

GENI

Exploring Networks of the Future

Ibrahim Matta

Thanks to the GPO: Mark Berman & Vic Thomas

www.geni.net

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Sponsored by the National Science Foundation

- Zongming Fei
- Jim Griffioen
- Hussamuddin Nasir
- Lowell Pike
- Charles Carpenter
- ... and all the UKY team!

- What is GENI?
- Building and deploying GENI
- How is GENI being used
- An experimenter's view of GENI

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


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

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



Regional nets

-  Existing
-  New

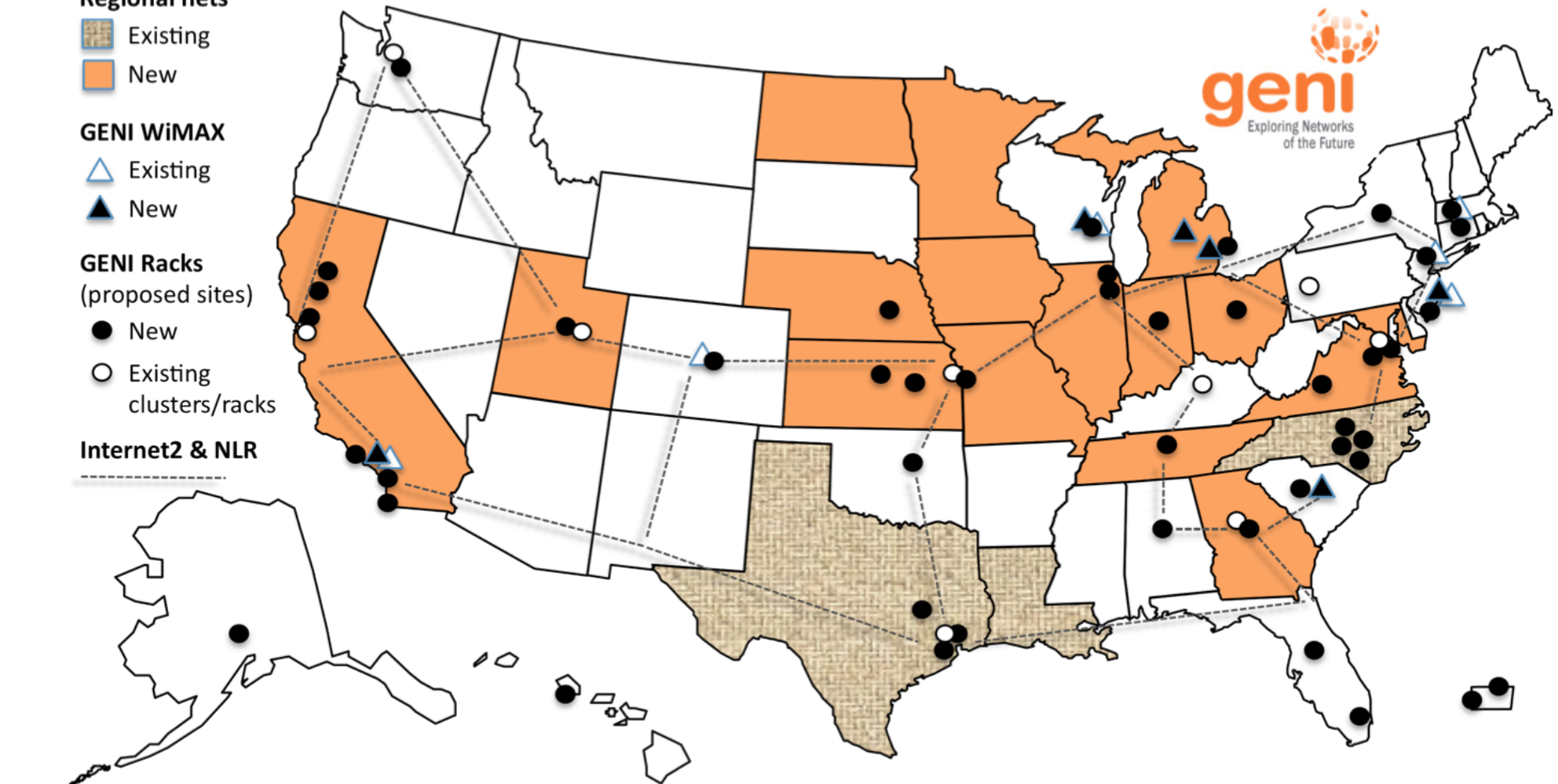
GENI WiMAX

-  Existing
-  New

GENI Racks (proposed sites)

-  New
-  Existing
clusters/racks

Internet2 & NLR

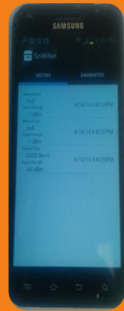


GENI provides compute resources that can be connected in experimenter specified Layer 2 topologies.

Compute Resources



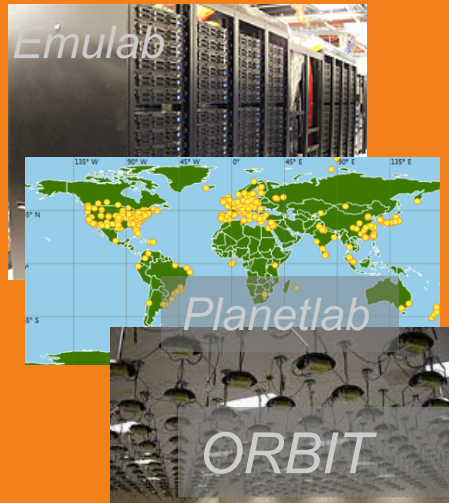
GENI Racks: small clouds
Virtual Machines
Bare metal Machines



Android
Phones



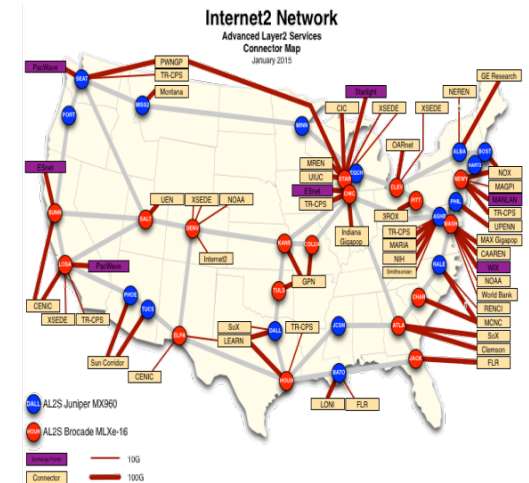
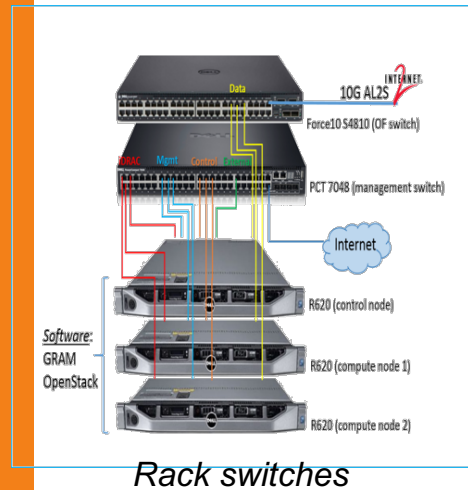
Wireless
nodes



Existing Testbeds

Network Resources

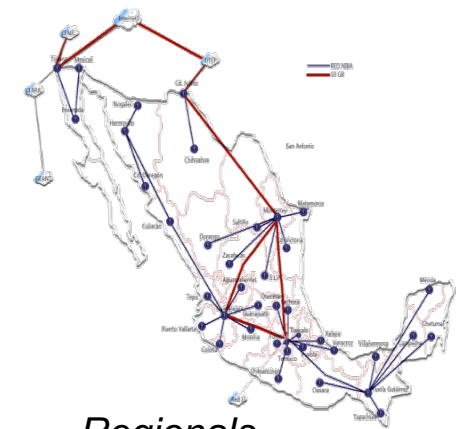
Layer 2 VLANs and Access to Programmable Switches



Internet2: US Research Backbone



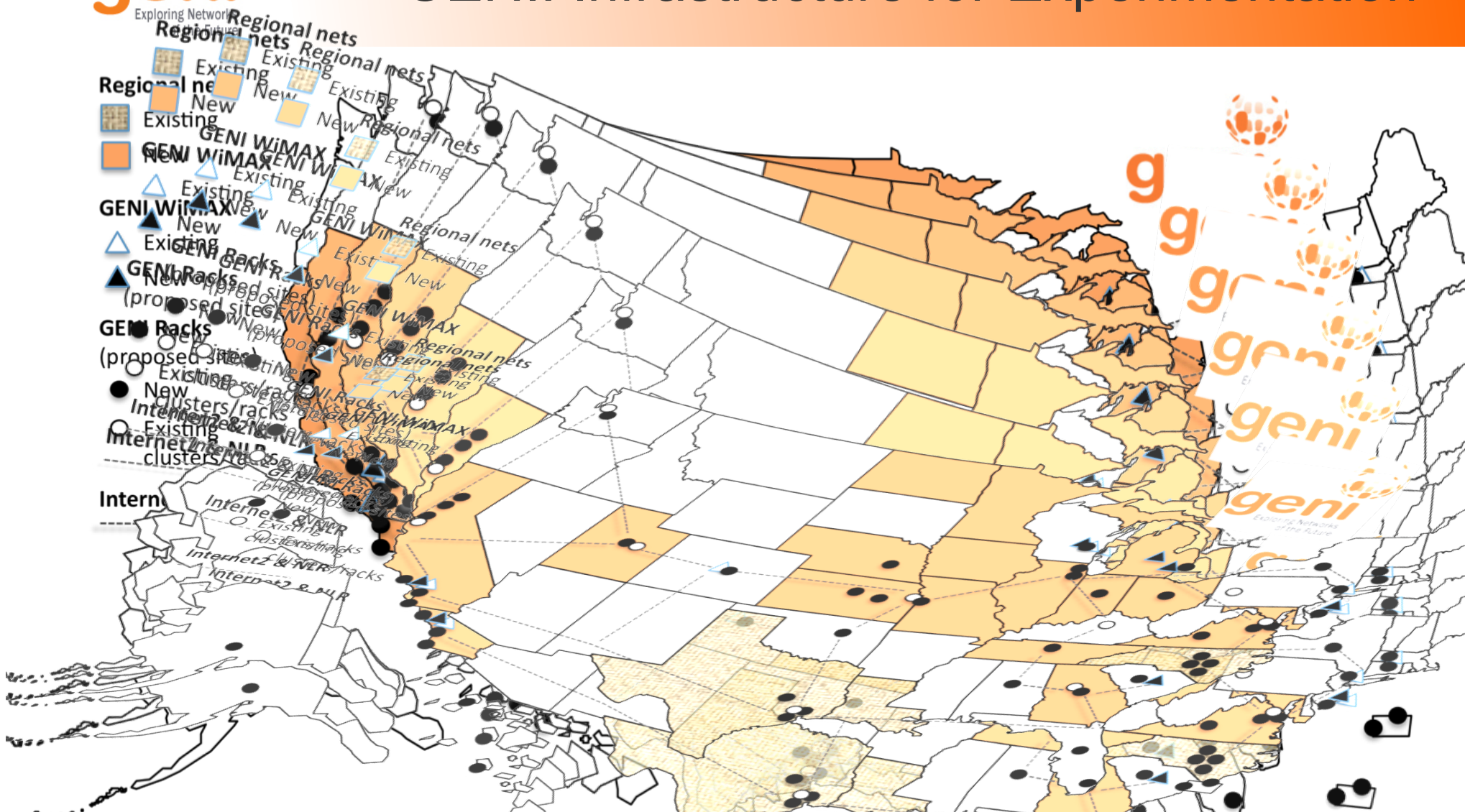
WiMAX/LTE
base stations,
4G/3G
Network



Regionals



GENI: Infrastructure for Experimentation

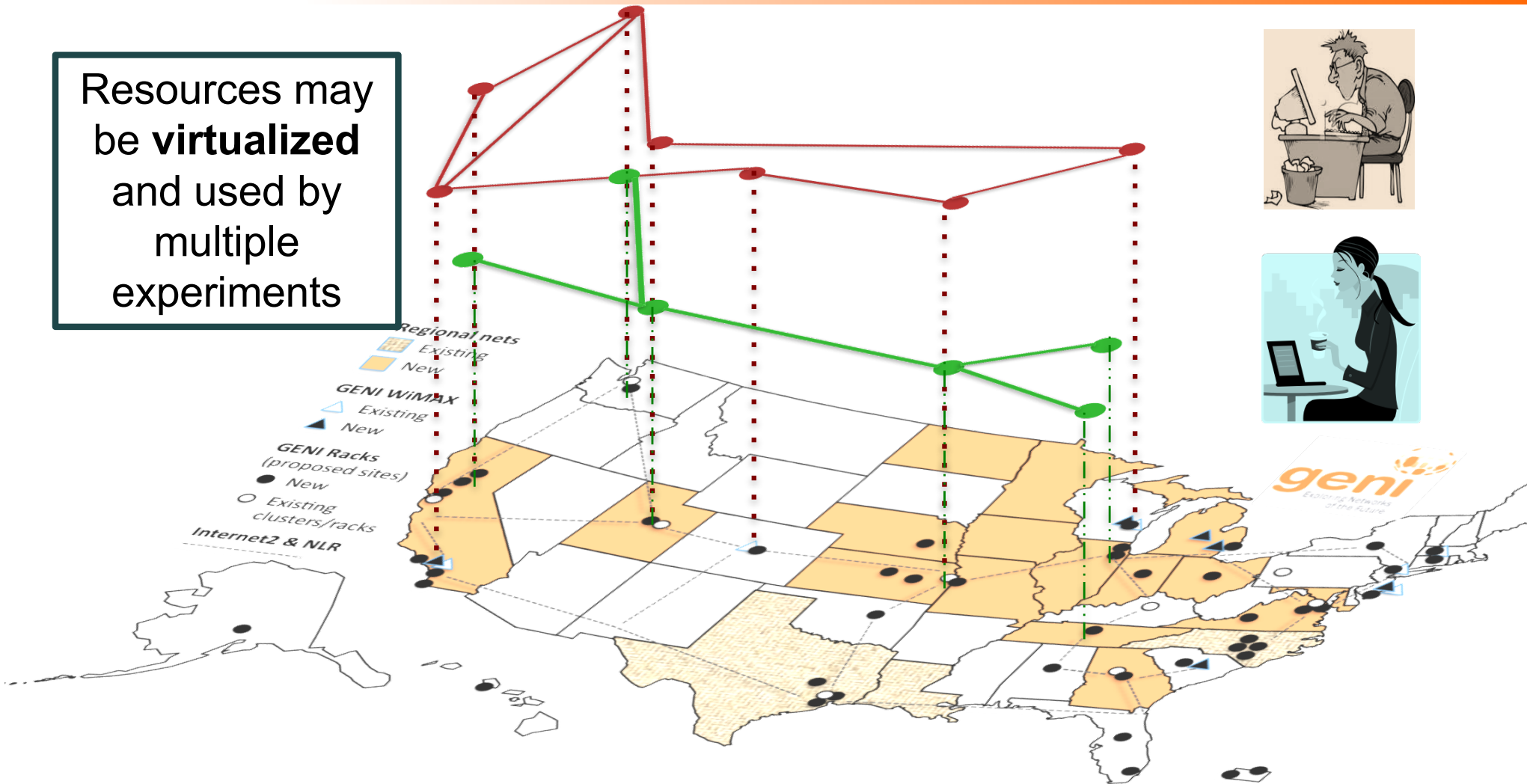


GENI provides compute resources that can be connected in experimenter specified Layer 2 topologies.



Multiple GENI Experiments run Concurrently

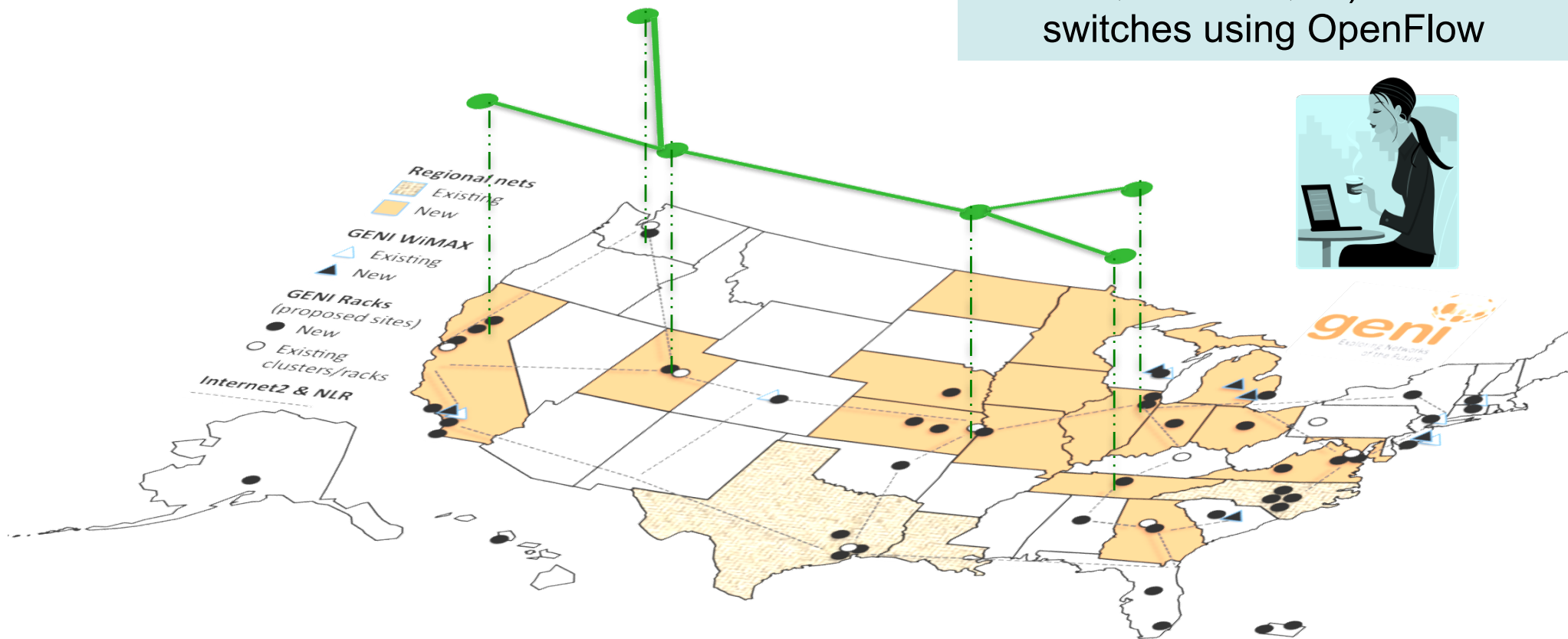
Resources may be **virtualized** and used by multiple experiments



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



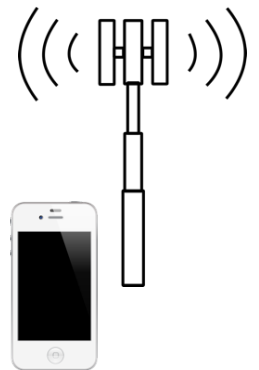
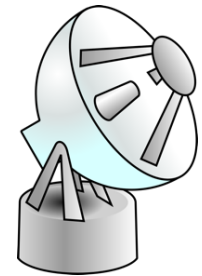
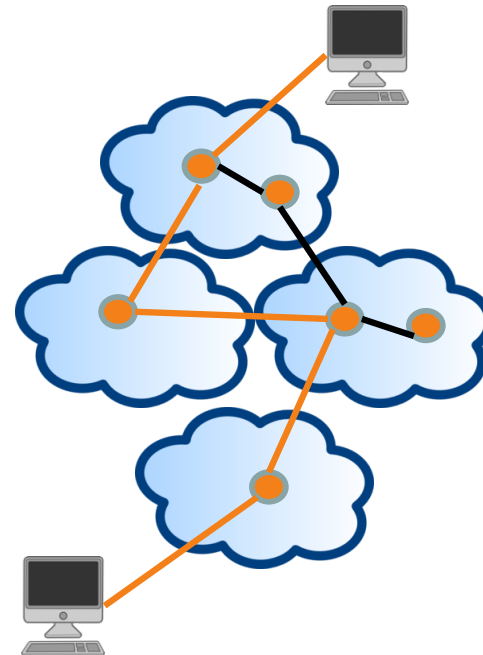
Everything is programmable: Experimenters create and
program custom topologies, protocols and flows

GENI is Precision Cyberinfrastructure

All applications and services
rely on cyberinfrastructure

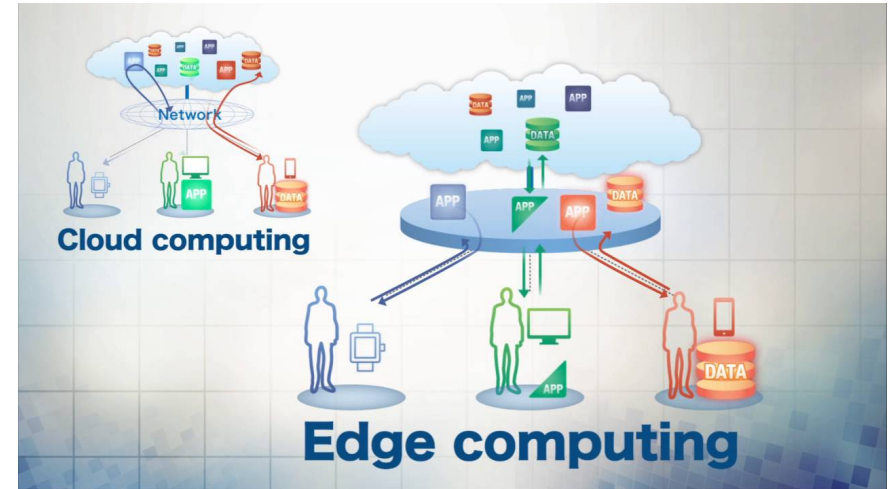
High performance applications
and services need precision
cyberinfrastructure

- The right resources
- In the right places
- Connected by the right network
- Running the right software

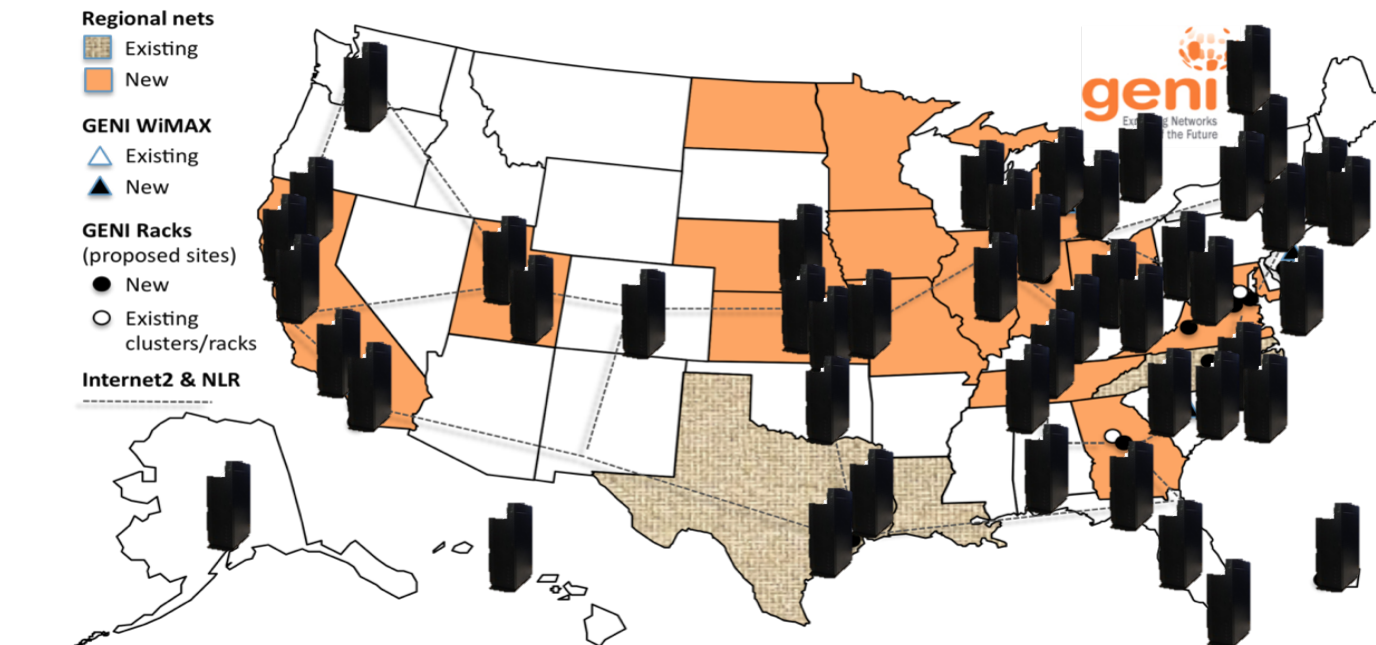


Edge computing: A method of optimizing cloud computing systems by performing data processing at the edge of the network, near the source of the data.

https://en.wikipedia.org/wiki/Edge_computing



Graphic from NTT Network Innovation Laboratories

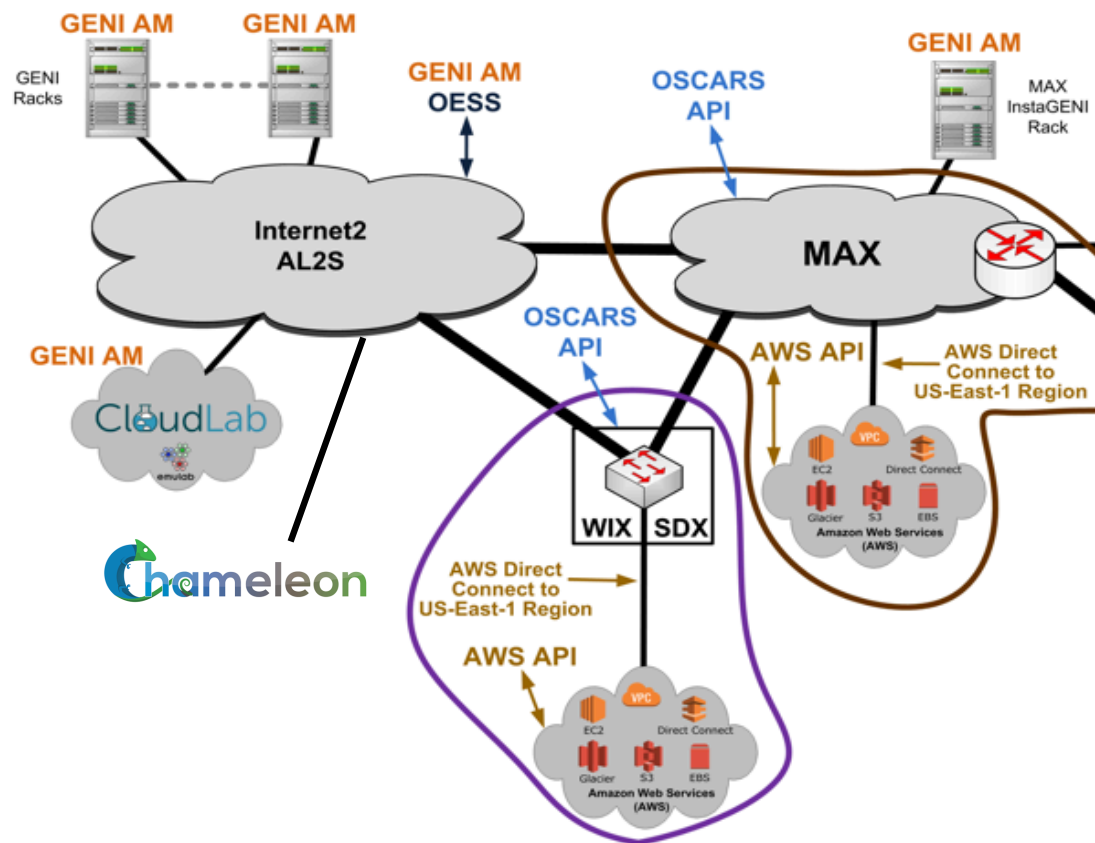


Every rack is a “cloudlet” in the GENI Edge Cloud

The GENI Edge Cloud connects to CloudLab, Chameleon and AWS

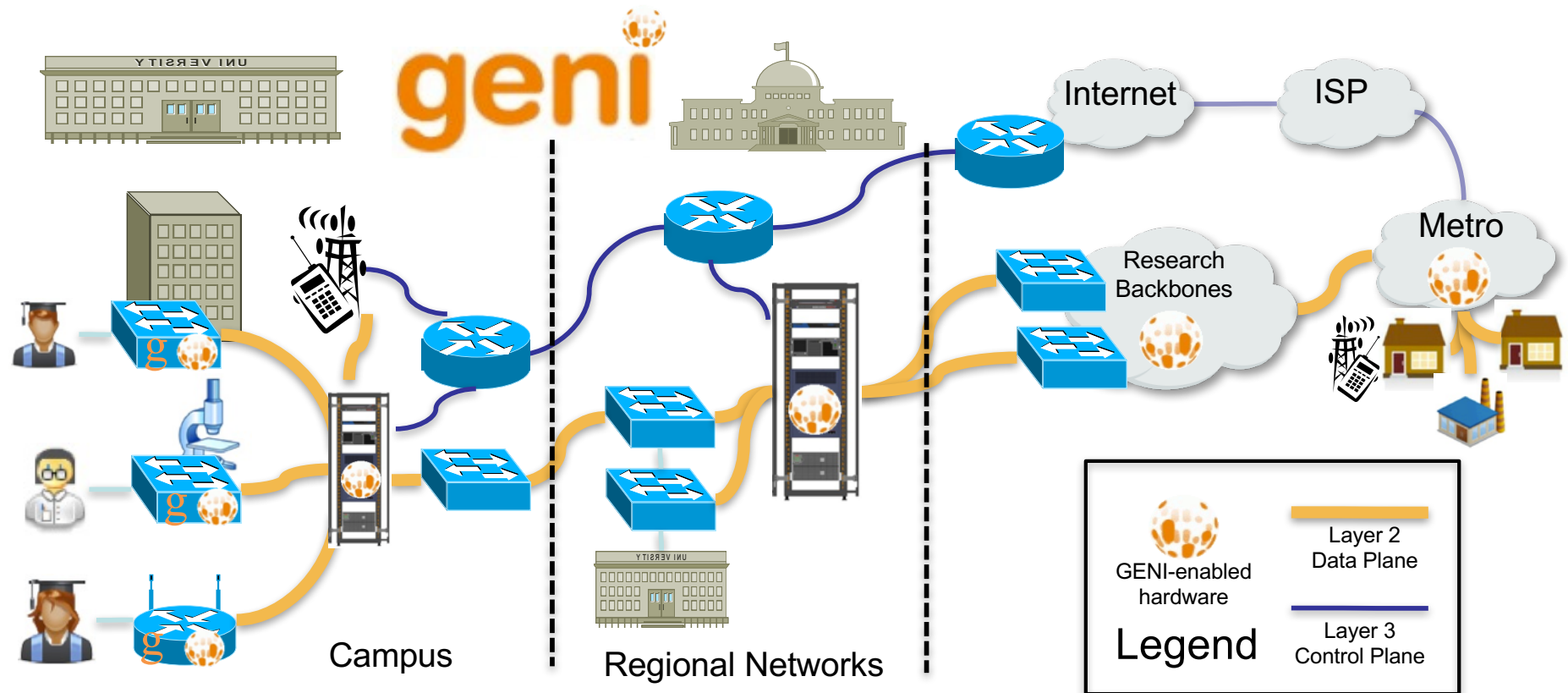
The GENI Edge Cloud connects to CloudLab, Chameleon and Amazon AWS

- Enables experiments that use GENI and CloudLab/AWS resources



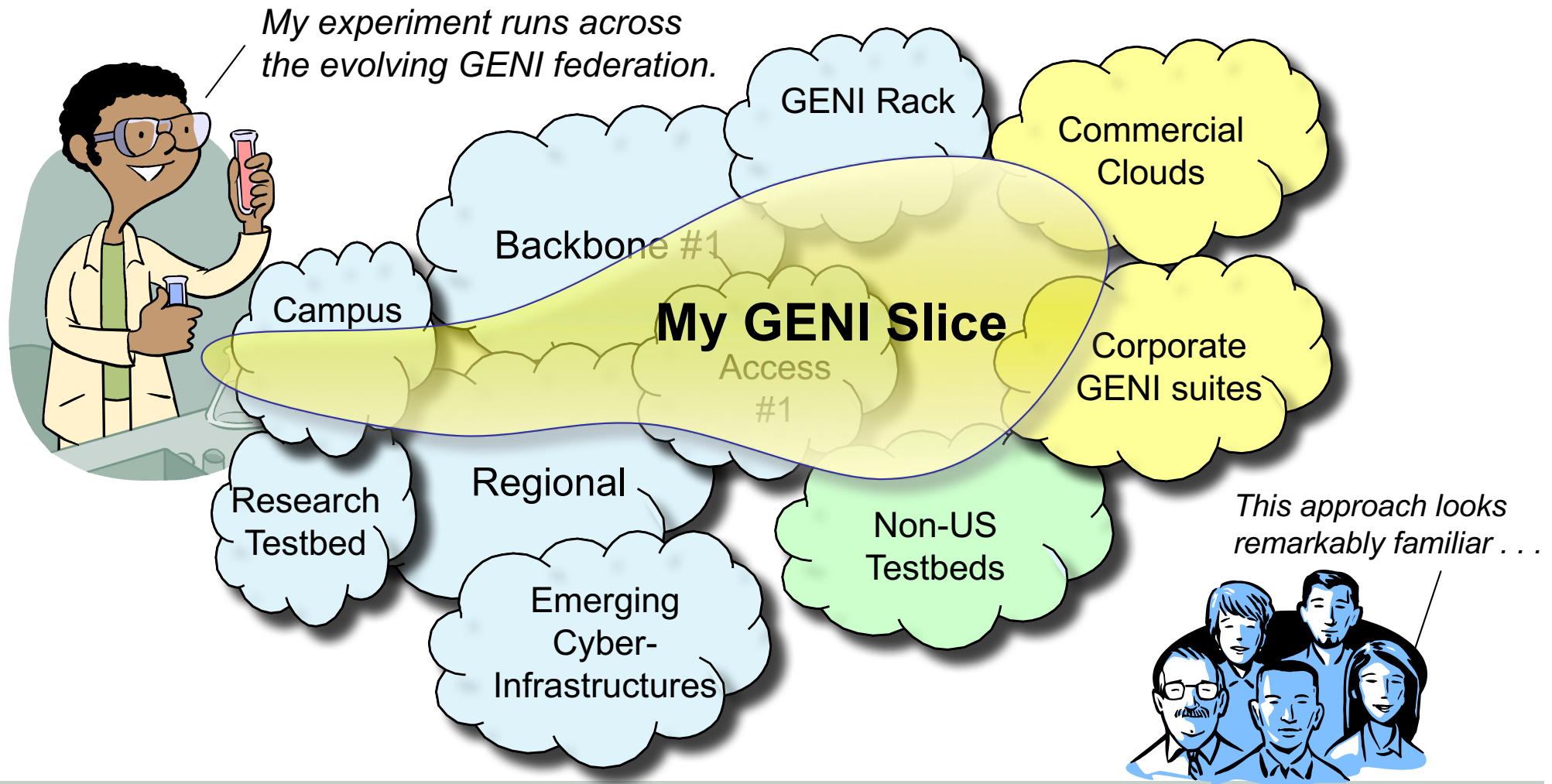
- What is GENI?
- **Building and deploying GENI**
- How is GENI being used
- An experimenter's view of GENI + Demo





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

GENI grows by GENI-enabling heterogeneous infrastructure



Avoid technology “lock in” and grow quickly by incorporating existing and new infrastructure



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

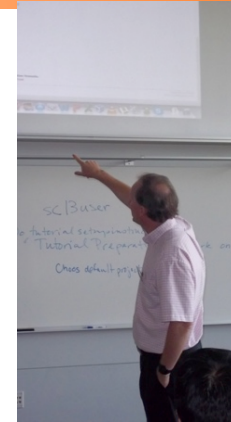
- What is GENI?
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GENI for Research and Education



Research

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

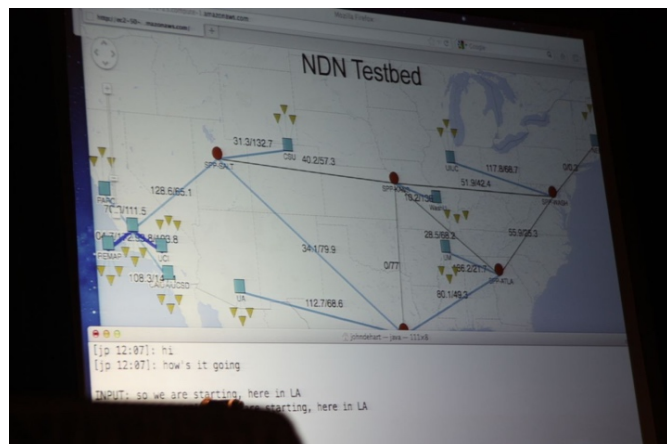


Education

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

GENI has over 12,000 users!

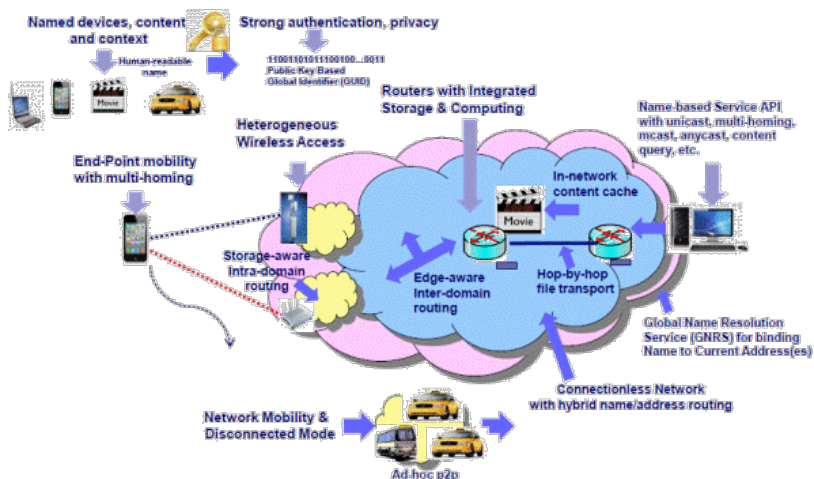
FIA Teams have Slices on GENI



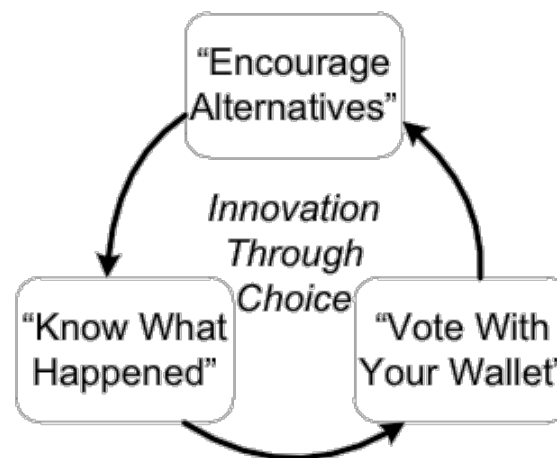
**Named Data
Networking**



**eXtensible
Internet
Architecture**



MobilityFirst



ChoiceNet

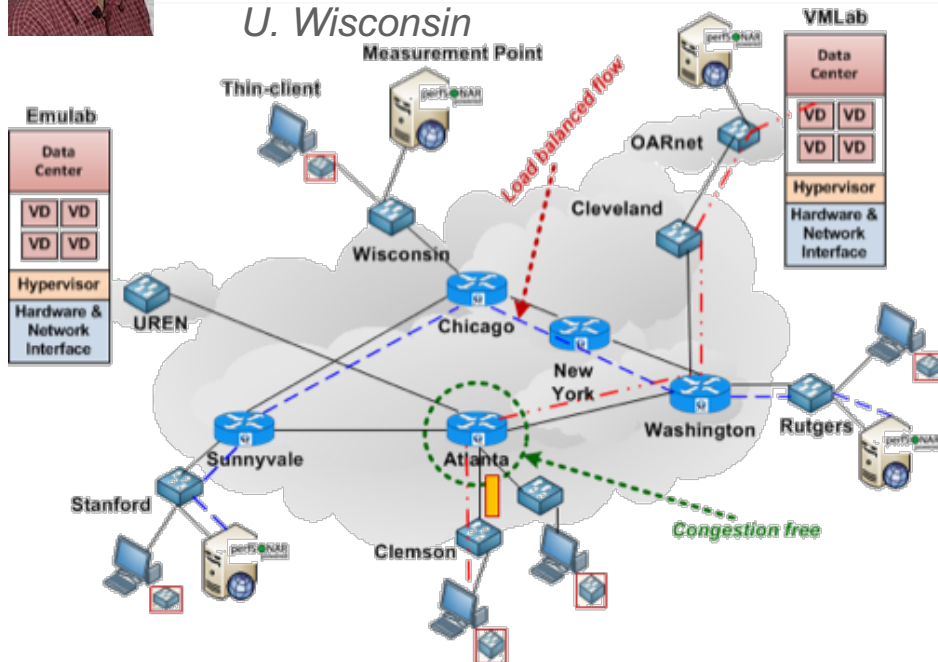
GENI is the only testbed that can support all these teams.



Parmesh Ramanathan
U. Wisconsin

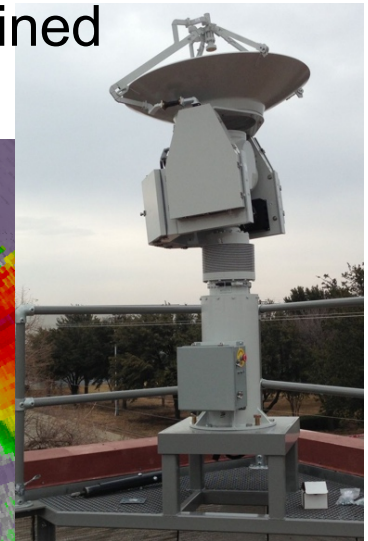
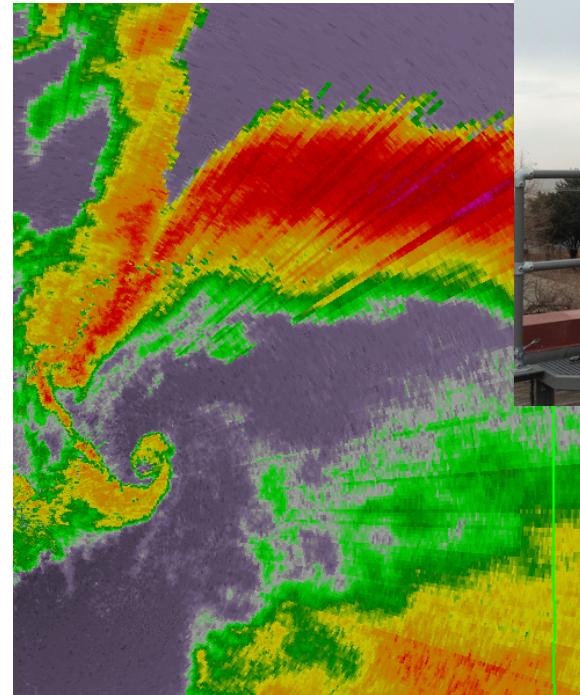


KC Wang
Clemson U.



GENI Cinema

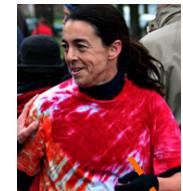
Improve in-time weather forecasting
using **Software Defined**
eXchanges



Mike Zink
Umass Amherst

GENI is the largest multi-domain SDN testbed

TransGeo Distributed Clouds: Think Globally, Compute Locally



Yvonne Coady
U. Victoria
Canada



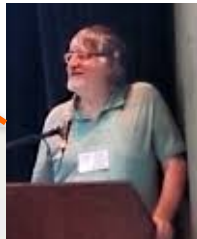
Rob Ricci
U. Utah
US



Joe Mamberti
Northwestern
US



Julio Ibarra
FIU, US



Michael Stanton
USP, Brazil



Piet Demeester
Ugent
Belgium



Rick McGeer
HP, US

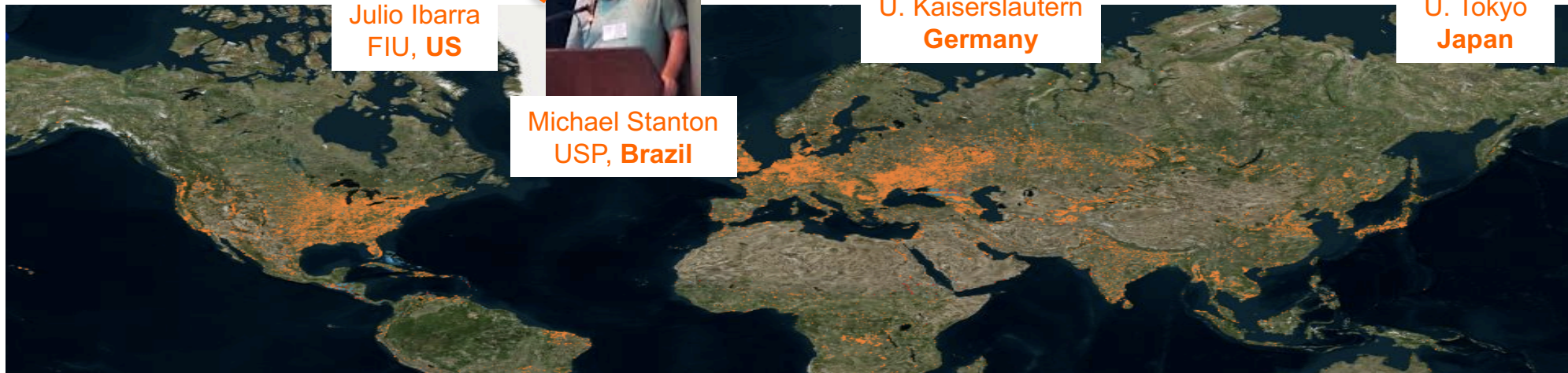


Paul Mueller
U. Kaiserslautern
Germany



Aki Nakao
U. Tokyo
Japan

Compute “*green index*” for cities
worldwide



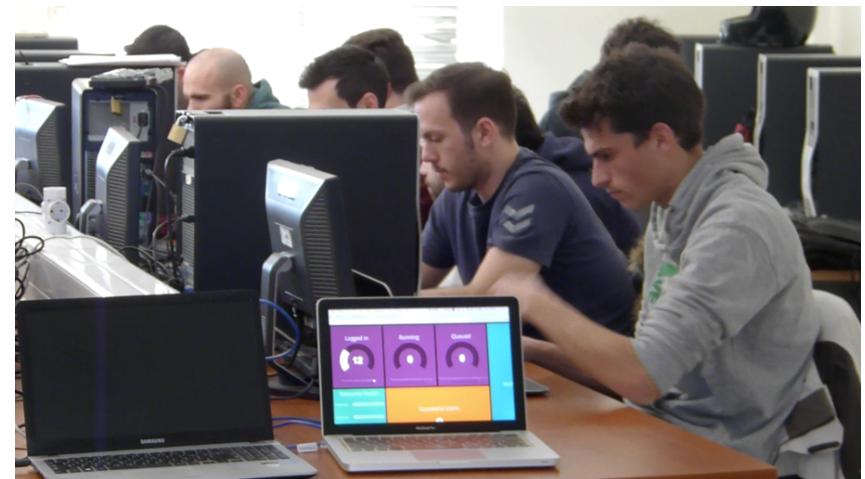
Federation fosters International Collaborations

GENI in the Classroom

Over 6000 students
have used GENI in
classes taught by 90
instructors



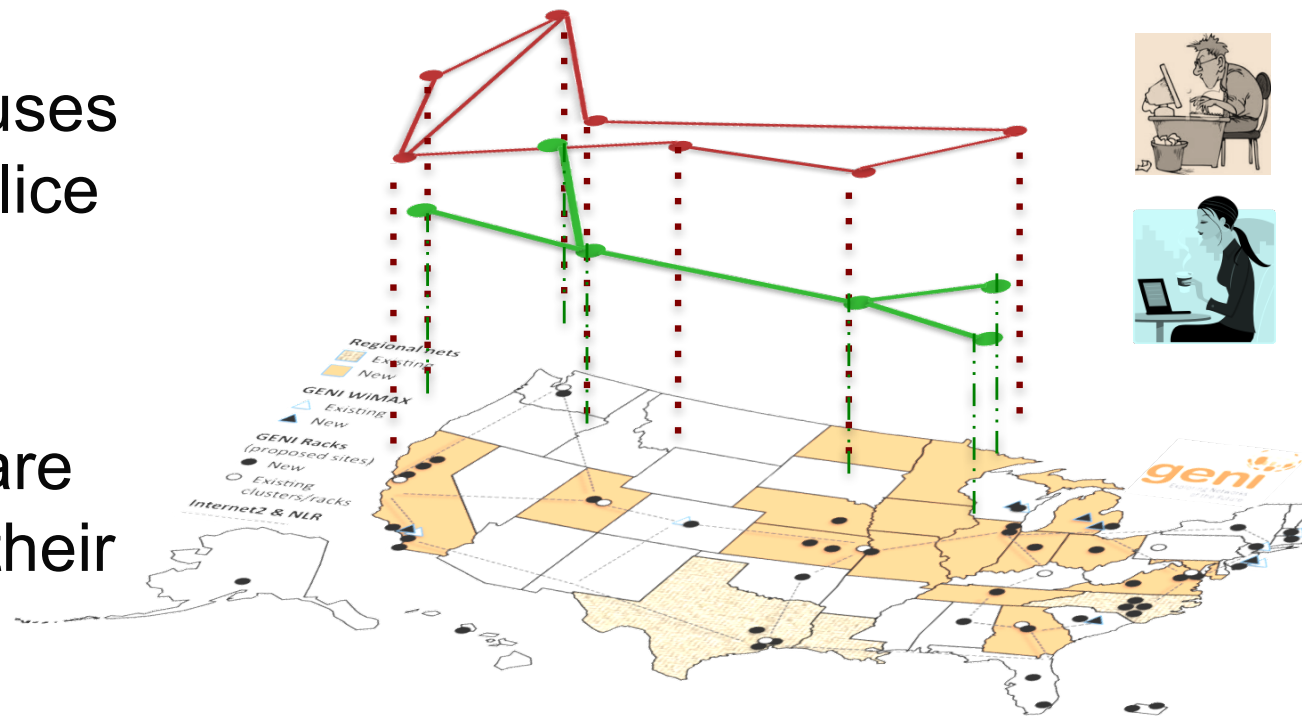
GENI as a remote, virtual lab for
networking, distributed systems
and cloud computing classes



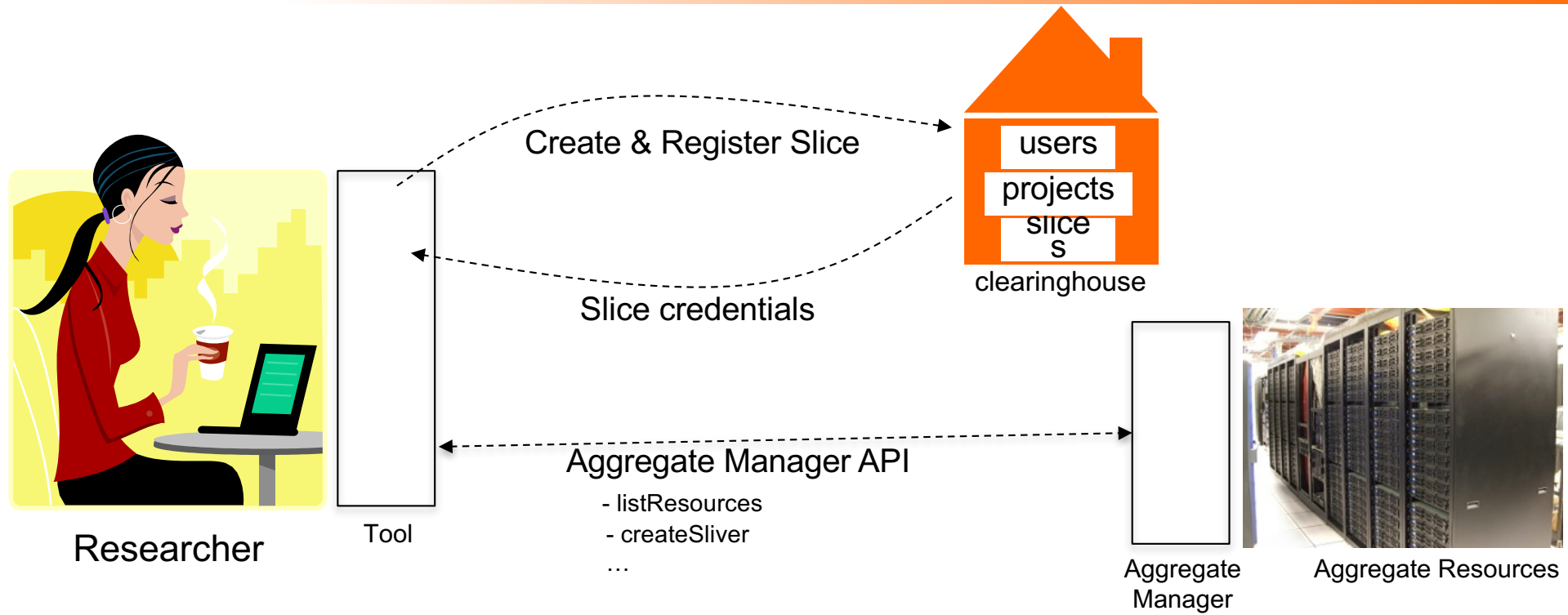
Slice

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



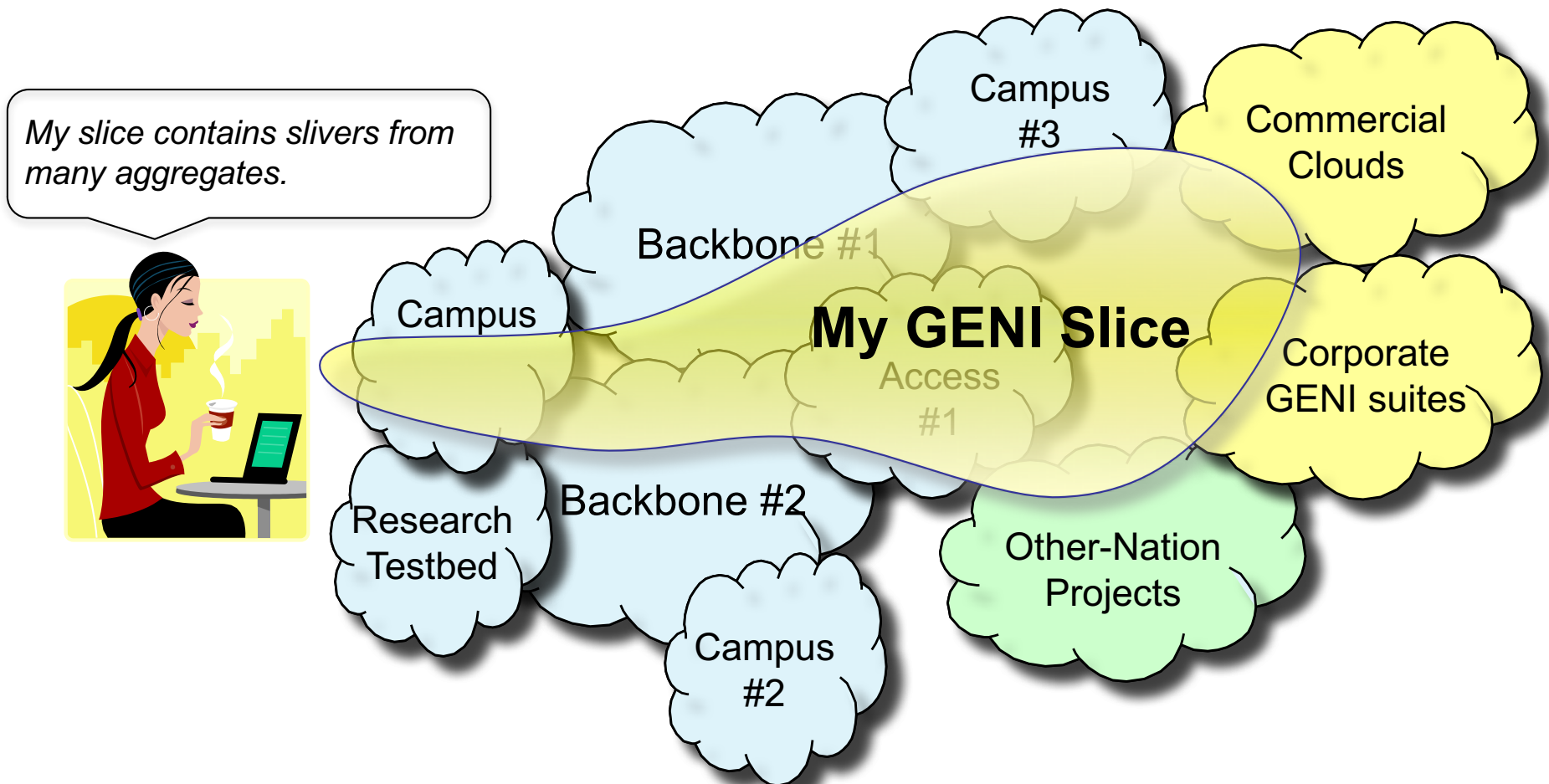
Clearinghouse and Aggregates



- **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

GENI: Terms and Definitions

- Sliver: 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

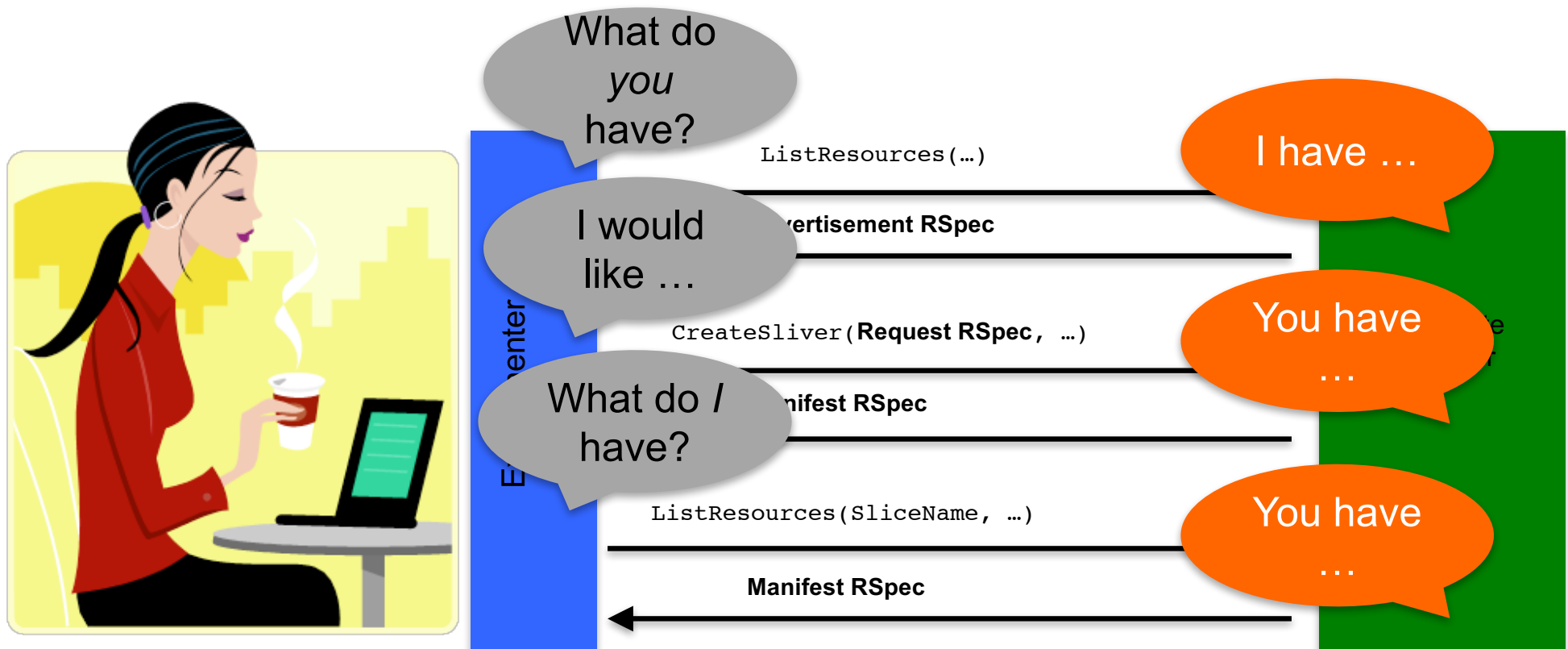
```
<?xml version="1.0" encoding="UTF-8"?>
<rspec xmlns="http://www.protopeni.net/resources/rspec/2"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xsi:schemaLocation="http://www.protopeni.net/resources/rspec/2
                        http://www.protopeni.net/resources/rspec/2/request.xsd"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



Use GENI for Your Research and Teaching

- Experimenter and Educator resources on the GENI wiki
 - Tutorials
 - Ready-to-use exercises
- Community support mailing lists
 - geni-users@googlegroups.com
 - geni-educators@googlegroups.com
- Webinars
 - Wide range of topics of interest to the GENI community (monthly)
 - Train-the-TA (at the beginning of each semester)

Welcome to the GENI Wiki

The GENI Wiki is a repository of information related to the GENI project.

Editing this Wiki: See [GeniWikiGettingStarted](#) for information.

Finding Information in this Wiki

Information for GENI Constituencies



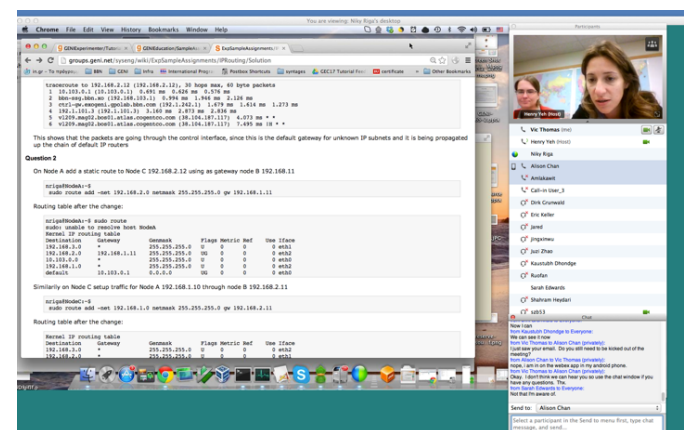
Newcomers
to GENI



Experimenters



Instructors



Train-the-TA Webinar
Offered every semester

- Zongming Fei
- Jim Griffioen
- Hussamuddin Nasir
- Lowell Pike
- Charles Carpenter
- ... and all the UKY team!

Subscribe to the geni-announce list

<http://www.geni.net/contact-us/join-a-mailing-list/>

QUESTIONS?