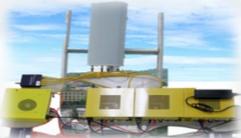




GENI in the Classroom



# GENI

## Exploring Networks of the Future

[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: Infrastructure for Experimentation

## Regional nets

-  Existing
-  New

## GENI WiMAX

-  Existing
-  New

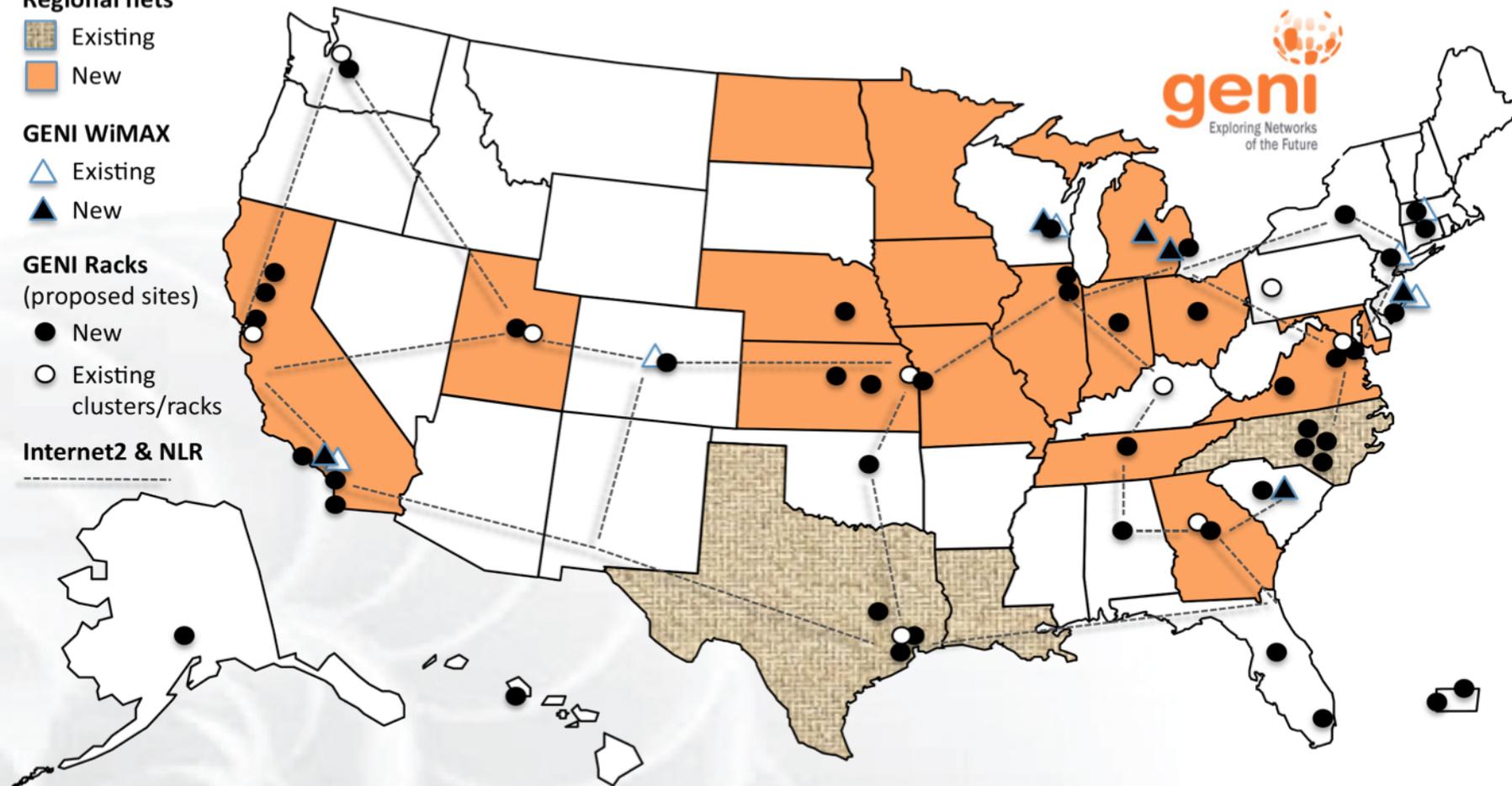
## GENI Racks

(proposed sites)

-  New
-  Existing clusters/racks

## Internet2 & NLR

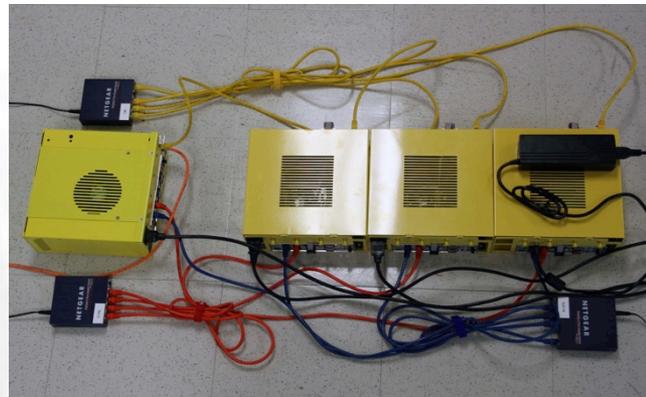
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GENI provides compute resources that can be connected in experimenter specified Layer 2 topologies.



GENI Racks



GENI Wireless  
compute nodes



Emulab

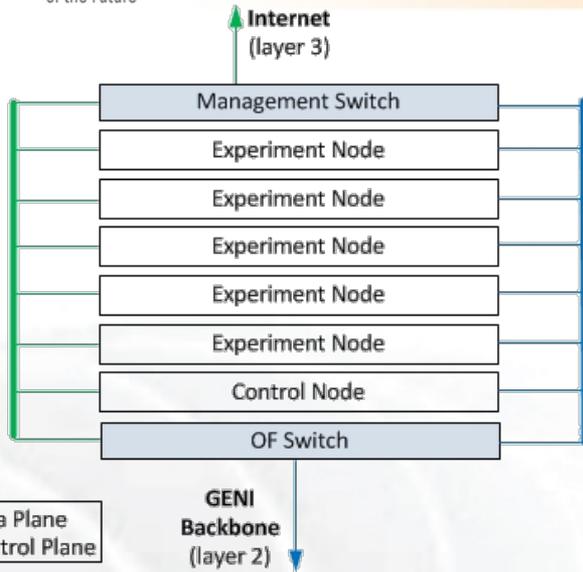


Planetlab



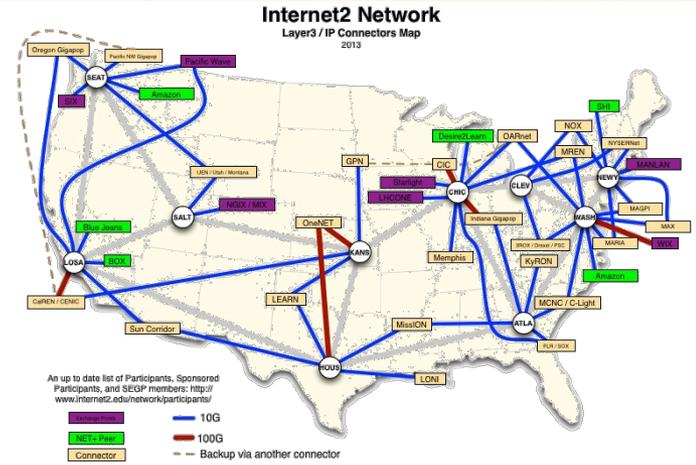
ORBIT

Existing Testbeds



Networking within a Rack

WiMAX Base Stations



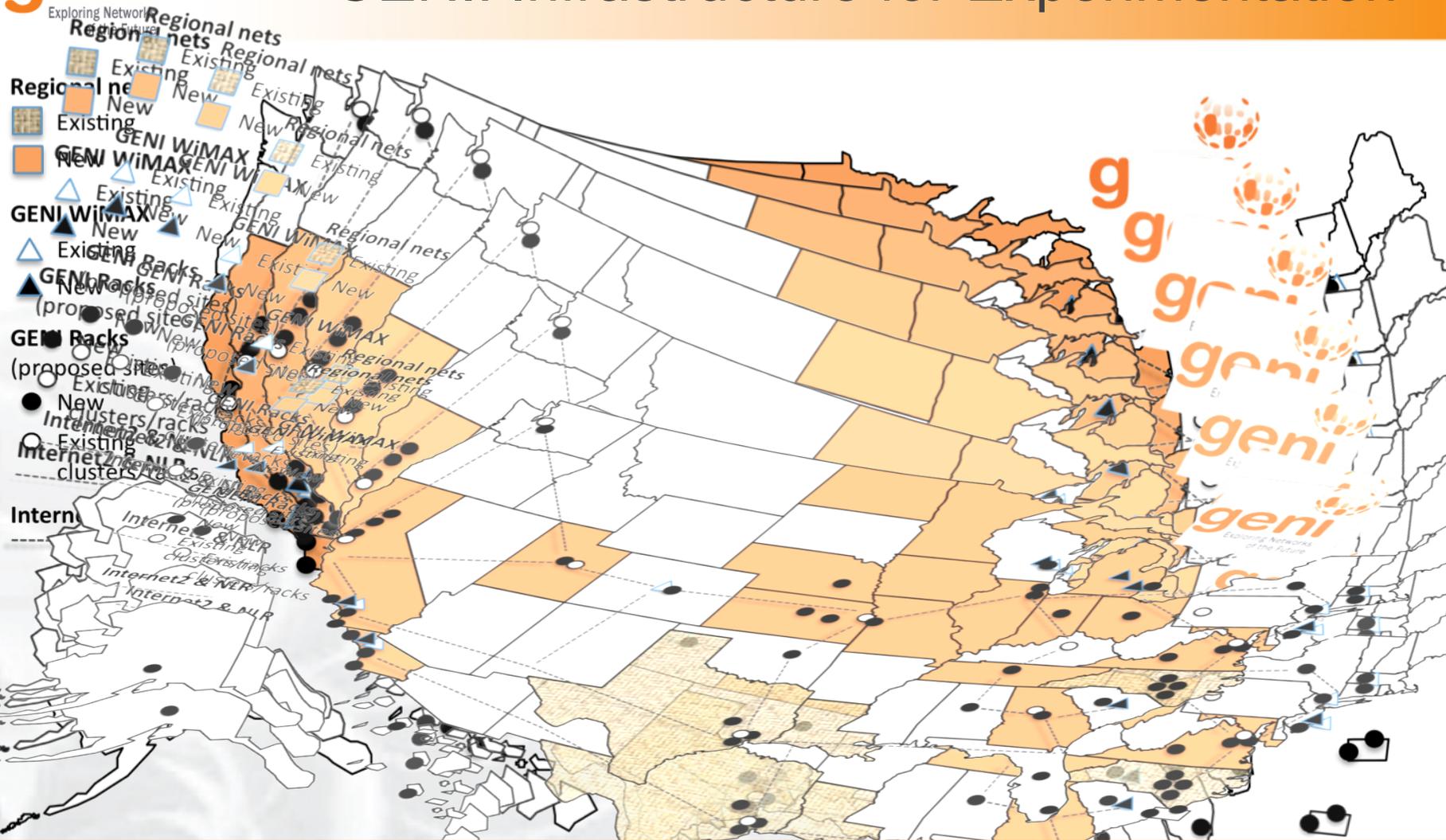
National Research Backbones (e.g. Internet2)



Regional Networks (e.g. CENIC)



# GENI: Infrastructure for Experimentation

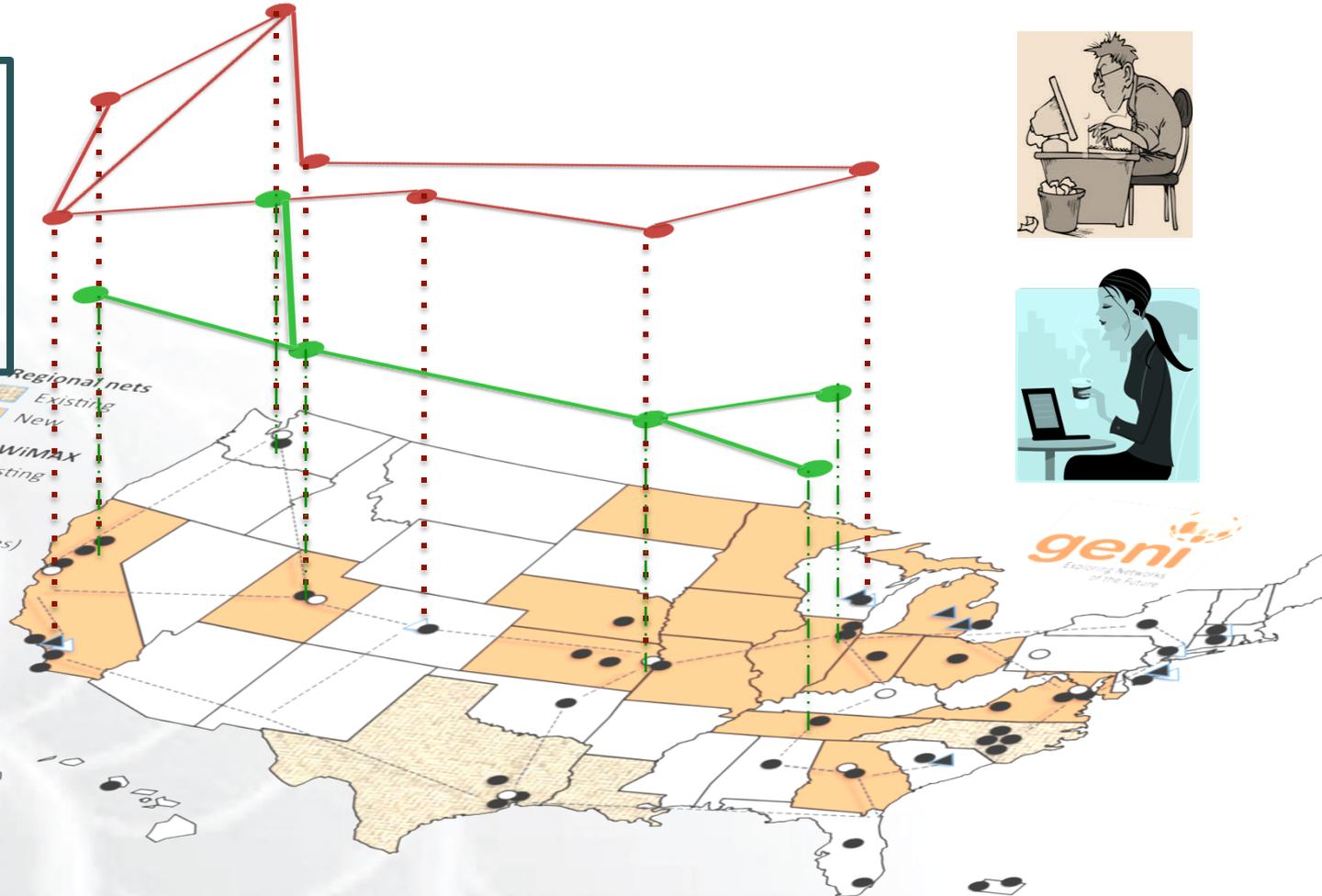


GENI provides compute resources that can be connected in experimenter specified Layer 2 topologies.



# Multiple GENI Experiments run Concurrently

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



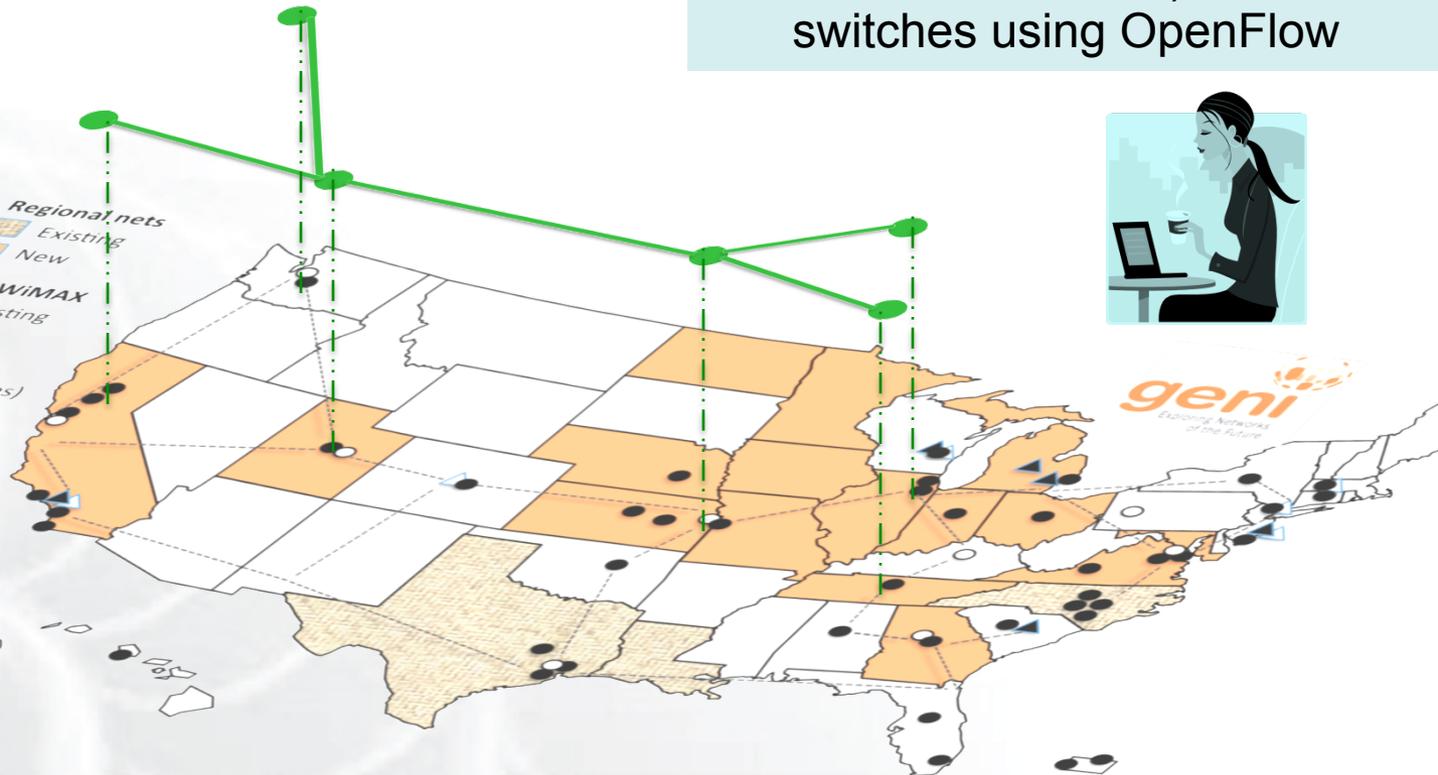
Experiments live in **isolated “slices”**

# GENI is “Deeply Programmable”

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



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



Experimenters can set up custom topologies, protocols and switching of flows

# GENI Build Out: Deploying GENI racks



**Ilia Baldine**  
**RENCI**

More resources / rack,  
fewer racks



**Rajesh Narayanan**  
**DELL**



**KC Wang** Clemson

Latest addition

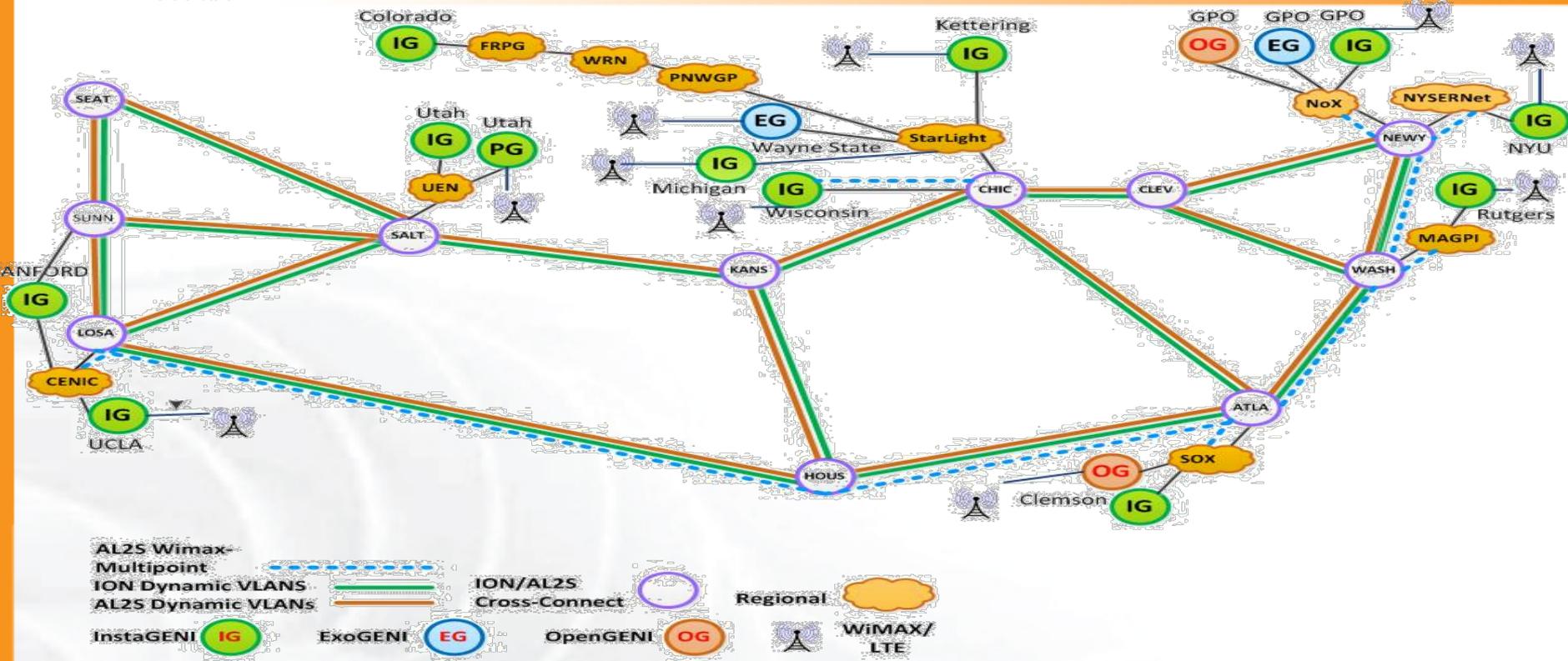


**Rick McGeer**  
**HP Labs**

Fewer resources / rack,  
more racks



Over 50 GENI Racks will be deployed by August 2015



- 26 Wimax Base Stations in 13 sites
- 90 android handsets available to experimenters
- Sliced, virtualized and interconnected through Internet2

## New wireless deployments will use LTE



GENI is working actively with peer efforts on five continents to define and adopt common concepts and APIs.

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## Research

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



## Education

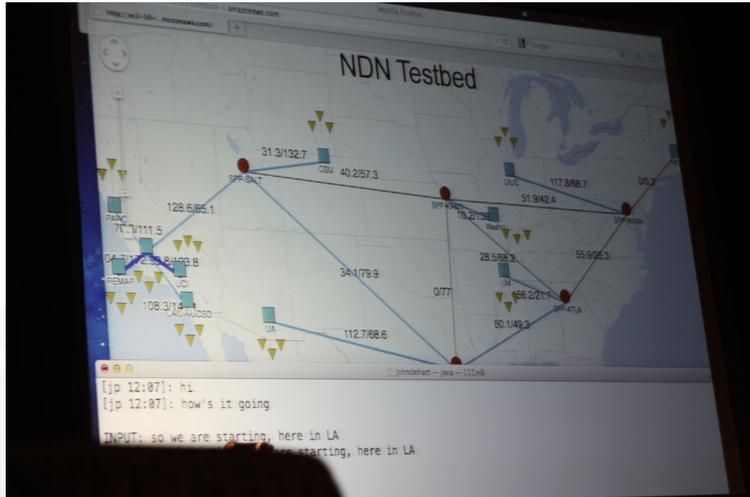
- Classes in:
  - Computer Networking
  - Distributed systems
  - Cloud computing
  - Wireless Communications
- Undergraduate, graduate

**GENI has over 4300 users!**

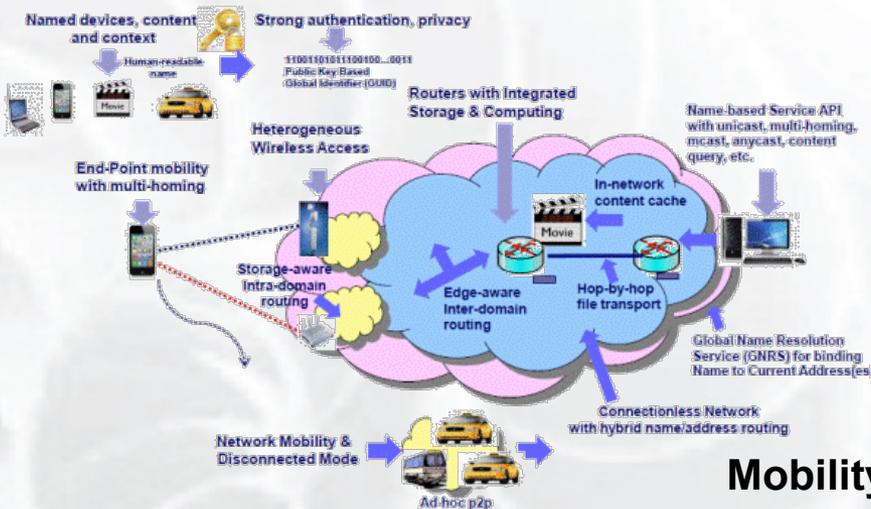
# Three FIA Teams have Slices on GENI

## All three did tutorials at GEC21

**NDN (demo at GEC 13)**



**XIA (demo at GEC15)**



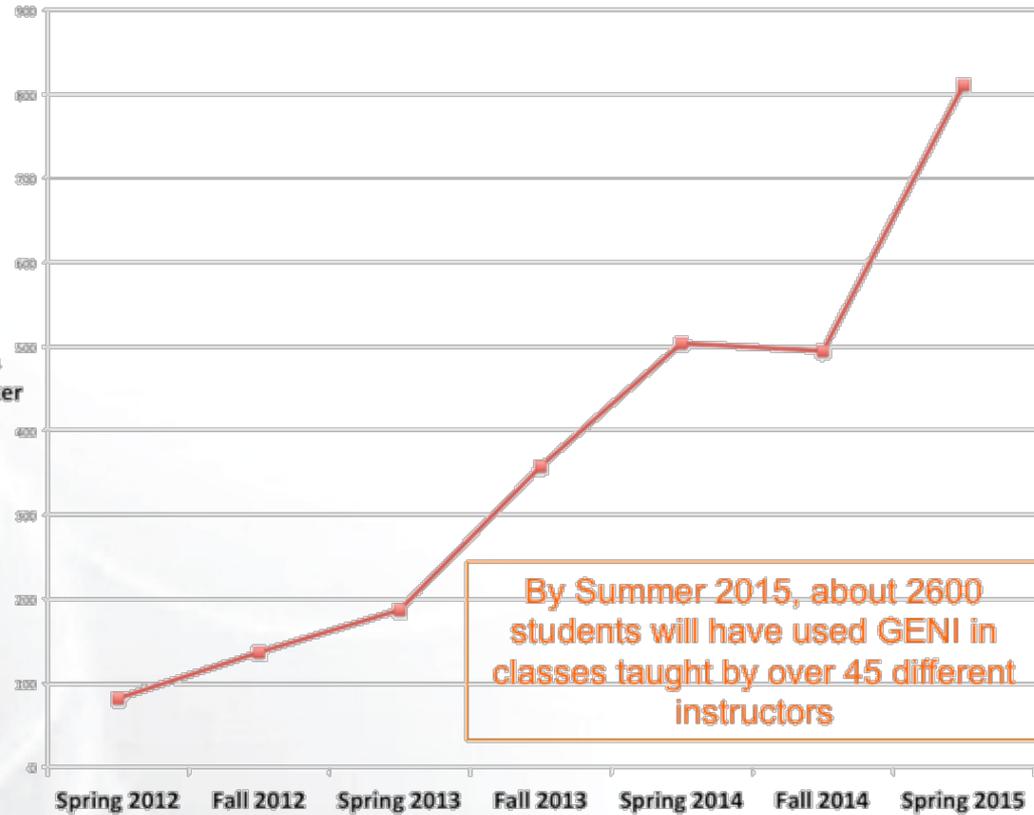
**MobilityFirst (demo at GEC 12, GEC18, GEC22)**

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



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

Students  
per semester





**Tutorial: Building Experiments  
Using the GENI and SAVI  
Testbeds**

24 June 2014

Vancouver, Canada

**Computer and Networking  
Experimental Research using  
Testbeds**

29 June 2014

With ICDCS in Columbus, OH

Papers and demos on research  
validated using testbeds



The International Workshop on Computer and Networking Experimental Research Using Testbeds

**CNERT**  
Computer and Networking  
Experimental Research  
using Testbeds

The 35th IEEE International Conference  
on Distributed Computing Systems  
(ICDCS 2015)

In Hilton Downtown, Columbus, Ohio, USA  
June 29th - July 2nd, 2015

June 29, 2015    Columbus, Ohio, USA

**Project Silver**

Rethinking Security in the Era of Cloud Computing

**Cloud Security Curriculum Development Workshop**

**Tutorial on Network Function  
Virtualization using GENI**

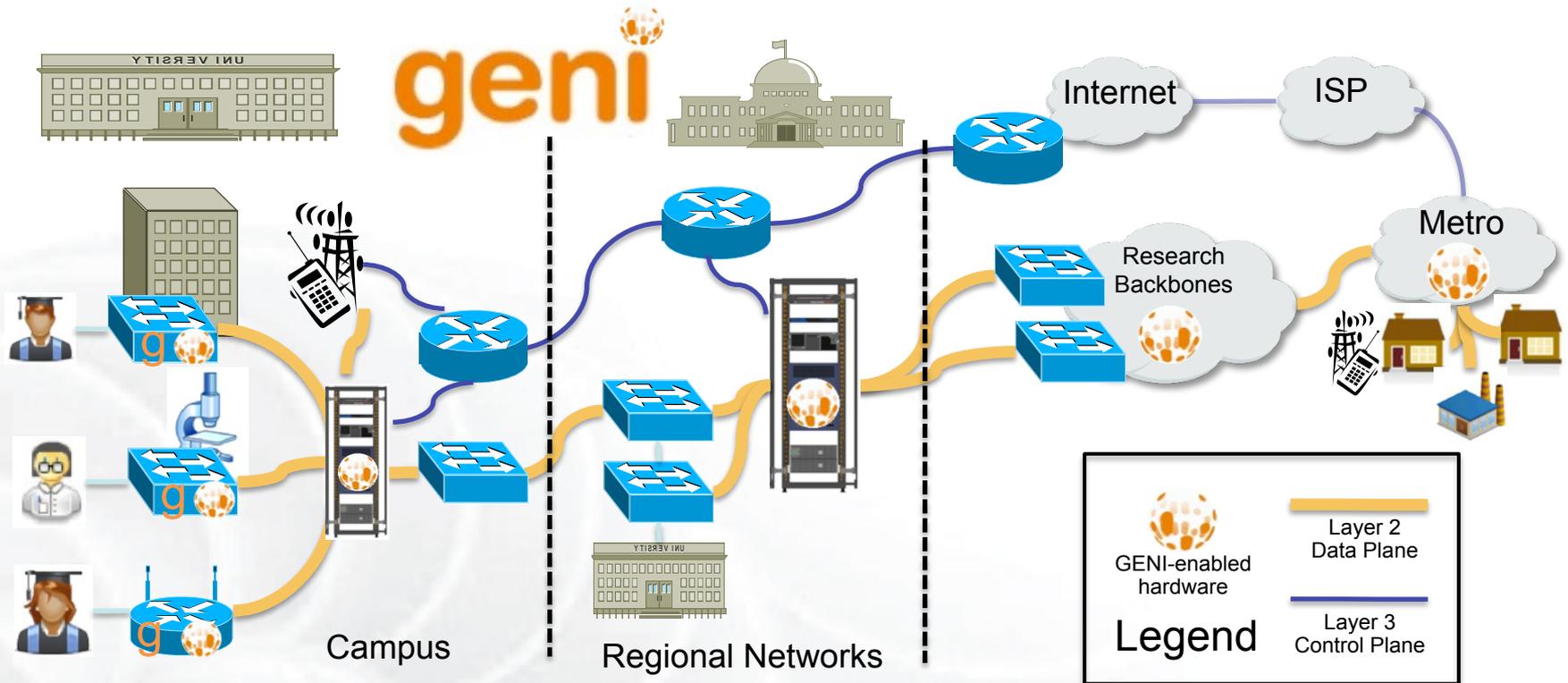
Organized by Jay Aikat, U. of North  
Carolina

What is GENI?

How is GENI being used?

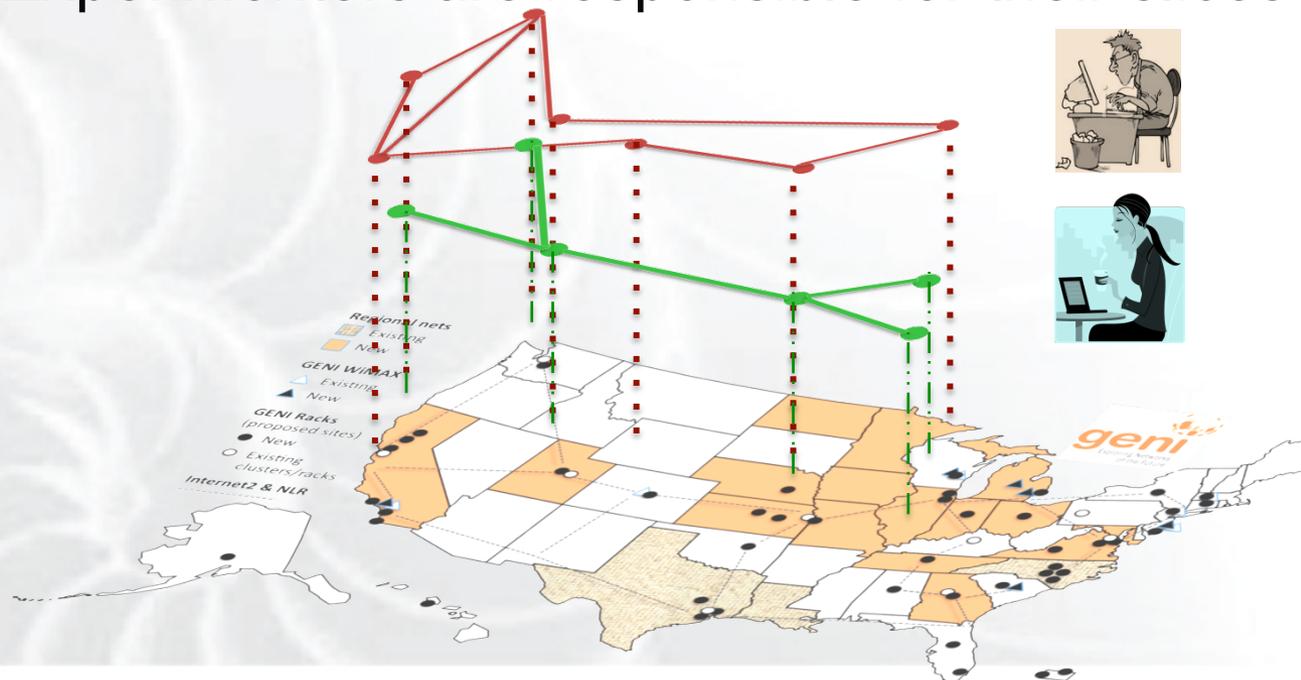
Key GENI Concepts

Demo: A simple experiment using GENI

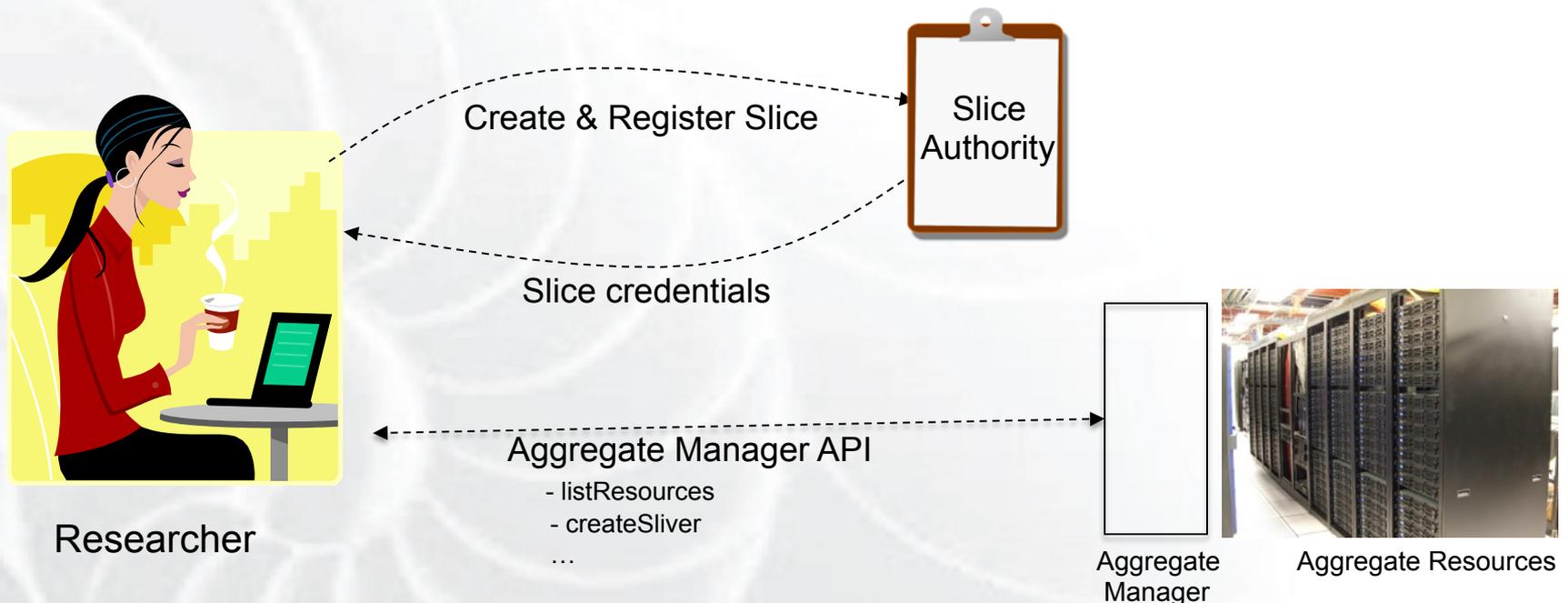


- Flexible network / cloud research infrastructure
- Distributed cloud (racks) for content caching, acceleration, etc.
- Also suitable for physics, genomics, other domain science

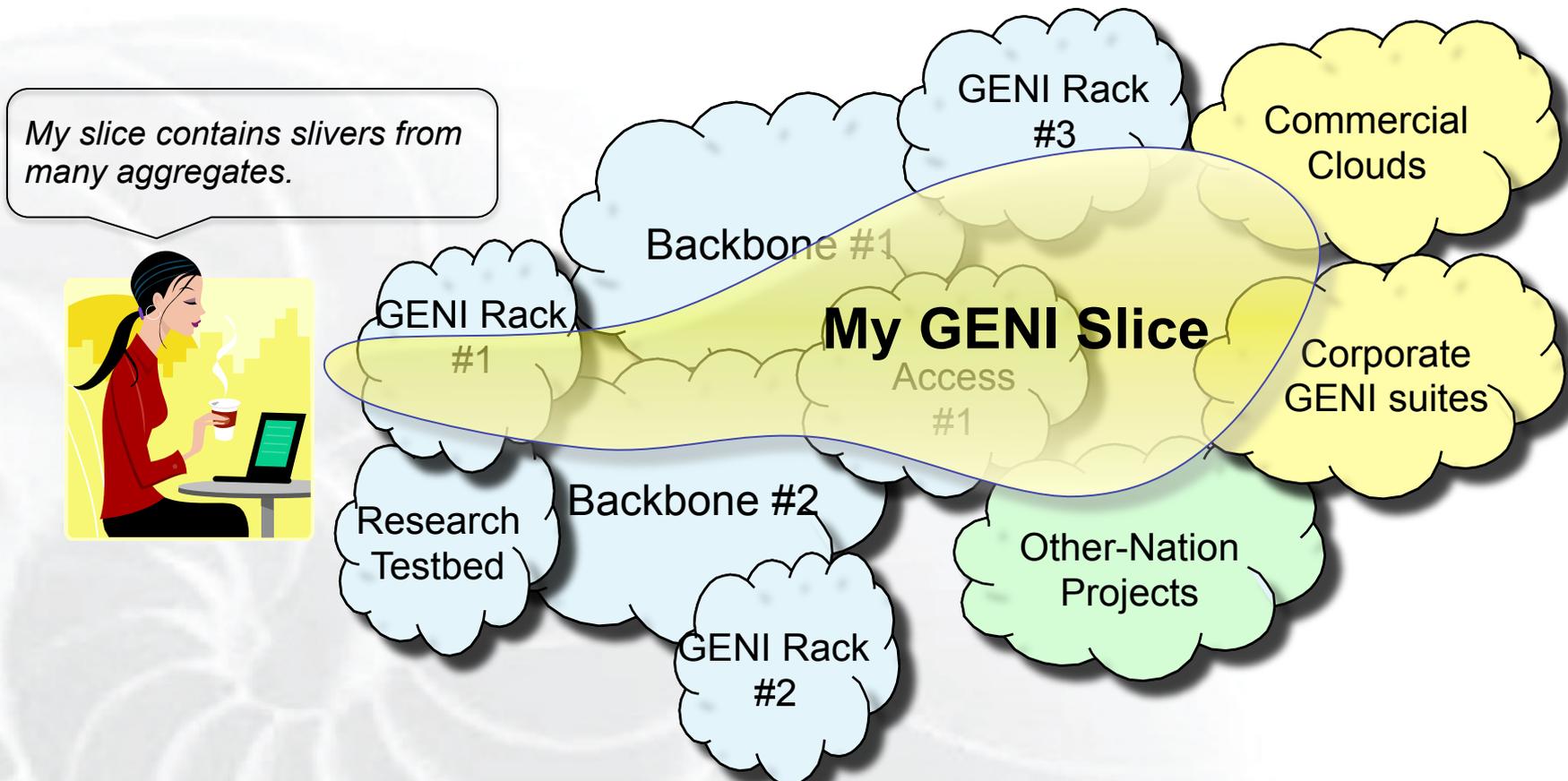
- Slice: Abstraction for a collection of resources capable of running experiments
  - An experiment uses resources in a slice
  - Slices isolate experiments
  - Experimenters are responsible for their slices



- **Slice authority:** Creates and registers slices
  - GENI slice authorities: GENI Portal, PlanetLab, ProtoGENI
- **Aggregate:** Provides resources to GENI experimenters
  - Typically owned and managed by an organization
  - Examples: GENI Racks, Internet2, Emulab, PlanetLab
  - Aggregates implement the GENI AM API



- Slivers: Resources held by a slice
  - E.g. Bare machines, virtual machines, VLANs

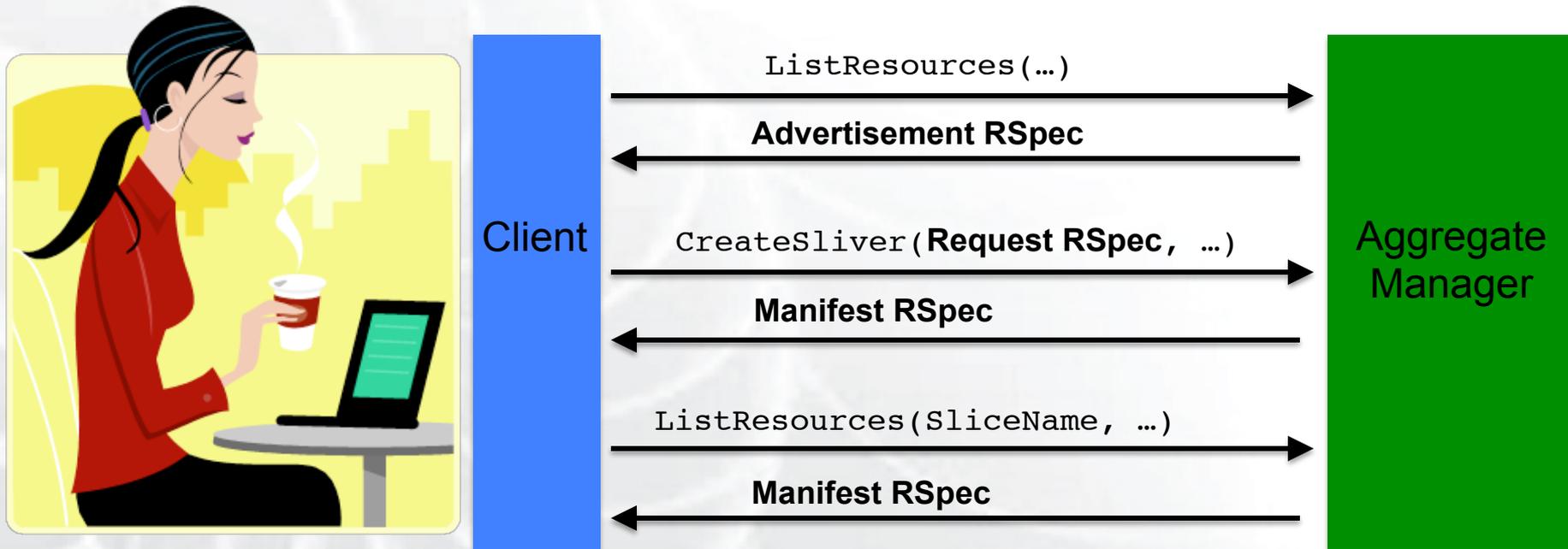


- RSpecs: Lingua franca for describing and requesting resources
  - “Machine language” for negotiating resources between experiment and aggregate
  - Experimenter tools eliminate the need for most experimenters to write or read RSpec

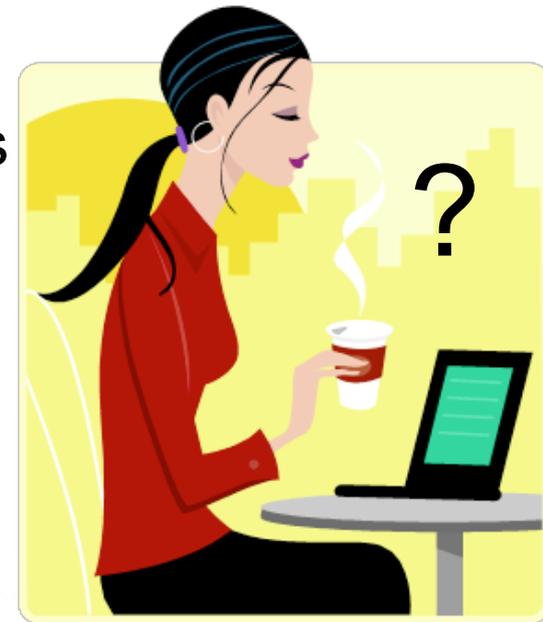
```
<?xml version="1.0" encoding="UTF-8"?>
<rspec xmlns="http://www.protogeni.net/resources/rspec/2"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.protogeni.net/resources/rspec/2
    http://www.protogeni.net/resources/rspec/2/request.xsd"
  type="request" >
  <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?



- **geni-announce**
  - GENI news and events
  - Announcements of events, opportunities
  - <http://lists.geni.net>
- **Help using GENI (community list)**
  - [geni-users@googlegroups.com](mailto:geni-users@googlegroups.com)
- **Email the GENI Project Office**
  - [help@geni.net](mailto:help@geni.net)



Full list at:

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

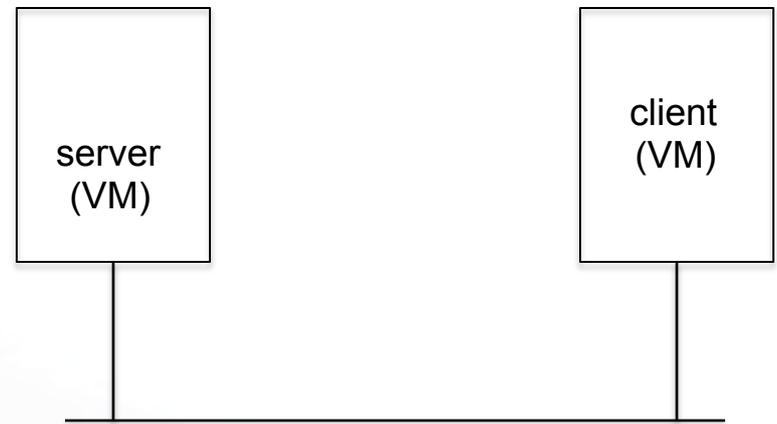
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- Demo
  - Create a slice
  - Create a sliver at one aggregate
    - Two computers (VMs), connected by a LAN
  - Install and run software on the machines
  - View output of software
  - Delete sliver
- Experimenter tool: Jacks



# QUESTIONS?