



# GENI

## Exploring Networks of the Future

**Vicraj Thomas**  
**GENI Project Office**

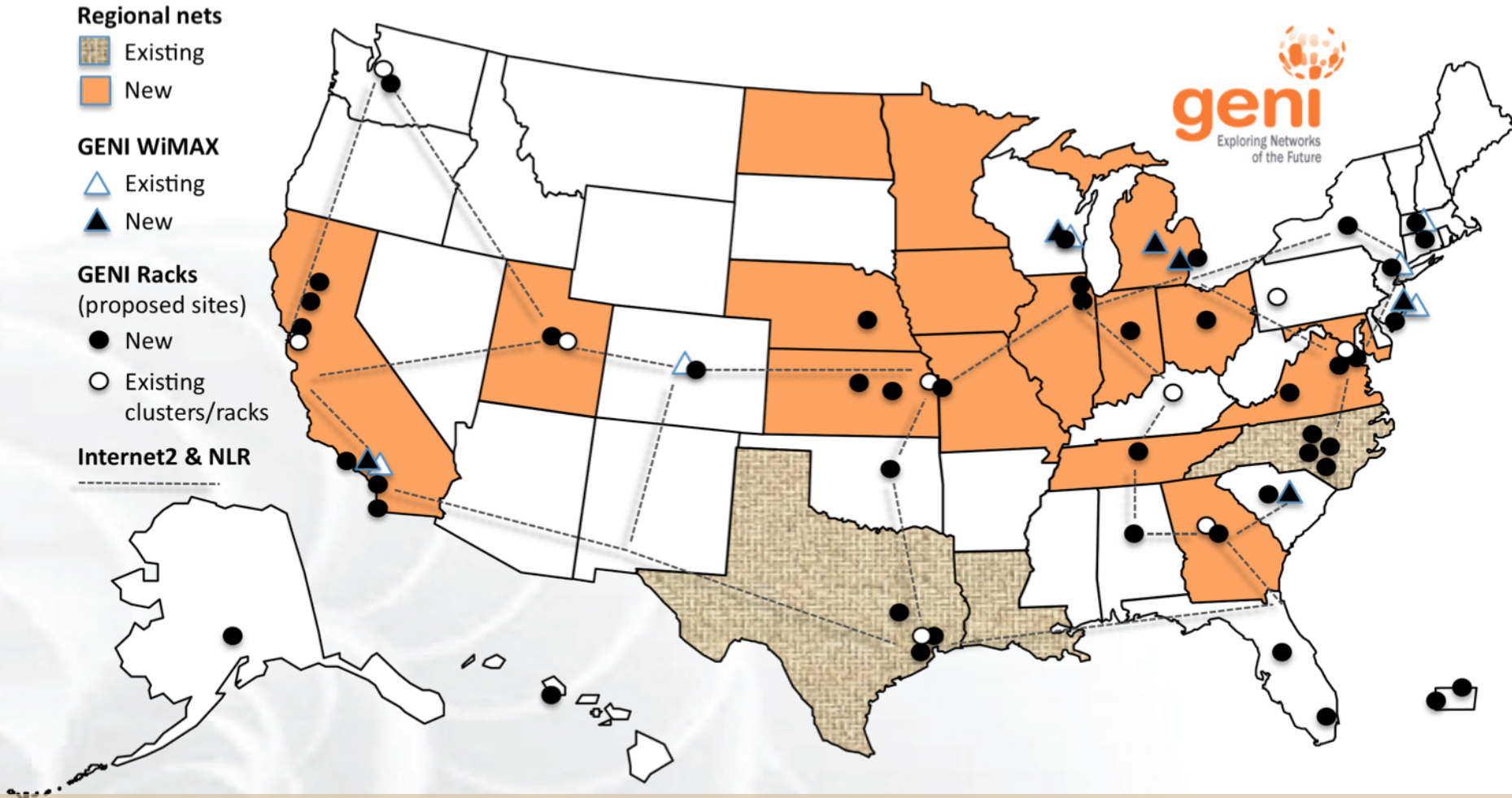
[www.geni.net](http://www.geni.net)

What is GENI?

How is GENI being used?

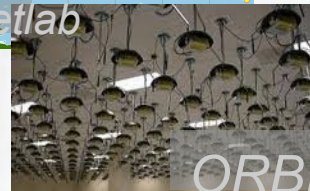
Key GENI Concepts

Demo: A simple experiment using GENI

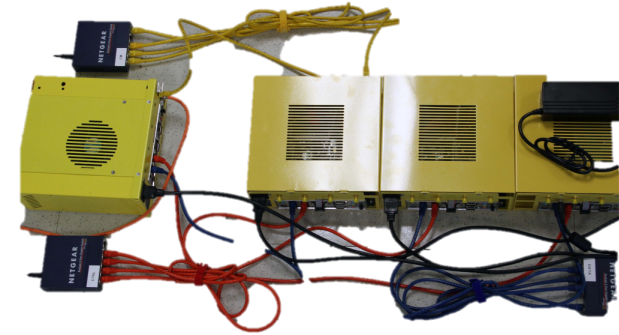


GENI provides compute resources that can be connected in experimenter specified Layer 2 topologies.

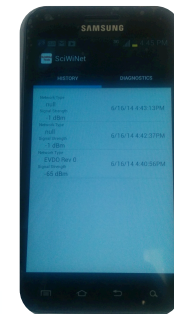
## GENI Racks



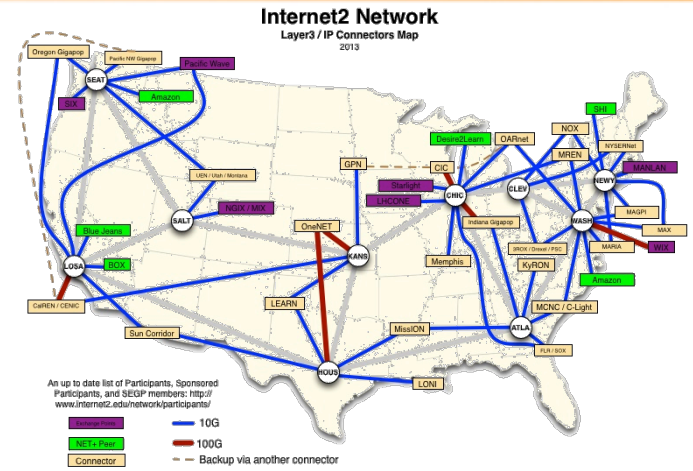
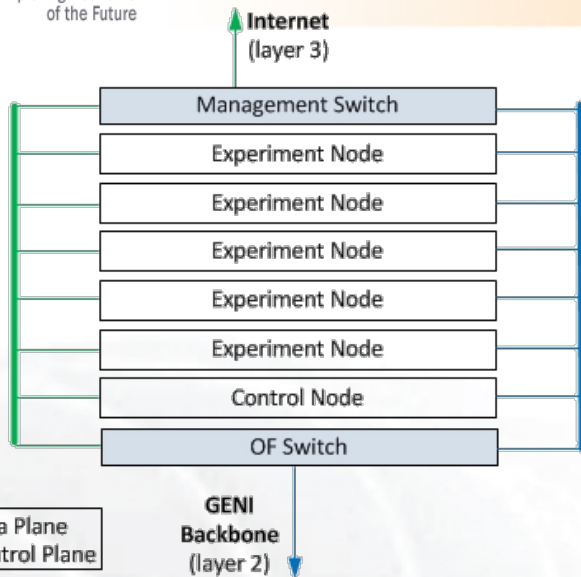
## Existing Testbeds



## GENI Wireless compute nodes





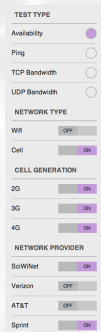


National Research Backbones (e.g. Internet2)

Networking within a Rack



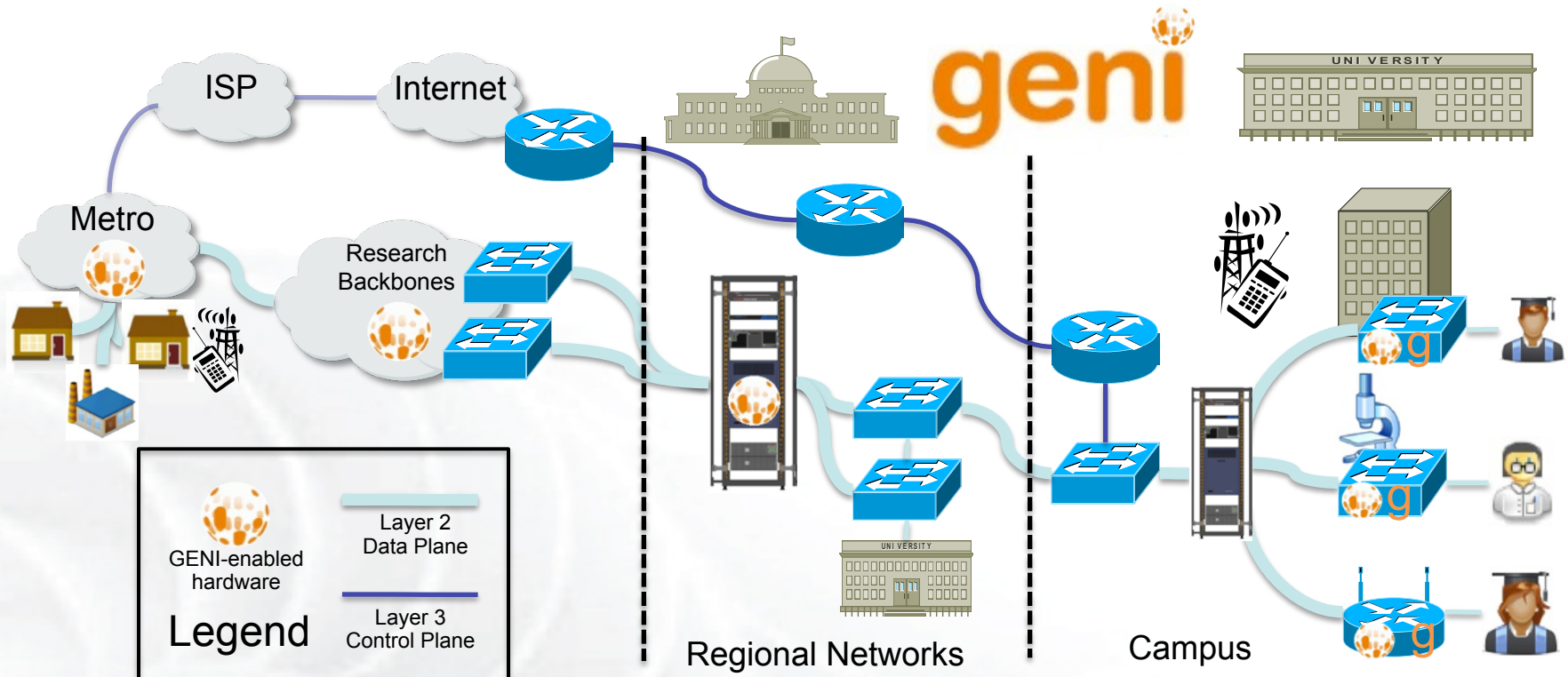
WiMAX Base Stations



4G/3G GENI network



Regional Networks (e.g. CENIC)



- Flexible network / cloud research infrastructure
- Distributed cloud (racks) for content caching, acceleration, etc.
- Also suitable for physics, genomics, other domain science

- More **WiMAX base stations** with Android handsets
- GENI-enable 5-6 **regional networks**
- Inject more **OpenFlow switches** into Internet2
- Add **GENI Racks** to 50-80 locations within campuses, regionals, and backbone networks



GENI Racks serve as programmable routers, distributed clouds, content distribution nodes, caching or transcoding nodes, etc



**Ilia Baldine**  
**RENCI**

More resources / rack,  
fewer racks



**Rajesh Narayanan**  
**DELL**



**KC Wang** Clemson

Latest addition

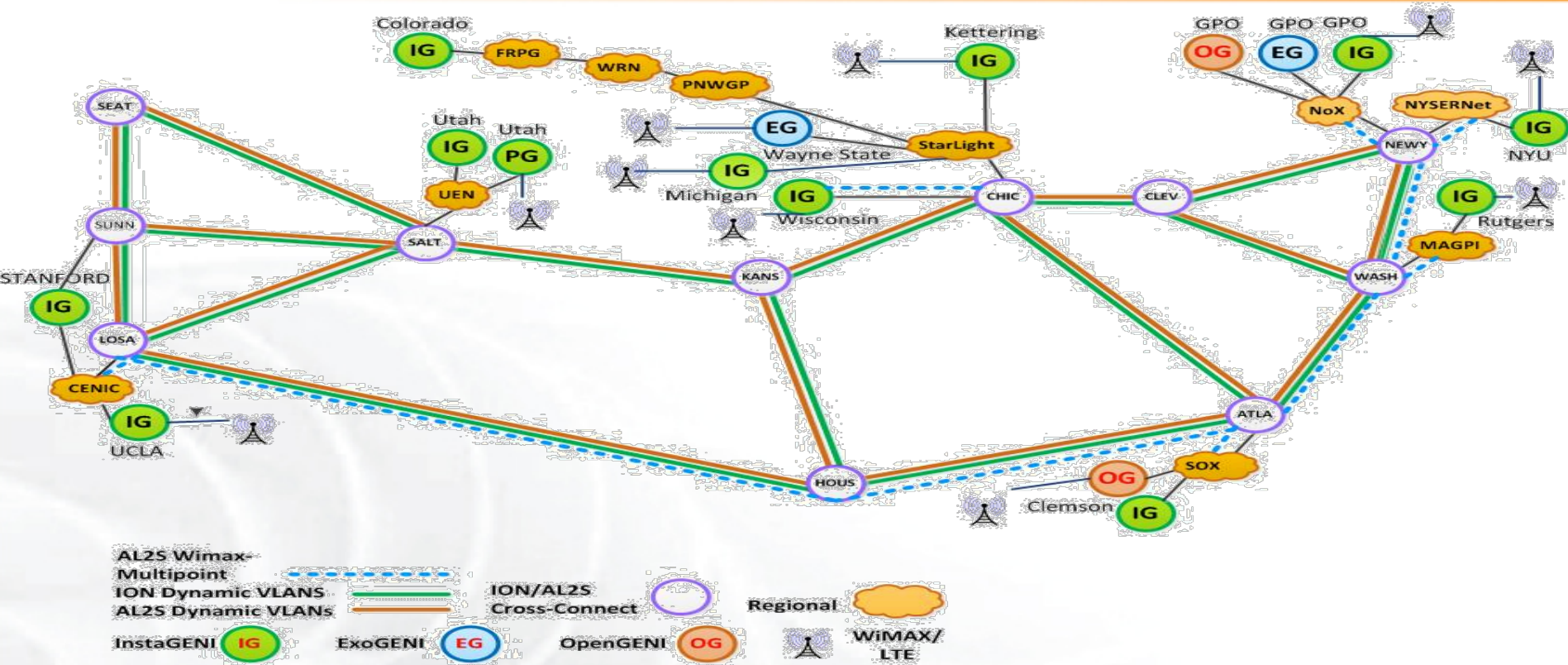


**Rick McGeer**  
**HP Labs**

Fewer resources / rack,  
more racks



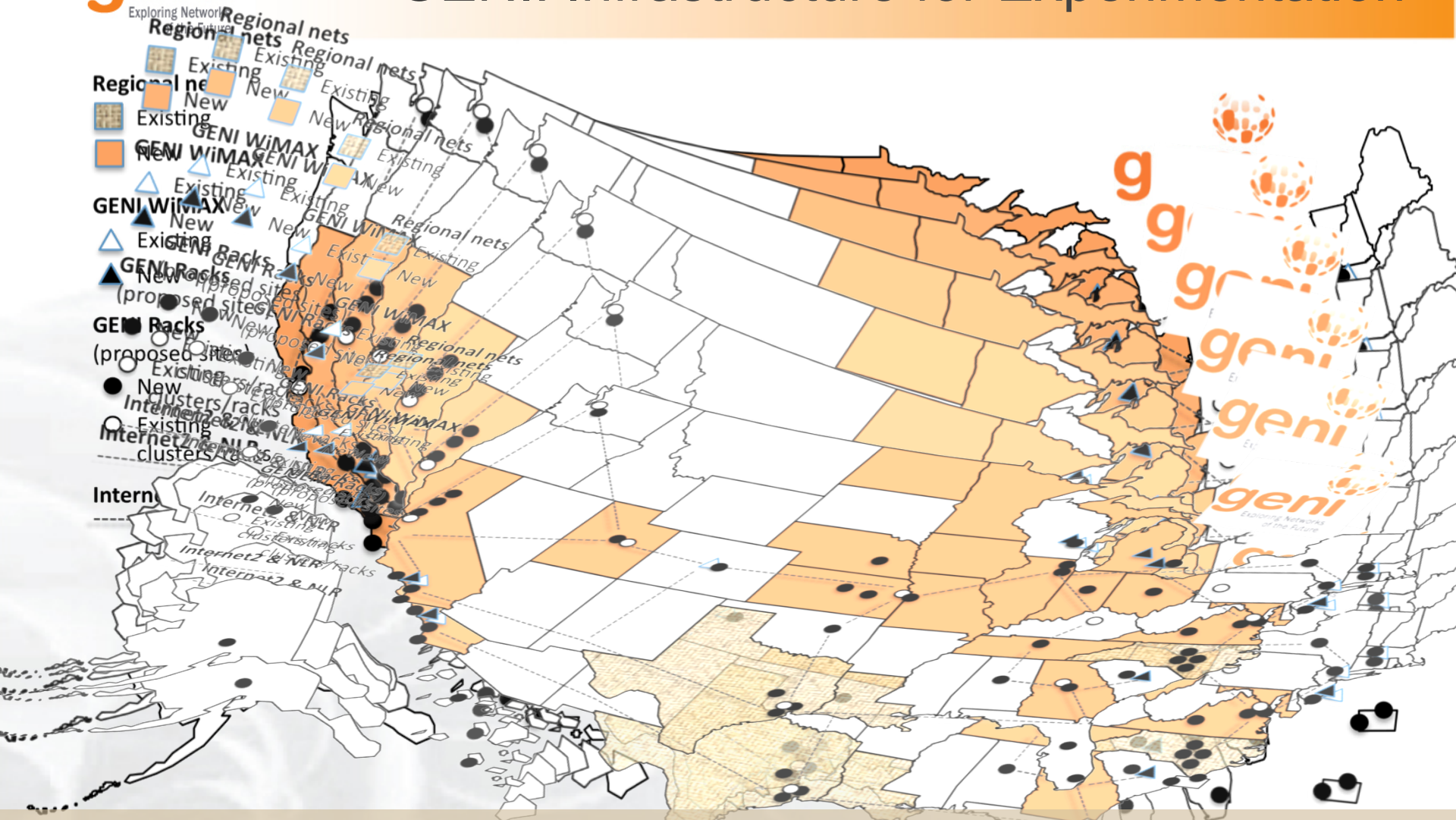




- 26 Wimax Base Stations in 13 Sites
- 90 android handsets available to experimenters

- Sliced, virtualized and interconnected through Internet2



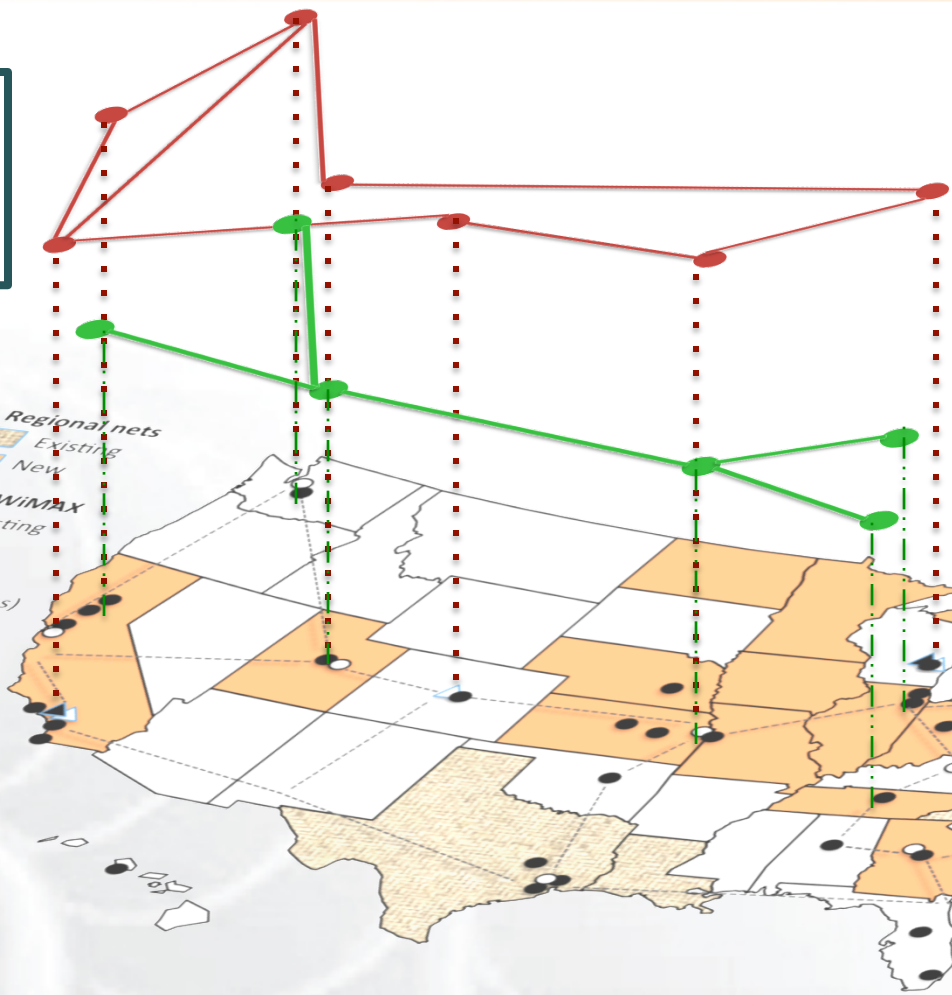


GENI provides compute resources that can be connected in experimenter specified Layer 2 topologies.

Resources in a slice may be virtualized



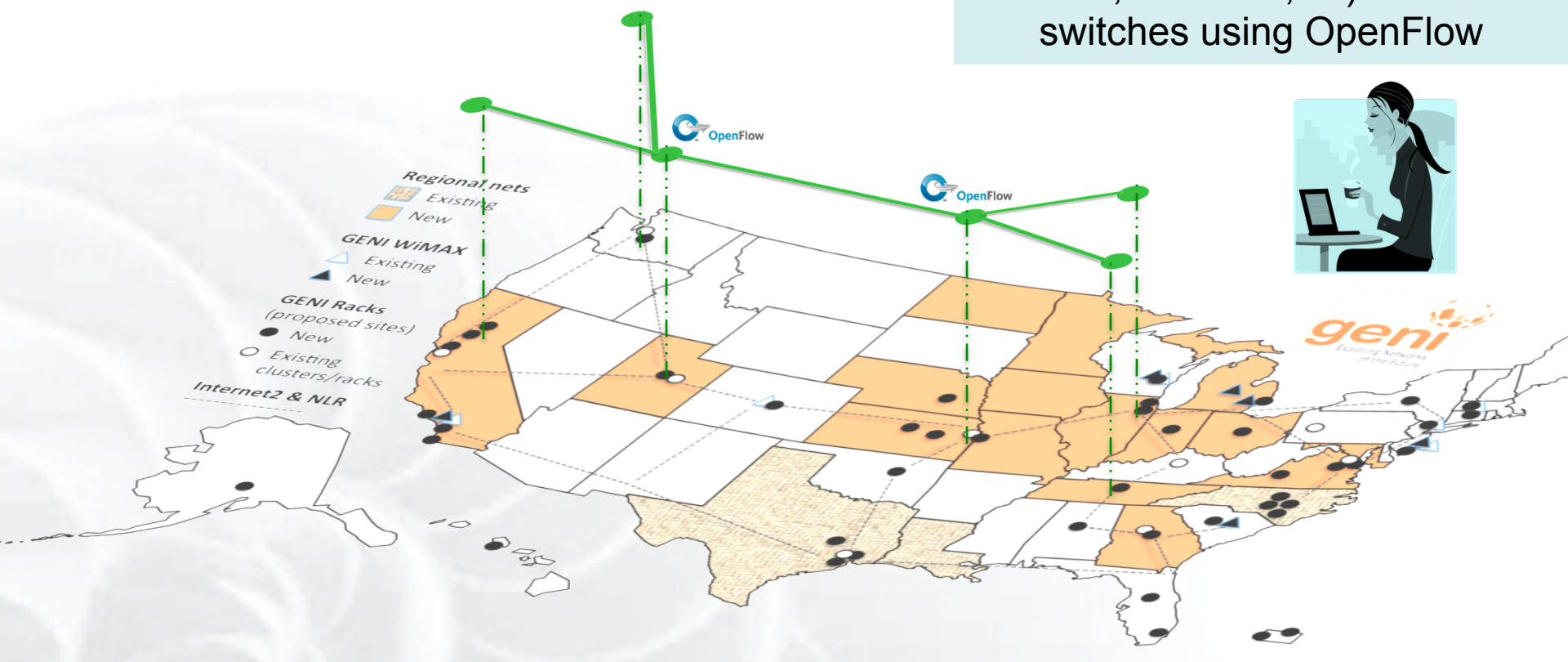
- Regional nets
  - Existing
  - New
- GENI WiMAX
  - Existing
  - New
- GENI Racks (proposed sites)
  - New
  - Existing clusters/racks
- Internet2 & NLR



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



OpenFlow part of the experiment not only the infrastructure

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How is GENI being used?

Key GENI Concepts

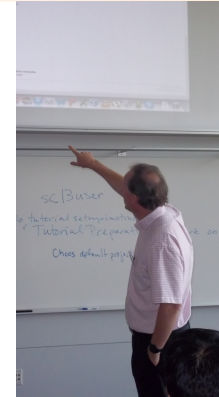
Demo: A simple experiment using GENI





## Research

- Future Internet architectures
- Software defined networking
- Large scale evaluation of smart grid protocols



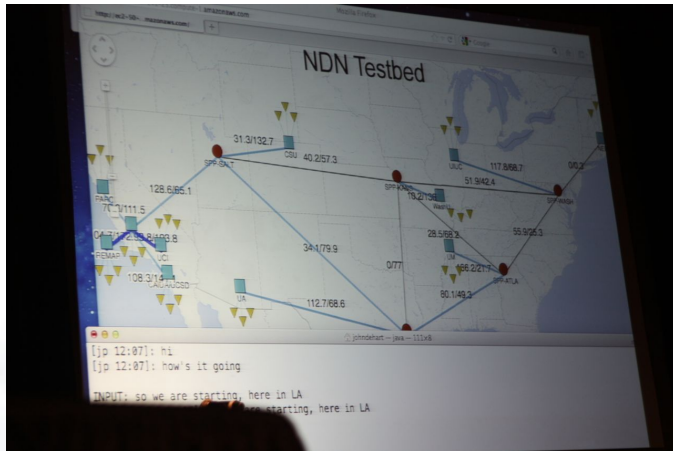
## Education

- Networking and Distributed systems classes
- Cloud computing classes
- WiMAX classes

**As of October 2014, GENI has over 2700 users!**



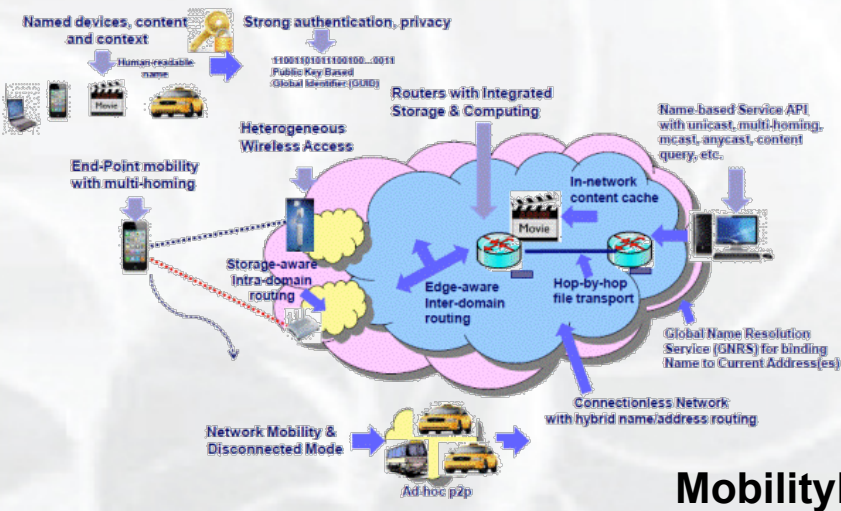
# Four FIA Teams have Slices on GENI



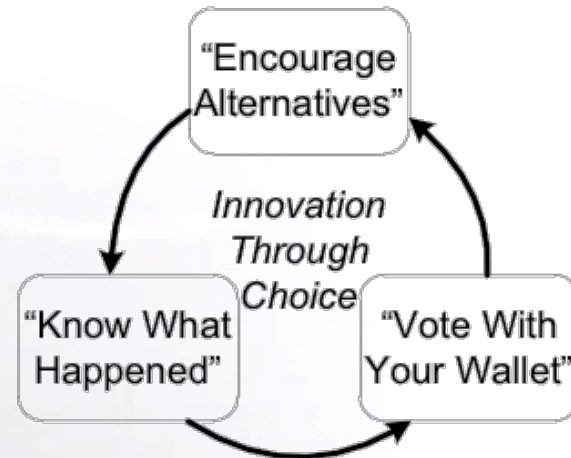
NDN



XIA



MobilityFirst



ChoiceNet

**GENI is the only testbed that can support these teams.**

## Over 50 classes have used GENI

- Undergrad level
- Graduate level
- Used Internationally

## Ready-to-use tutorials assignments

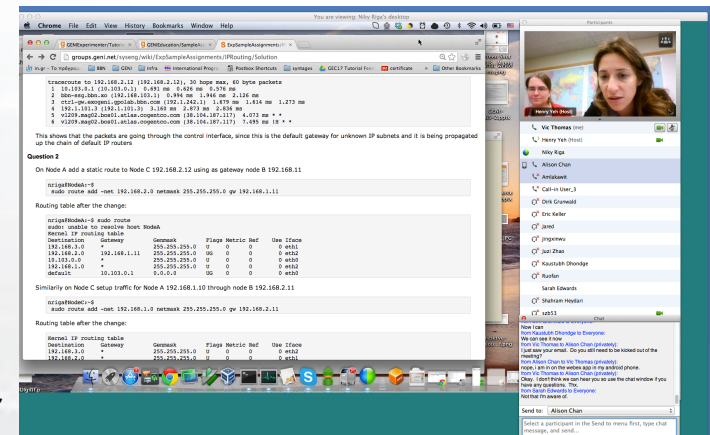
- Teach how to use GENI
- Teach networking concepts
- Teach distributed computing concepts
- Teach programmable networks

## Train-the-TA tutorials

- Start of each semester
- Taught over WebEx



*Jeannie Albrecht (Williams College) with students from her Spring 2012 Distributed Systems class*



*Train-the-TA Webinar*

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How is GENI being used?

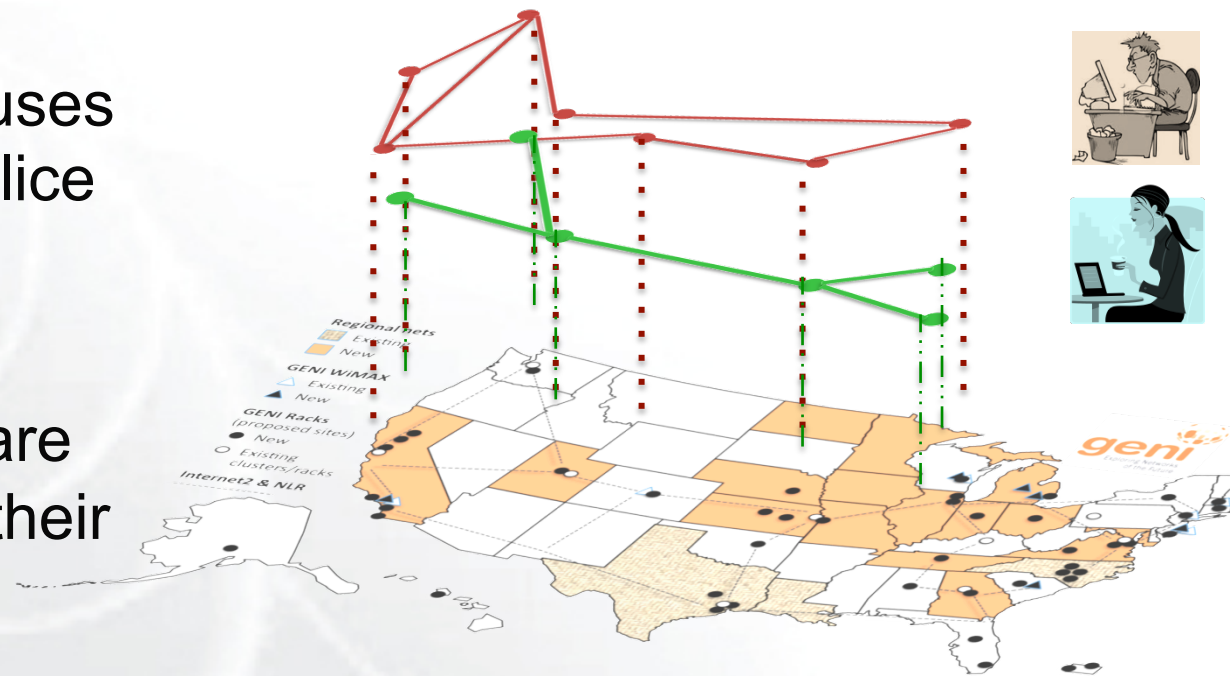
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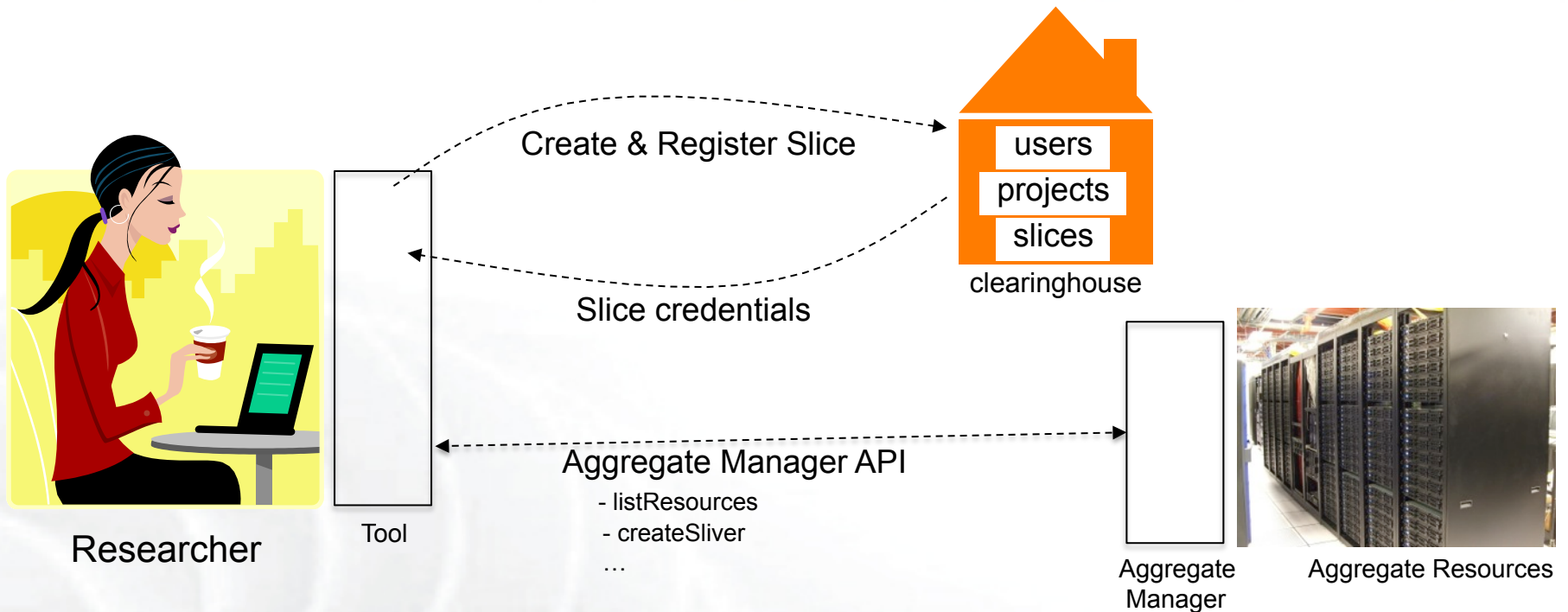
## Slice

Abstraction for a collection of resources capable of running experiments

- An experiment uses resources in a slice
- Slices isolate experiments
- Experimenters are responsible for their slices



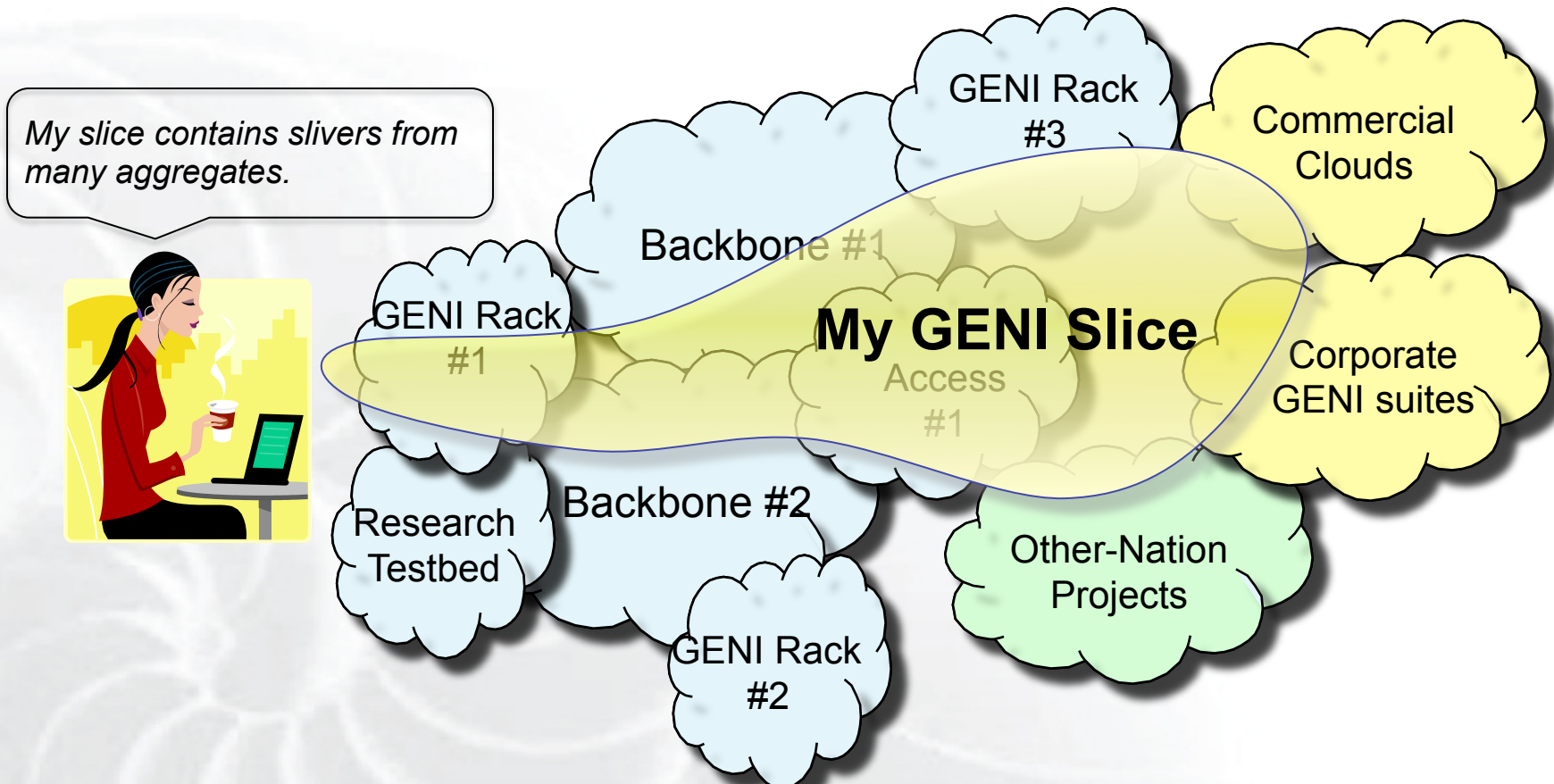




- **Clearinghouse: Manages users, projects and slices**
  - Standard credentials shared via custom API or new Common CH API
  - GENI supported accounts: GENI Portal/CH, PlanetLab CH, ProtoGENI CH
- **Aggregate: Provides resources to GENI experimenters**
  - Typically owned and managed by an organization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



- A slice : One or more resources provided by an aggregate
  - E.g. Bare machines, virtual machines, VLANs

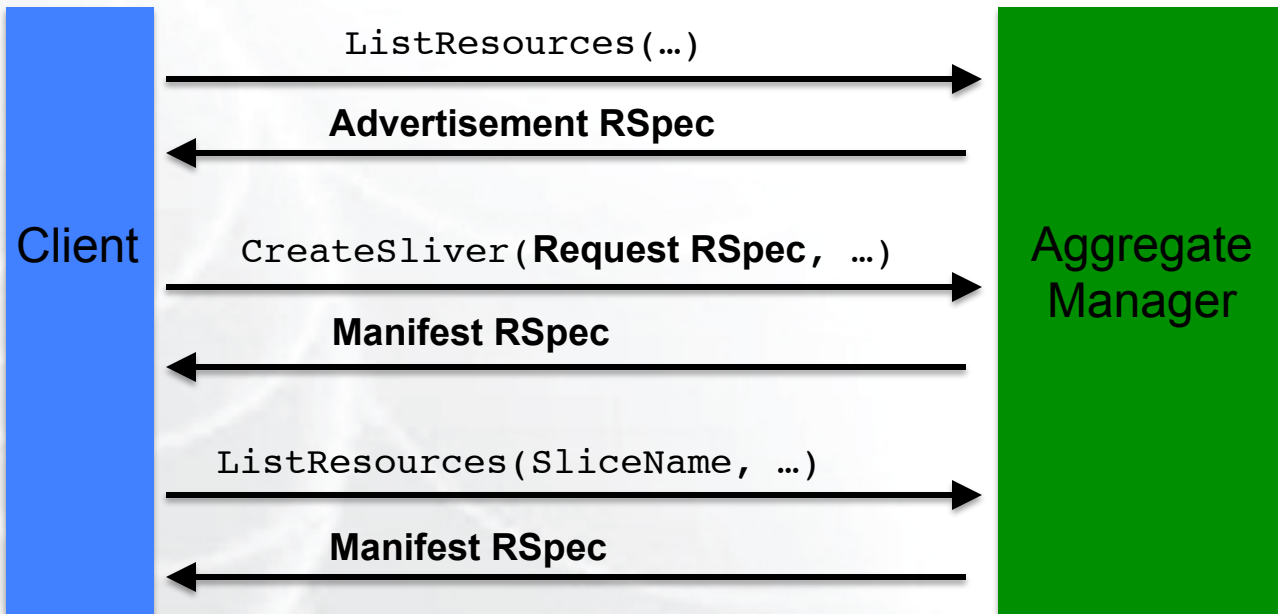
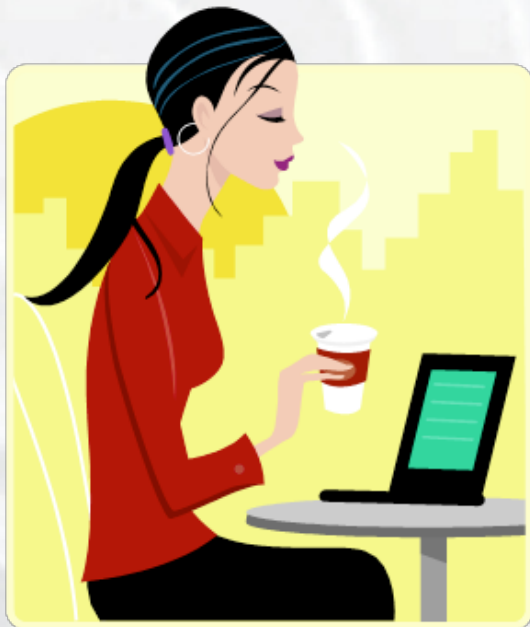


- RSpecs: Lingua franca for describing and requesting resources
  - “Machine language” for negotiating resources between experiment and aggregate
  - Experimenter tools eliminate the need for most experimenters to write or read RSpec

```
<?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**

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



What is GENI?

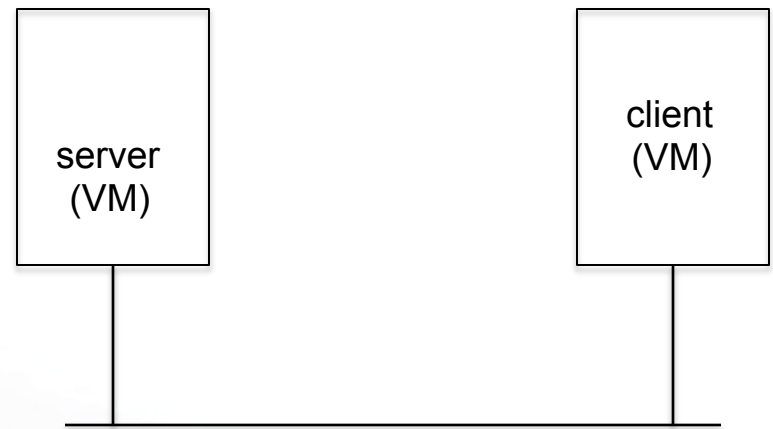
How is GENI being used?

Key GENI Concepts

Demo: A simple experiment using GENI



- Demo
  - Create a slice
  - Create a sliver at one aggregate
    - Two computers (raw PCs), connected by a LAN
  - Install and run software on the machines
  - View output of software
  - Delete sliver
- Experimenter tool: jFed





## **GENI Winter Camp** **University of Connecticut**

13 – 17 January 2015

[http://groups.geni.net/geni/wiki/  
APRAGENI/GREE-WC2015](http://groups.geni.net/geni/wiki/APRAGENI/GREE-WC2015)

Travel grants available!  
Apply by: 21 November 2014



## **GENI in** **Education**

Pre-symposium event at  
**SIGCSE 2015**  
**Kansas City, Missouri**  
4-7 March 2015

# GENI Engineering Conferences

## We welcome your participation in GENI

- **22<sup>nd</sup> meeting, open to all:**  
**March 23-26, 2015, Washington, DC**
  - Planning & discussion for experimenters, software, infrastructure
  - Tutorials and workshops
  - **Travel grants** to US academics for participant diversity





- Sign Up for :  
[geni-users@googlegroups.com](mailto:geni-users@googlegroups.com)
- Use #geni IRC chatroom
- HowTo pages on the GENI Wiki

*<http://groups.geni.net/geni/wiki/GENIExperimenter/GetHelp>*



- **geni-announce**
  - GENI news and events
- **Experimenters**
  - Announcements of interest to GENI experimenters
- **Experimenter-ops**
  - Announcements about infrastructure maintenance

Full list at:

<http://groups.geni.net/geni/wiki/GENICommunicationChannels>

# Have a question?

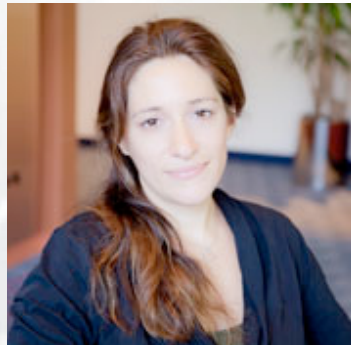
## Answer is

# help@geni.net

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



Sarah Edwards



Niky Riga

(However, the archive of the list is public)



Vic Thomas

# QUESTIONS?