **Figure out GENI Resources/Tools**
   - Wireless/Wired
   - Flack, Omni, Portal, I&M?

2. **Test your exercise**

3. **Adjust writeup for GENI**
   - Remember to include Clean Up!

Test the Assignment in GENI

- **Run through the exercise**

- **Automate:**
  - Install scripts (HowTo/WriteInstallScripts)
  - Custom Image

Create RSpec that instantiate the topology

– install scripts, images are included

Resource Reservation

1. **Students make the reservation:**
   - RSpec (URL, File, Upload it in Portal)
     - Or the topology if they are just drawing it in Flack (e.g. Lab 0)
   - AMs, Tool

2. ***Admin (Prof., TA) makes all the reservations:**
   - Create a Slice per student/group
   - Make the student(s) member of the slice
   - Ensure they have keys (email us if needed)
   - Reserve resources **from the Portal or omni**
   - Omni scripts automate this process

*** Lab Exercises:** Resource reservation might take time
Assignments: Resource reservation is complicated/unique or out of scope

GENI Accounts and Projects

Resources for Instructors

Tips

Wrap Up

Tip #1: Load Balance the students

- Split students/groups between equivalent resources (e.g. racks) to avoid resource contention

- If using scarce resources consider a rolling deadline

Tip #2: Notify GMOC

GMOC: GENI Meta-operation Center

- Keeps track of outages
- Notification system for resource reservation

GMOC Google Calendar keeps track of reservations/outages

http://groups.geni.net/geni/wiki/HowTo/PreReserveGENIResources

Tip #3: Setup for the Students

- **Use their personal laptop**
  - **LabZero** is a good way to get setup
  - There are Mac/Windows Binaries for Omni
- **Use Lab computers**
  - Go through the exercises in lab computers
  - stress-test the resources or split students
- **Use a VM with all the software loaded**
  - http://groups.geni.net/geni/wiki/HowTo/CreateTutorialVM

Make sure they test it early in the class!

Tip #4: Accessing GENI Resources: SSH

Login to all GENI compute resources using

ssh keys – **no password**

If you are ever **prompted** for a **password** during login to **GENI nodes** something is **wrong**

Using key-pair to SSH:

Public key: is public to everyone, loaded to nodes

Private key: kept private in your computer, provided to SSH to verify it matches the loaded public key

Tip #4: SSH Challenges

- Students might not be familiar with CLI
- Students might not be familiar with public key cryptography
  - Hard to distinguish between private and public
  - Hard to distinguish between password and passphrase

Consider a brief SSH tutorial/intro

http://groups.geni.net/geni/wiki/HowTo/LoginToNodes

Tip #4: SSH from Windows

SSH with keys from **Windows** is **non-trivial**

- No built-in ssh client

Possible Solutions

- BitVise
- FireSSH – javascript plugin for Firefox
- SecureCRT (not free)
- cygwin
- *Linux VM – make use of a slim OS*
- PuTTy (private key format different)

Need to address this early!

http://groups.geni.net/geni/wiki/HowTo/LoginToNodes

Tip #5: Effective debugging

- Ask students to be specific about what is not working
  - Step-by-step run through usually helps
- Ask for what they see:
  - screenshots
  - omni output errors
- Gather as much information as you can
  - get slice name
  - tool they used
  - rspec
- Remember you have access to their slices, check for yourself!
- Register for resource mailing lists
  - Better that you, not the students, contact resource owners

Tip #5: Debugging Example

Problem: Can't login to a node

Possible causes:

- **Slice/sliver expired**
- Wrong username
- Public key isn't loaded, Private key is wrong or non-existing
- Private key has wrong permissions (it should have 0600)
- Technical issue with node

Debug strategy:

1. Check the status of the Slice/sliver
2. Try logging in to the node yourself
   - Look for loaded keys

     ```
     sudo cat <student_user_path>/.ssh/authorized_keys
     ```
3. Ask them to use `'-v'` option

   ```
   ssh -v foo@bar.example.net
   ```

Tip #6: Passwords

Tell your students …

Do NOT manually create user accounts with insecure passwords on your VMs

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GENI Accounts and Projects

Exercises on GENI

Tips

Wrap up

Have a question? Answer is

help@geni.net

which is an email list which only goes to members of the GPO including…

Vic Thomas

(However, the archive of the list is public)

Ways to Get Help

- Sign Up for :

  geni-users@googlegroups.com
- Sign Up for :

  geni-educators@googlegroups.com
- Use #geni IRC chatroom
- Go over HowTo pages

http://groups.geni.net/geni/wiki/GENIExperimenter/GetHelp

Finding other resources

- GENI wiki
  - Pages for **Instructors** and **Experimenters**

http://groups.geni.net/geni/wiki

“How To” pages

- Listed under the “Experimenters” section
- Each “How To” is a short descriptions of how to do various tasks
- New entries being added all the time

Tutorials
PlanetLab
Index

Using GENI

- How to Pick a Slice Name
- How to Login to Nodes
- How to Write Install Scripts
- How to pre-reserve GENI resources (aka How to Notify GMOC)

Omni

- How to Specify Aggregates In Omni
- How to Specify RSpecs In Omni
- How to Add Users to an `omni_config`

OpenFlow

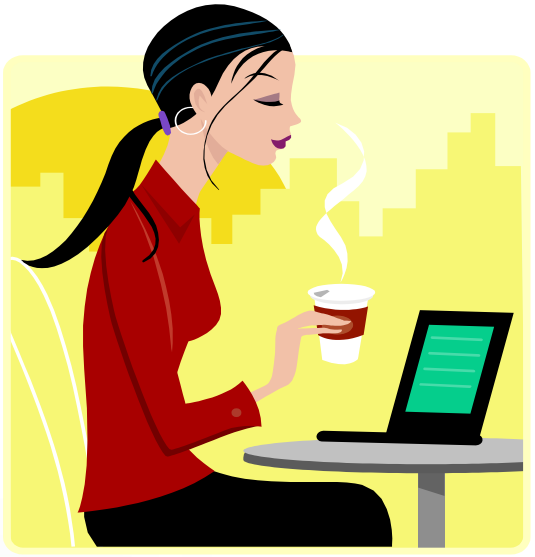
- How to Install OVS in ProtoGENI
- How to Run OpenFlow tutorial
- How to write OpenFlow v3 rspecs
- How to run the OpenFlow Nox controller in Fedora8 (OS in many MyPlc hosts)

RSpecs

- How to Convert ProtoGENI v2 to GENI v3 RSpecs

GENI Events

GENI Experimenter Contest!

GENI Engineering Conference 25
March 14-15, 2017
Florida International University, Miami FL

Thank you for attending!