



# GENI

## Exploring Networks of the Future

An introduction to GENI

November 2011  
GENI Project Office  
[www.geni.net](http://www.geni.net)

- GENI – Exploring future internets at scale
- Introducing GENI: an example
- GENI's growing suite of infrastructure
- Experiments going live across the US!
- What's next for GENI?
- GENI and US Ignite
- Experimenters' view of GENI

# Global networks are creating extremely important new challenges

## Science Issues

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



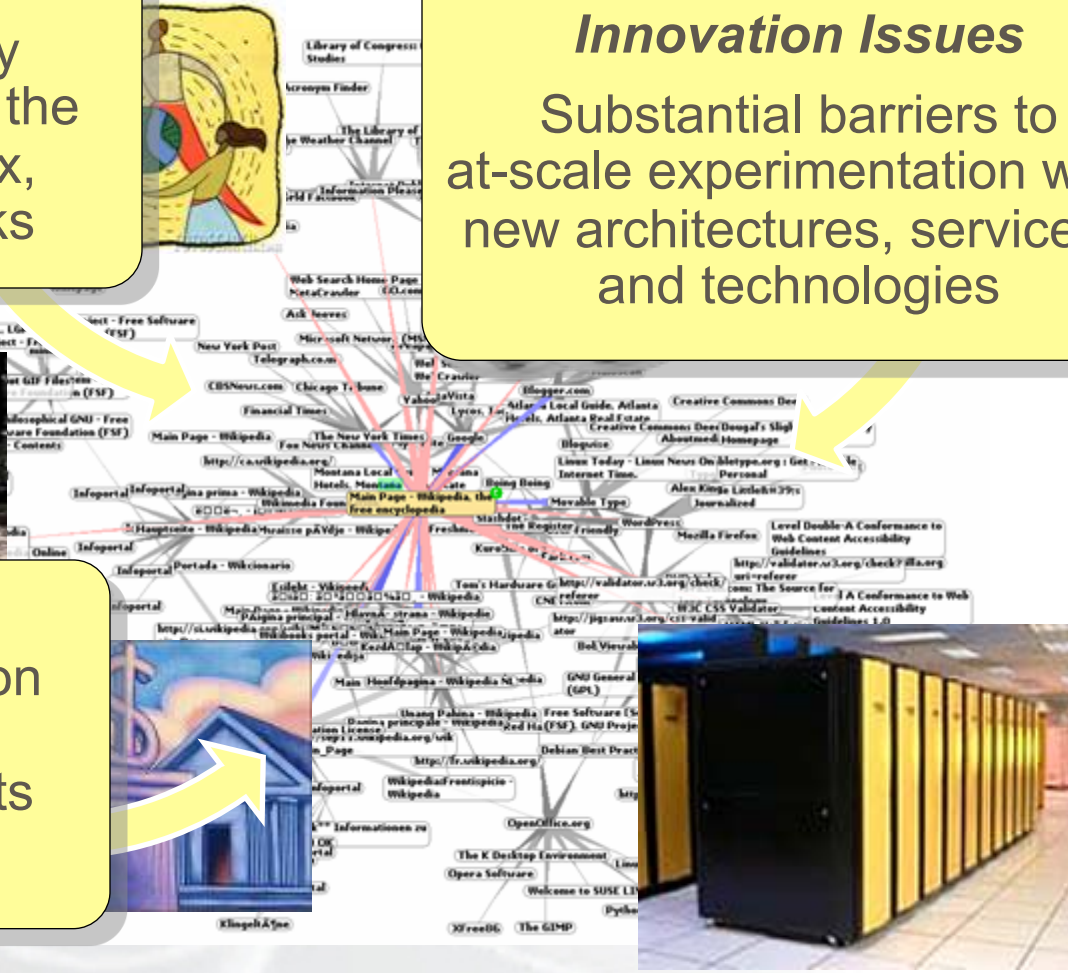
## Innovation Issues

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

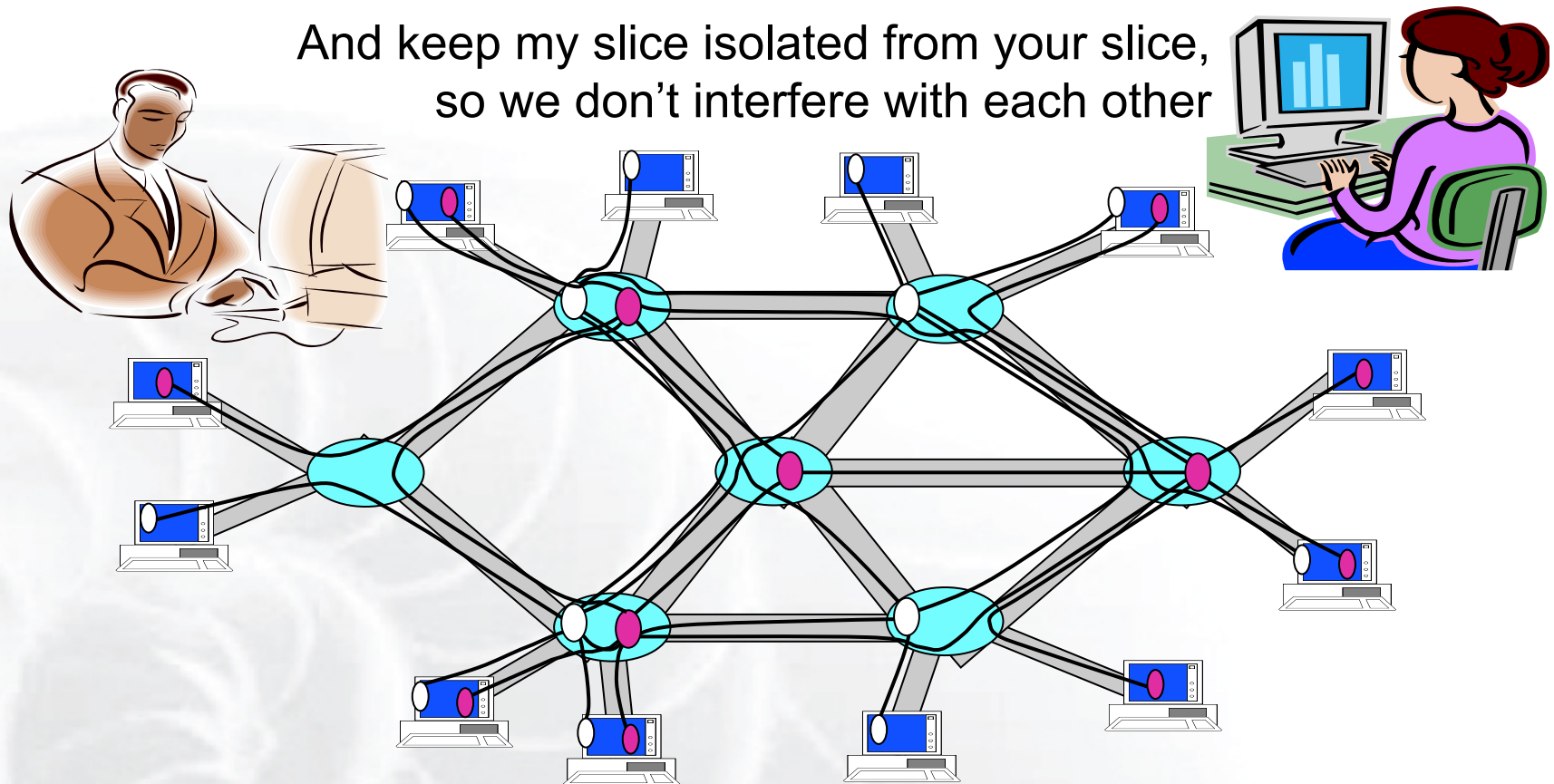


- GENI is a virtual laboratory for **exploring future internets at scale**, now rapidly taking shape in prototype form across the United States
- GENI opens up huge new opportunities
  - **Leading-edge research** in next-generation internets
  - **Rapid innovation** in novel, large-scale applications
- Key GENI concept: slices & deep programmability
  - Internet: open innovation in application programs
  - GENI: open innovation deep into the network

# Revolutionary GENI Idea Slices and Deep Programmability

Install the software I want *throughout* my network slice  
(into firewalls, routers, clouds, ...)

And keep my slice isolated from your slice,  
so we don't interfere with each other



We can run many different “future internets” in parallel

# GENI is now going live across the US

## GENI-enabling testbeds, campuses, and backbones



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# A bright idea

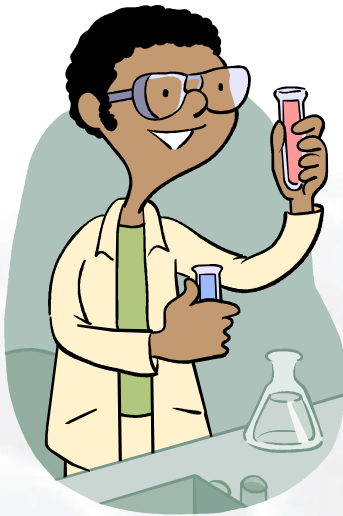


I have a great idea! The original Internet architecture was designed to connect one computer to another – but a better architecture would be fundamentally based on PEOPLE and CONTENT!

*That will never work! It won't scale!  
What about security? It's impossible  
to implement or operate! Show me!*

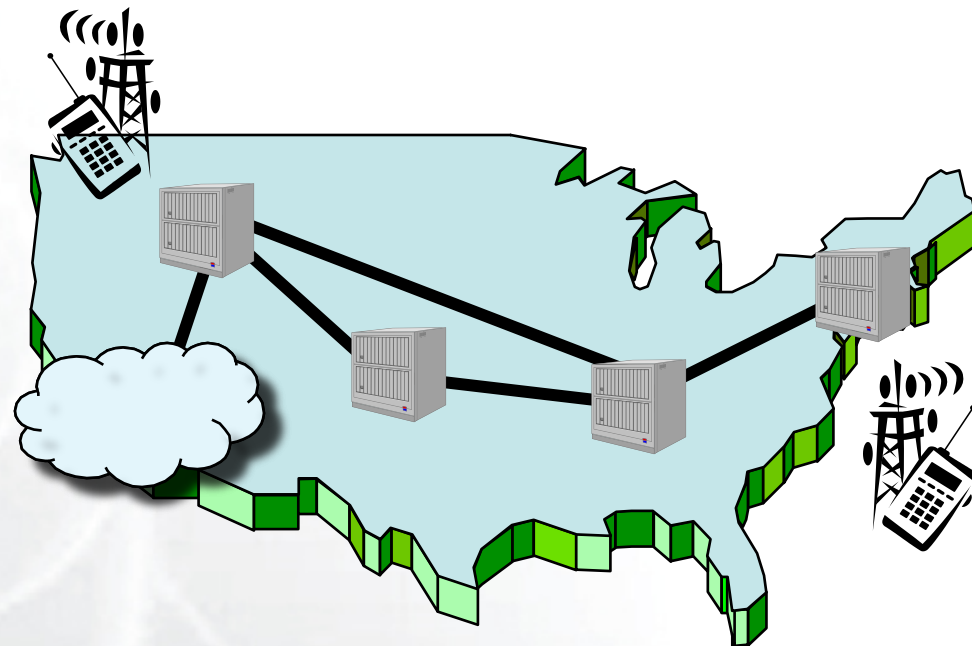






My new architecture worked great in the lab, so now I'm going to try a larger experiment for a few months.

And so he poured his experimental software into clouds, distributed clusters, bulk data transfer devices ('routers'), and wireless access devices throughout the GENI suite, and started taking measurements . . .



He uses a modest slice of GENI, sharing its infrastructure with many other concurrent experiments.

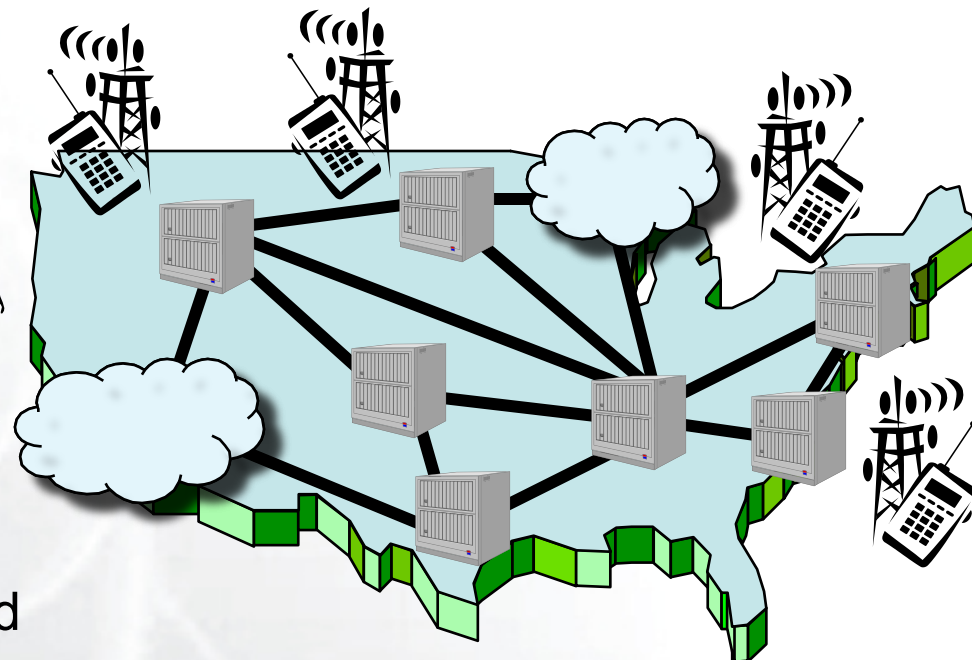
# It turns into a really good idea

Boy did I learn a lot! I've published papers, the architecture has evolved in major ways, and I'm even attracting real users!



*Location-based social networks are really cool!*

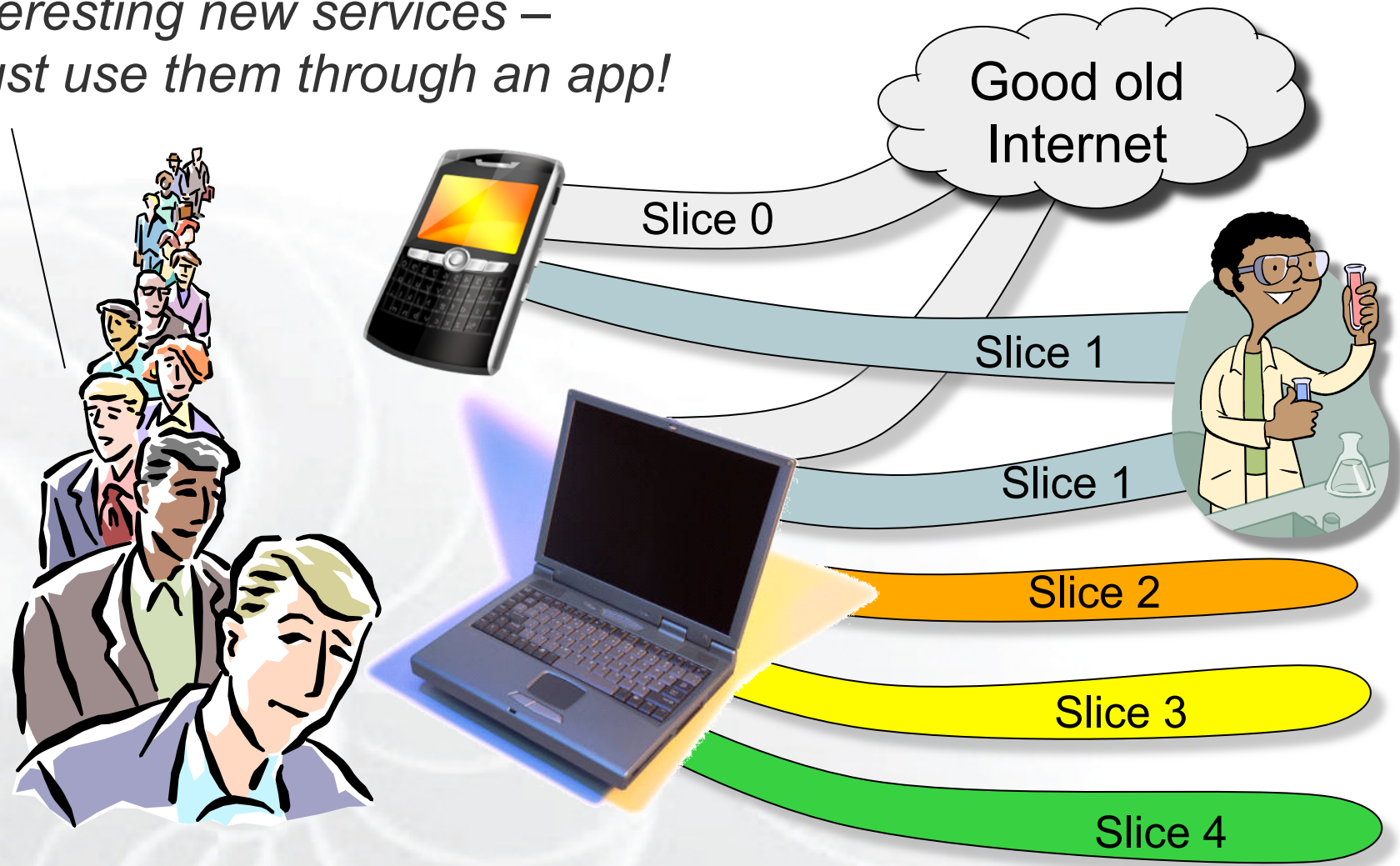
His experiment grew larger and continued to evolve as more and more real users opted in . . .



His slice of GENI keeps growing, but GENI is still running many other concurrent experiments.

# The (opt-in) user's view

*Interesting new services –  
I just use them through an app!*



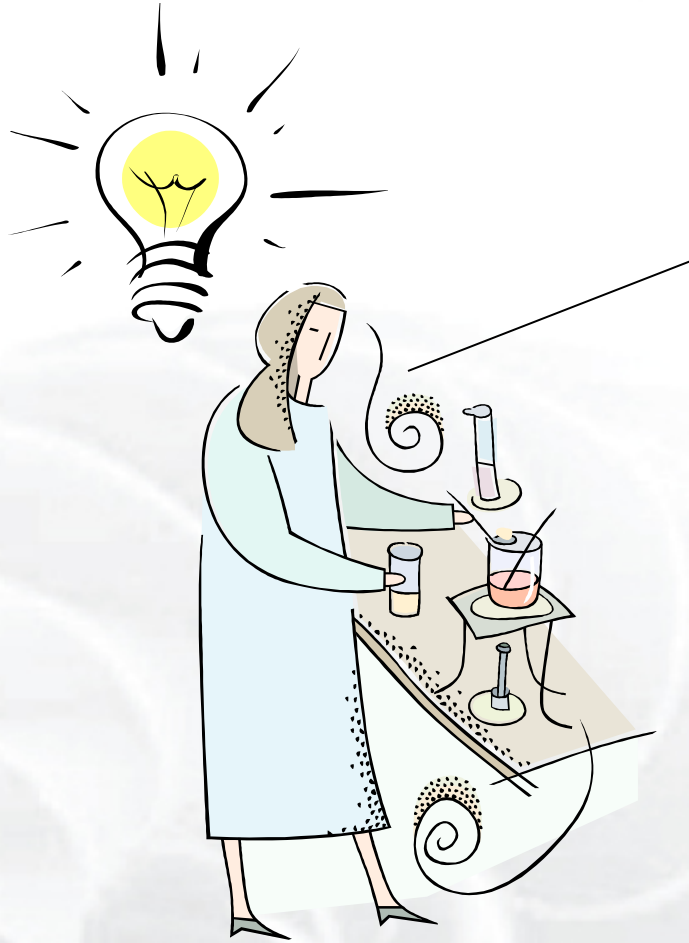
# Experiment turns into reality



My experiment was a real success, and my architecture turned out to be mostly compatible with today's Internet after all – so I'm taking it off GENI and spinning it out as a real company.

*I always said it was a good idea, but way too conservative.*





I have a great idea! If the Internet were augmented with a scalable control plane and realtime measurement tools, it could be 100x as robust as it is today . . . !

And I have a great concept for incorporating live sensor feeds into our daily lives !



If you have a great idea, check out the **NSF CISE research programs for current opportunities.**

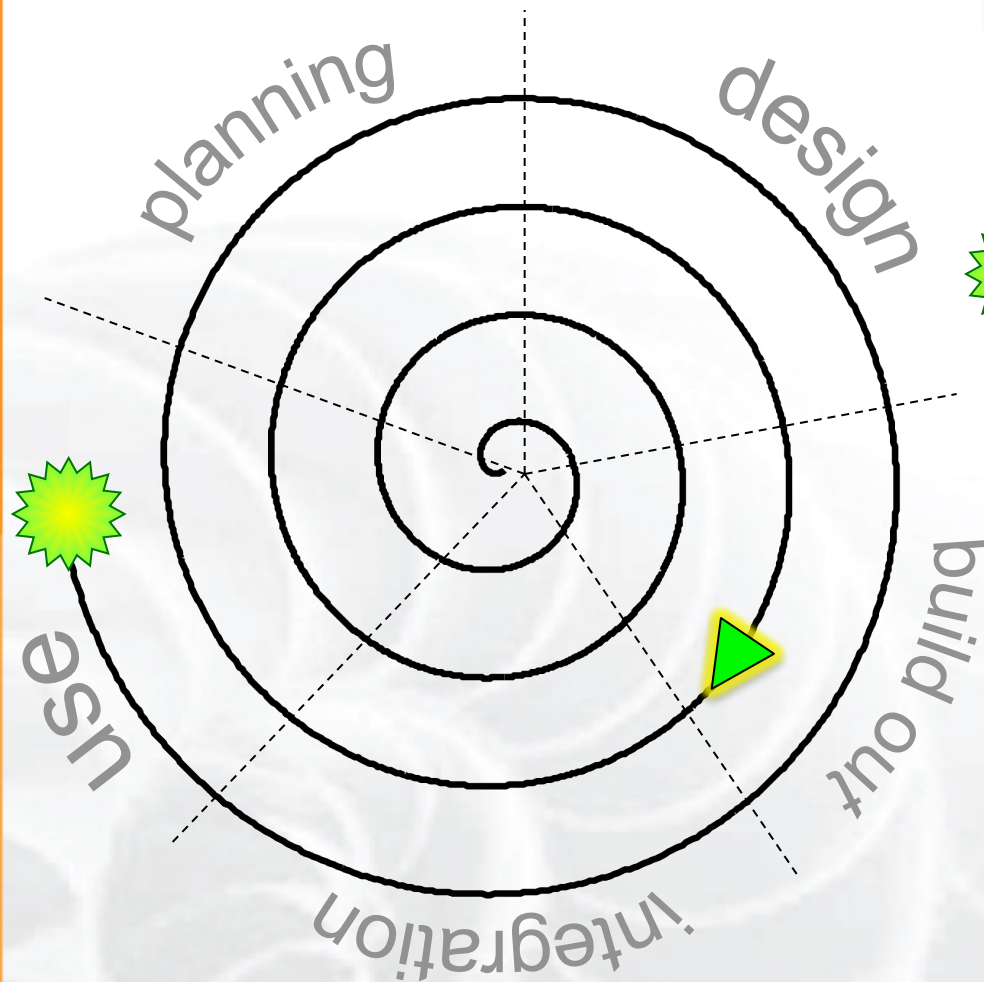
- GENI is meant to enable . . .
  - **At-scale experiments**, which may or may not be compatible with today's Internet
  - **Both repeatable and “in the wild” experiments**
  - **‘Opt in’ for real users** into long-running experiments
  - Excellent **instrumentation and measurement** tools
  - **Large-scale growth for successful experiments**, so good ideas can be shaken down at scale

**GENI creates a huge opportunity for ambitious research!**

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# Spiral Development

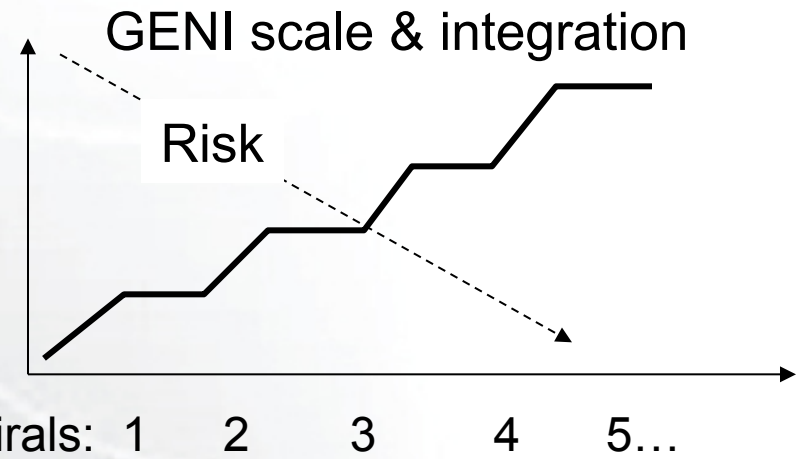
GENI grows through a well-structured, adaptive process



**GENI Prototyping Plan**

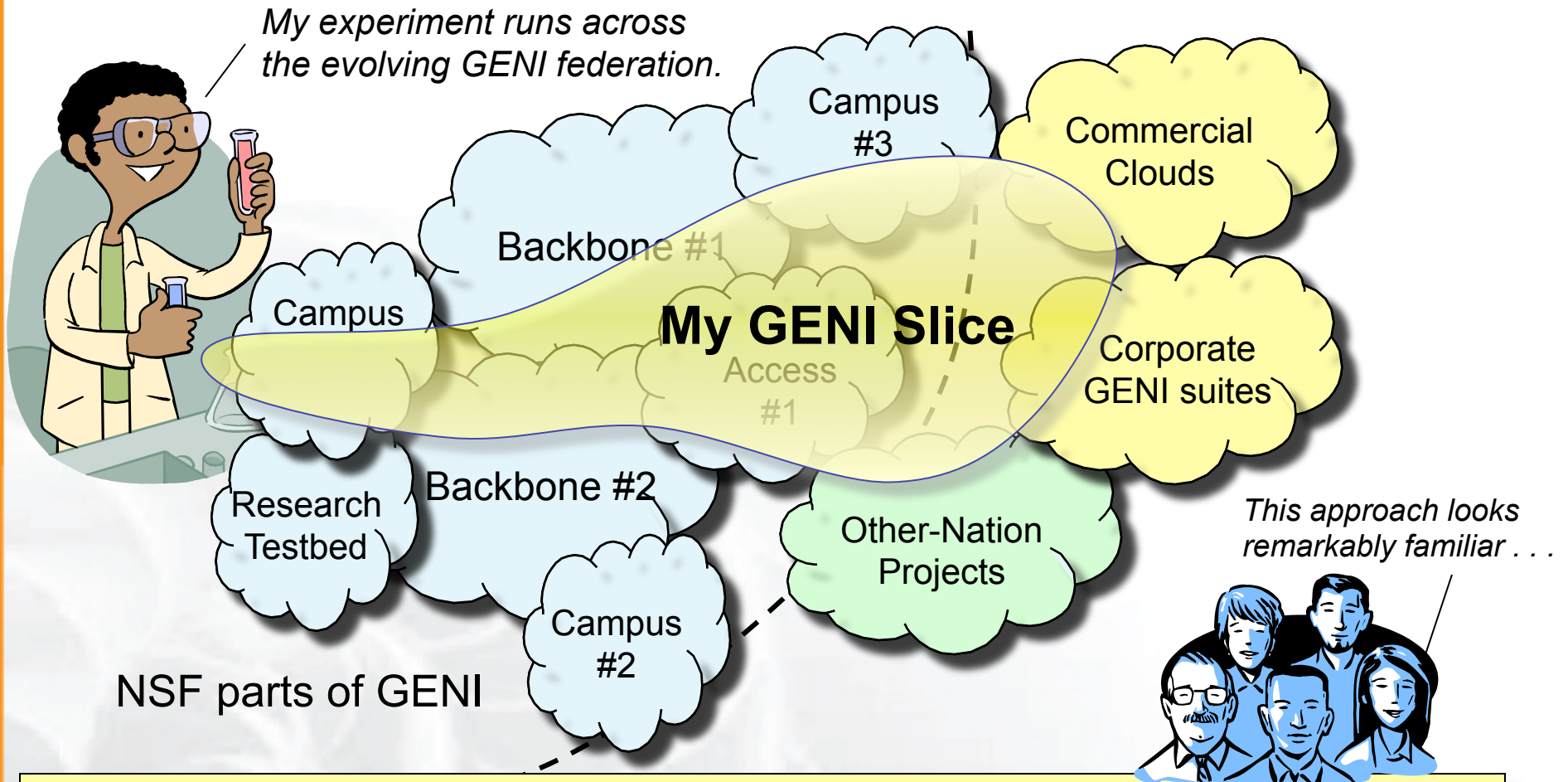
**GENI Spiral 3**  
 Early experiments, meso-scale build, interoperable control frameworks, ongoing integration, system designs for security and instrumentation, starting up operations.

**Envisioned ultimate goal**  
 Large-scale distributed computing resources, high-speed backbone nodes, nationwide optical networks, wireless & sensor nets, etc.



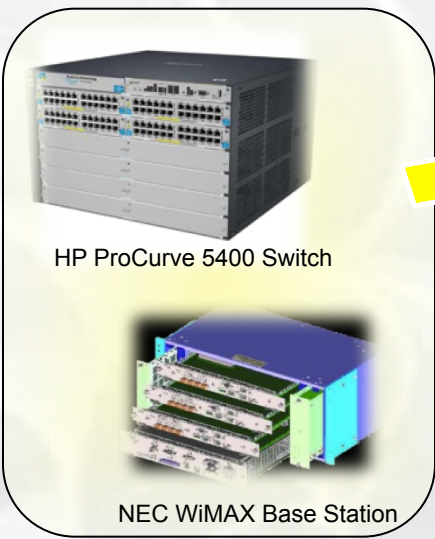


GENI grows by “GENI-enabling” heterogeneous infrastructure



Goals: avoid technology “lock in,” add new technologies as they mature, and potentially grow quickly by incorporating existing infrastructure into the overall “GENI ecosystem”

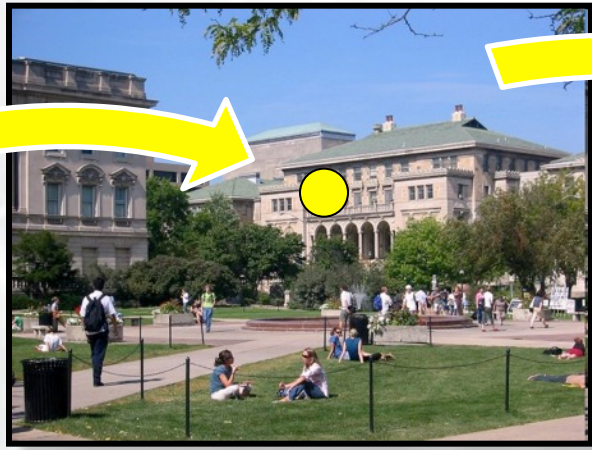
- **How can we afford / build GENI at sufficient scale?**
  - Clearly infeasible to build research testbed “as big as the Internet”
  - Therefore we are “GENI-enabling” testbeds, commercial equipment, campuses, regional and backbone networks
  - **Students are early adopters / participants in at-scale experiments**
  - Key strategy for building an at-scale suite of infrastructure



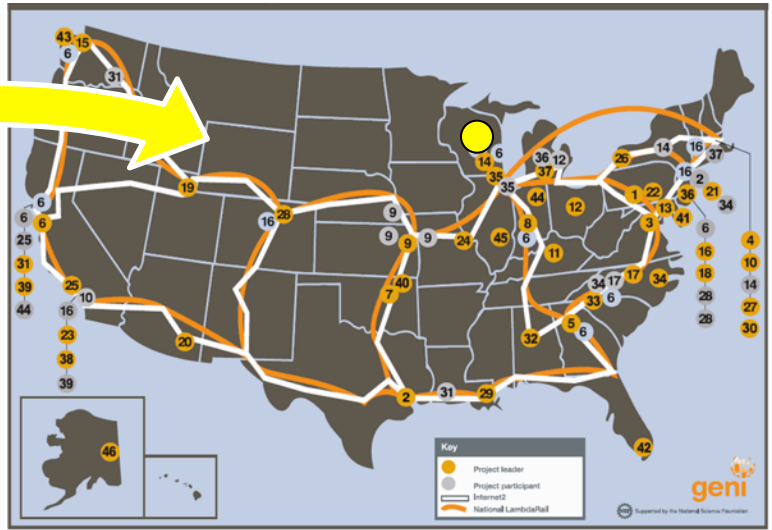
HP ProCurve 5400 Switch

NEC WiMAX Base Station

GENI-enabled equipment



GENI-enabled campuses, students as early adopters



“At scale” GENI prototype

# Georgia Tech: a Great Example

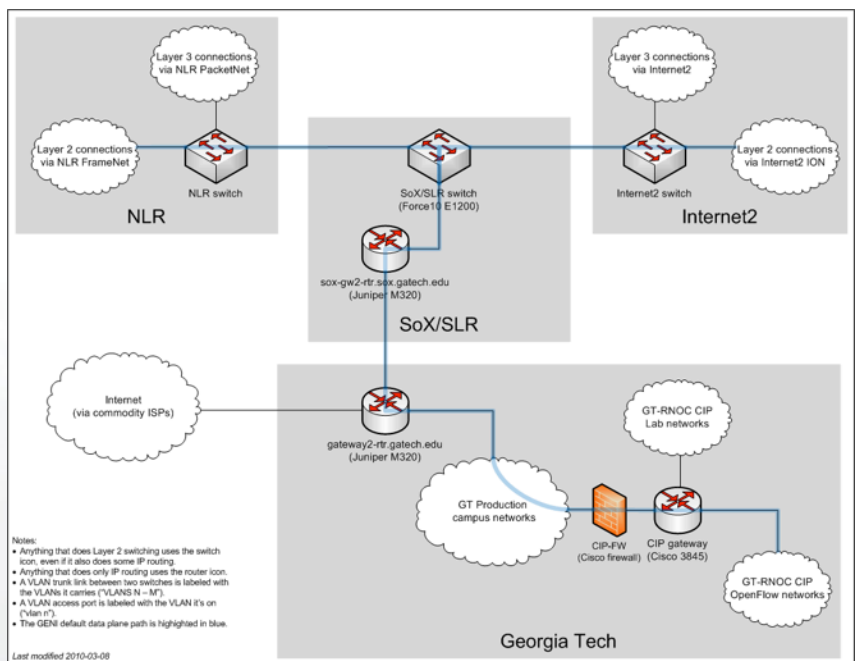
## One of the first 14 GENI-enabled campuses



Nick Feamster, PI  
Ellen Zegura, PI



Russ Clark, GT-RNOC  
Ron Hutchins, OIT



- OpenFlow in 4 GT lab buildings *now*
- OpenFlow/BGPMux coursework *now*
- Dormitory trial
- Students will “live in the future” – Internet in one slice, multiple future internets in additional slices

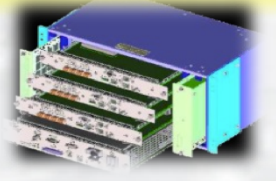
## Trials of “GENI-enabled” commercial equipment



HP ProCurve 5400 Switch



Juniper MX240 Ethernet Services Router



NEC WiMAX Base Station



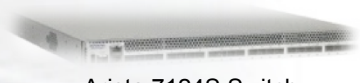
HTC Android smart phone



Toroki LightSwitch 4810



NEC IP8800 Ethernet Switch



Arista 7124S Switch



GENI racks

# Building the GENI Meso-scale Prototype

## OpenFlow

- Stanford
- U Washington
- Wisconsin
- Indiana
- Rutgers
- Princeton
- Clemson
- Georgia Tech

## ShadowNet

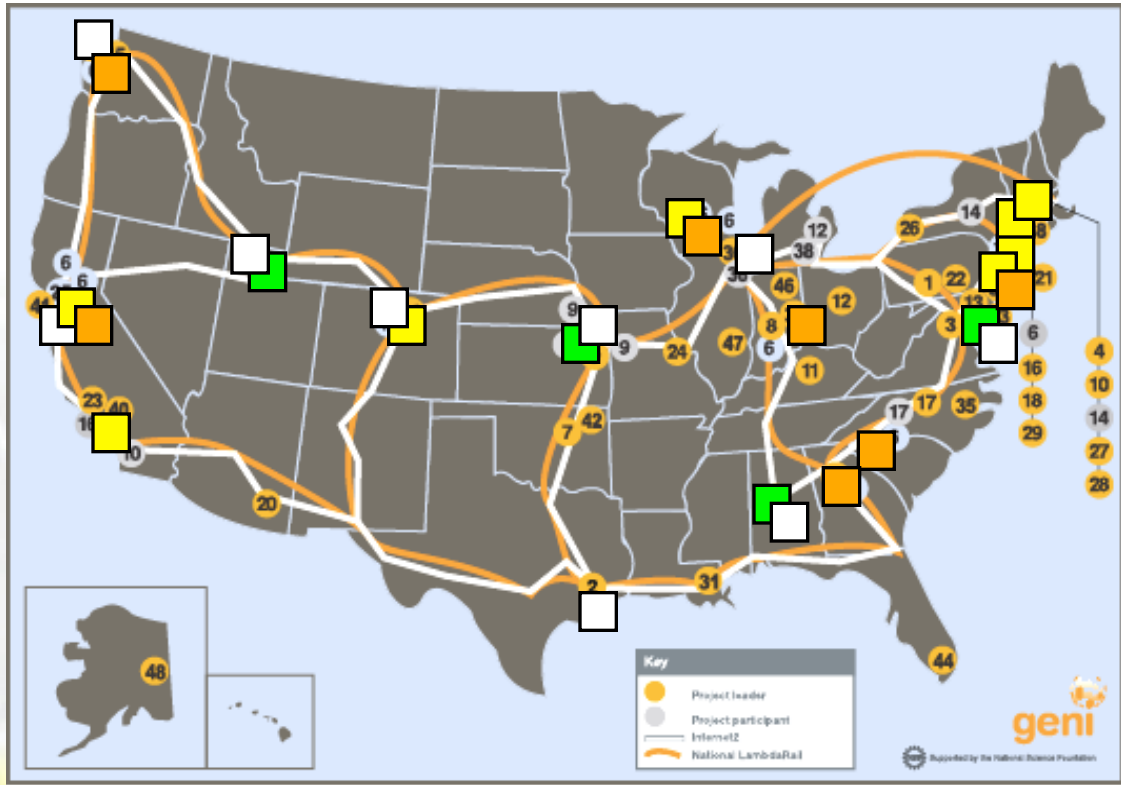
- Salt Lake City
- Kansas City
- DC
- Atlanta

## WiMAX

- Stanford
- UCLA
- UC Boulder
- Wisconsin
- Rutgers
- Polytech
- UMass
- Columbia

## OpenFlow Backbones

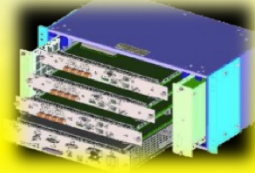
- Seattle
- Salt Lake City
- Sunnyvale
- Denver
- Kansas City
- Houston
- Chicago
- DC
- Atlanta



HP ProCurve 5400 Switch



Juniper MX240 Ethernet Services Router



NEC WiMAX Base Station



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NEC IP8800 Ethernet Switch

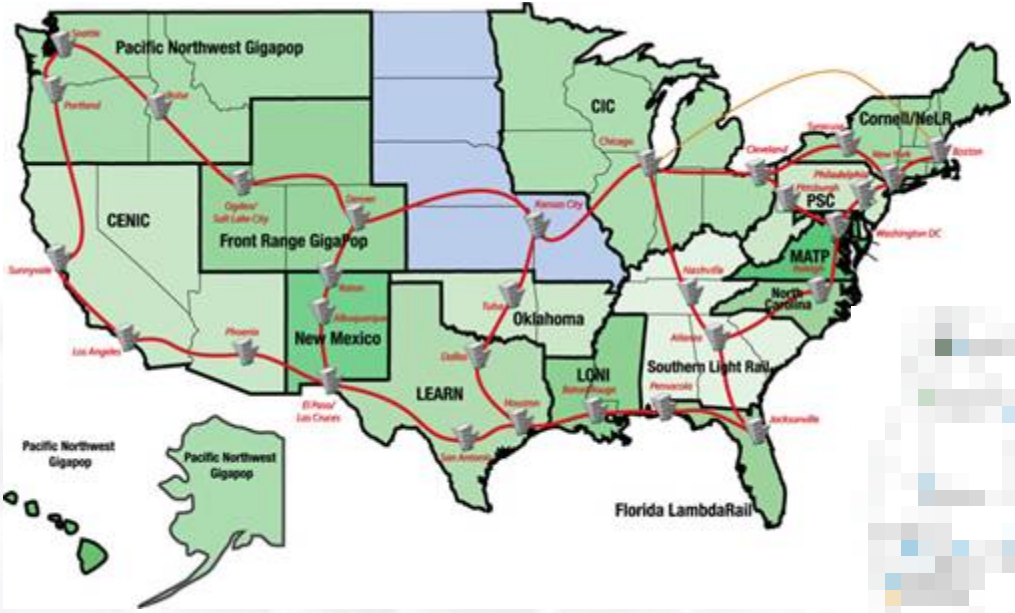


Arista 7124S Switch



GENI racks

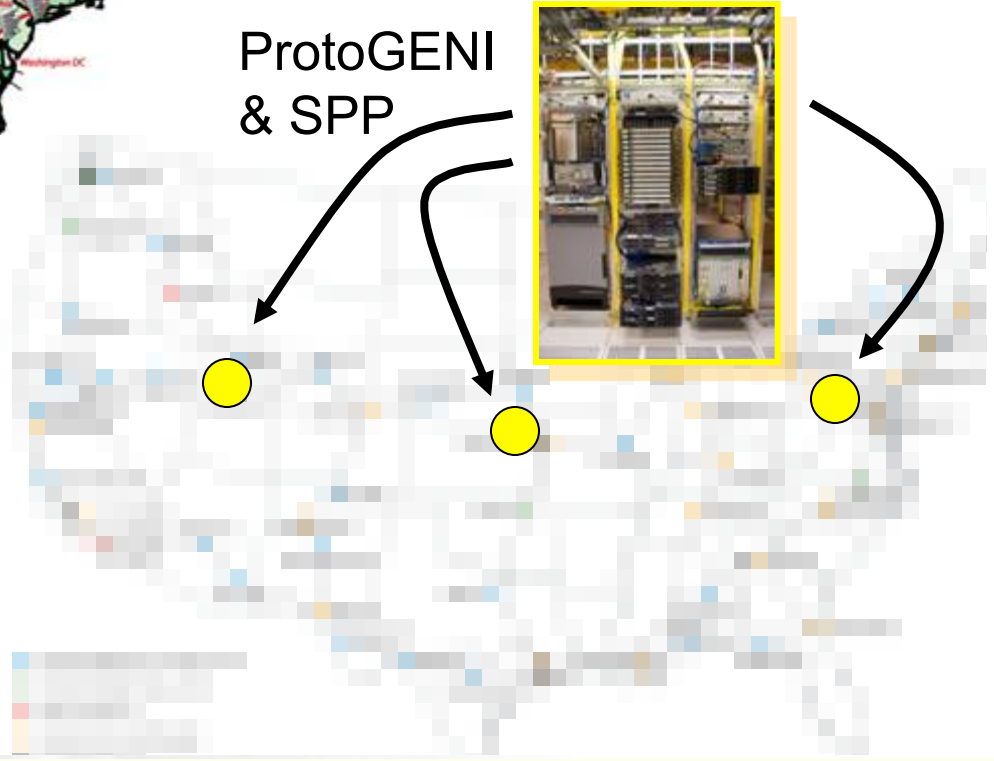
# National LambdaRail and Internet2



**National LambdaRail**  
Up to 30 Gbps bandwidth

## Internet2

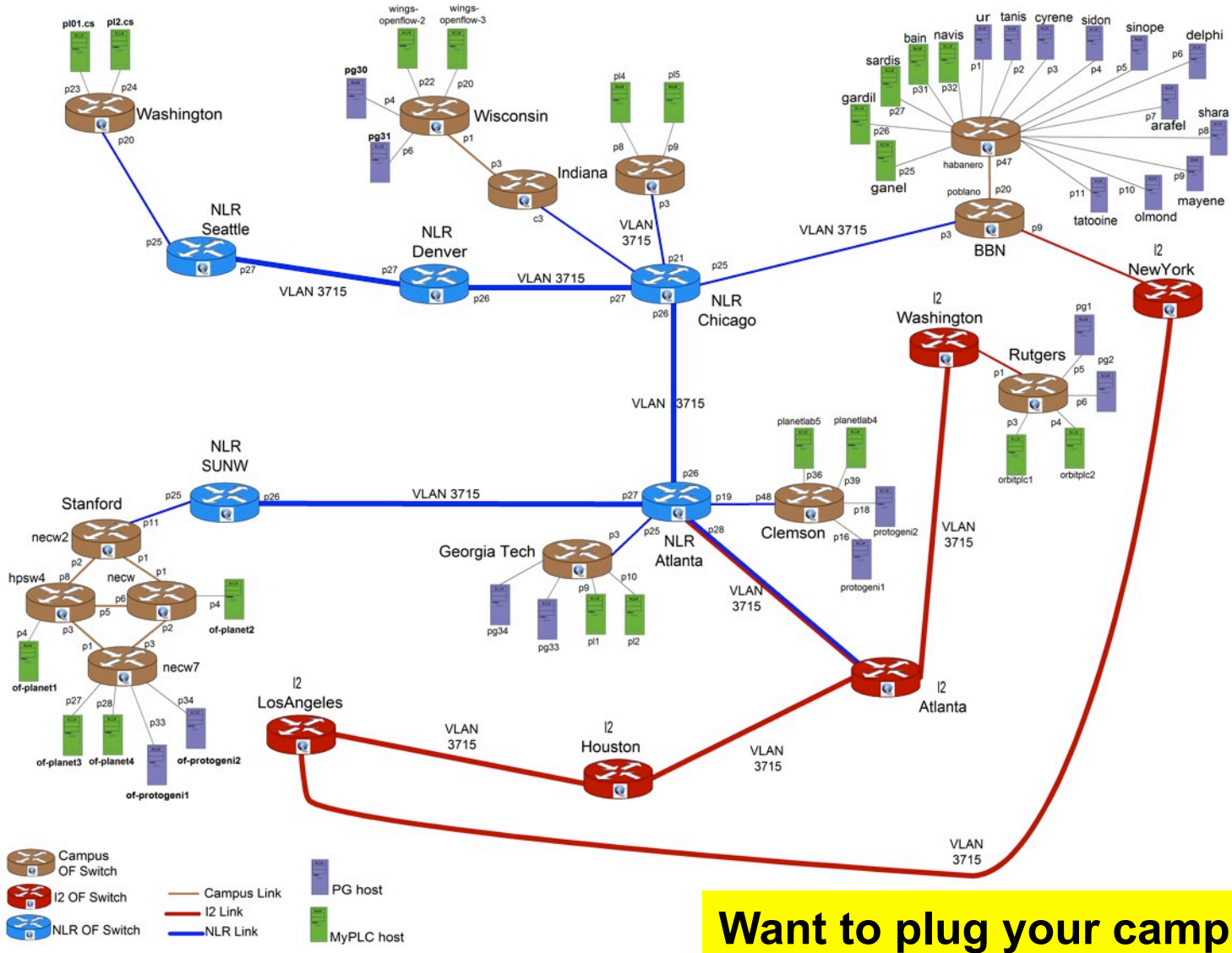
ProtoGENI & SPP



**Buildout for GENI prototyping within two national footprints to provide end-to-end GENI slices (IP or non-IP).**

- Layer 2 slices span campuses, Internet2, and NLR
- Each VLAN contains ~ 25 OpenFlow switches and 40+ computers (PlanetLab & ProtoGENI)
- OpenFlow / FlowVisor manages slices within a VLAN
- Ongoing federated ops (8 campuses, 2 backbones, GMOC), each organization with its own operators, policies, etc.
- Now shaking down large-scale slices

# PlanetLab, ProtoGENI, OpenFlow resources spanning multiple campuses, Internet2, & NLR



**Want to plug your campus in?  
Send email: [help@geni.net](mailto:help@geni.net)**



PLANETLAB

An open platform for developing, deploying, and accessing planetary-scale services

ProtoGENI

of the Future



Many, many groups are already engaged in building GENI



ARISTA

Battelle



ciena



Corporation for National Research Initiatives

FUJITSU



infinera



JEFFREY HUNKER ASSOCIATES LLC  
Technology • Government • Global business • Insights with impact

JUNIPER NETWORKS

Microsoft

NETRONOME



NEC

Qwest

Radio Technology Systems



Sponsored by the National Science Foundation



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# Major research demos, Nov 2010

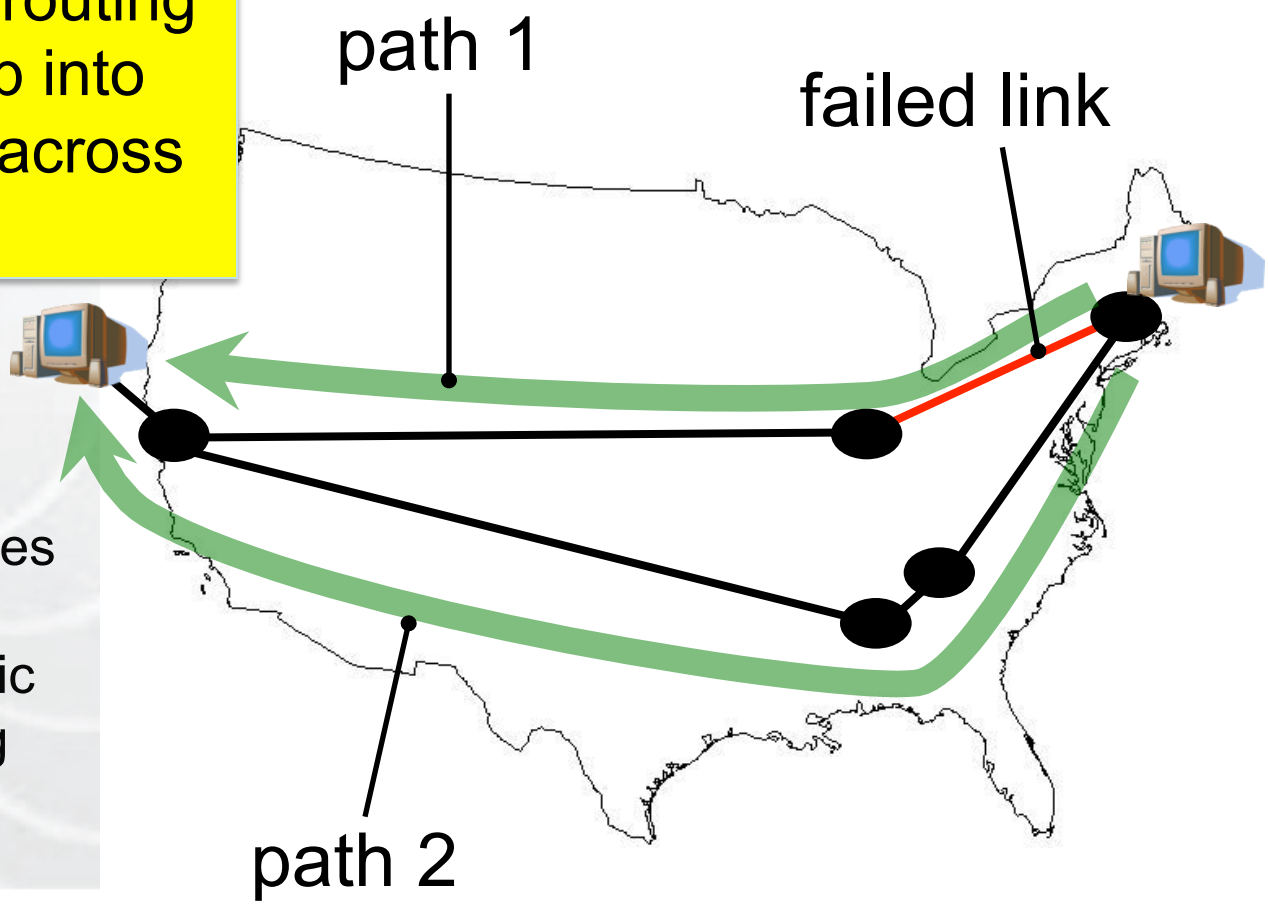


- **Some of the nation's best young researchers . . .**
  - Academic and industrial
  - Networking and distributed systems
  - Some helped build GENI, most have not
- **Demonstrating their earliest research experiments**
  - Many different ideas for “future internets”
  - Now being tried out experimentally for the first time
- On the nationwide, “meso-scale” GENI prototype

**GENI supported 9 different future internet experiments,  
simultaneously, each in its own slice.**

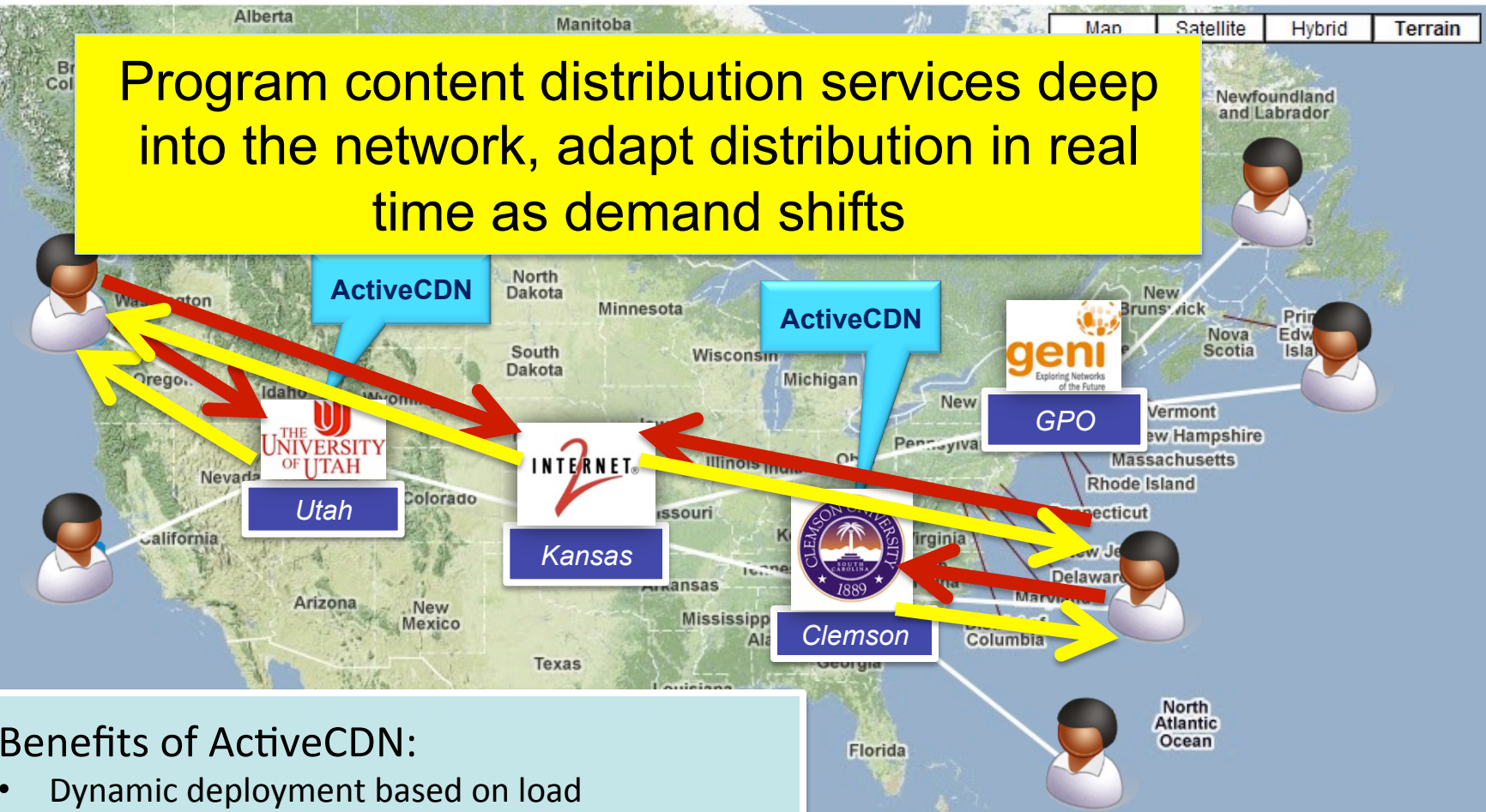
Deploy innovative routing architecture deep into network switches across the US

- Lets *users* monitor and select their own network paths to optimize their services
- Protects critical traffic even without waiting for adaptation time





Program content distribution services deep into the network, adapt distribution in real time as demand shifts



- Benefits of ActiveCDN:**
- Dynamic deployment based on load
  - Localized services such as weather, ads and news

Jae Woo Lee, Jan Janak, Roberto Francescangeli, SumanSrinivasan, Eric Liu, Michael Kester, SalmanBaset, Wonsang Song, and Henning Schulzrinne



ViSE views steerable radars as shared, virtualized resources  
<http://geni.cs.umass.edu/vise>

# Weather NowCasting

## GEC 9 experiment demonstration

### David Irwin et al



Revolutionizing our ability to observe, understand, predict and respond to hazardous weather events



Generate "raw" live data  
ViSE/CASA radar nodes

<http://stb.ece.uprm.edu/current.jsp>



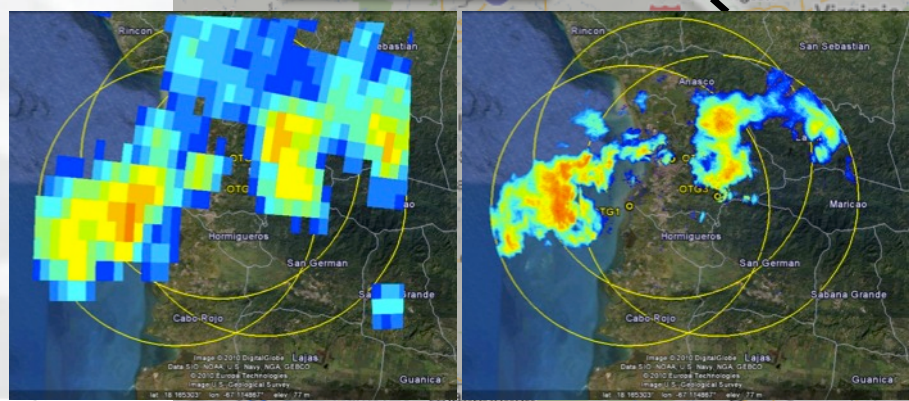
Create and run realtime "weather service on demand" as storms turn life-threatening

"raw" live data

Nowcast images for display

1. Spin up system in Amazon commercial EC2 and S3 services on demand

Multi-radar NetCDF Data

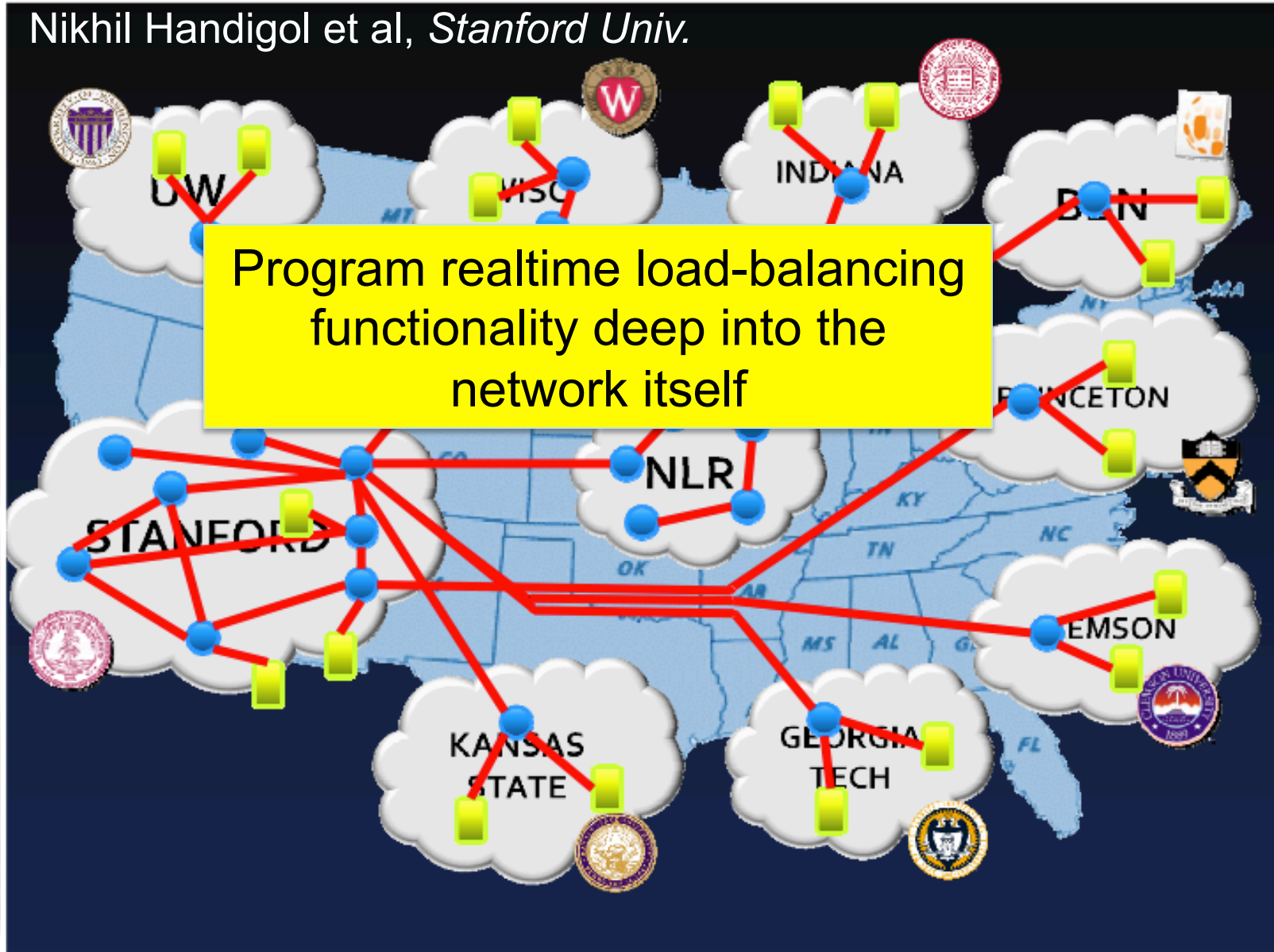


Nowcast Processing



# Aster\*x Load Balancing (via OpenFlow)

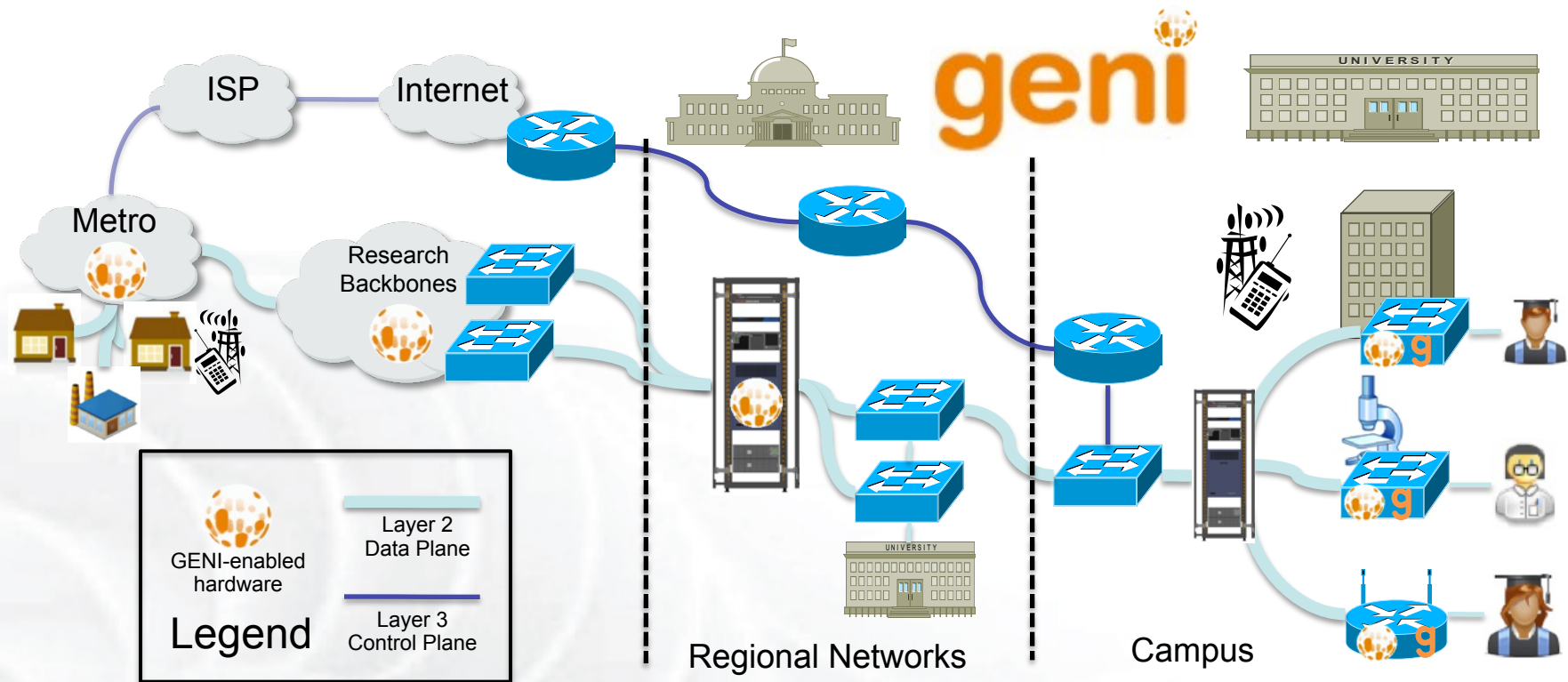
Nikhil Handigol et al, *Stanford Univ.*



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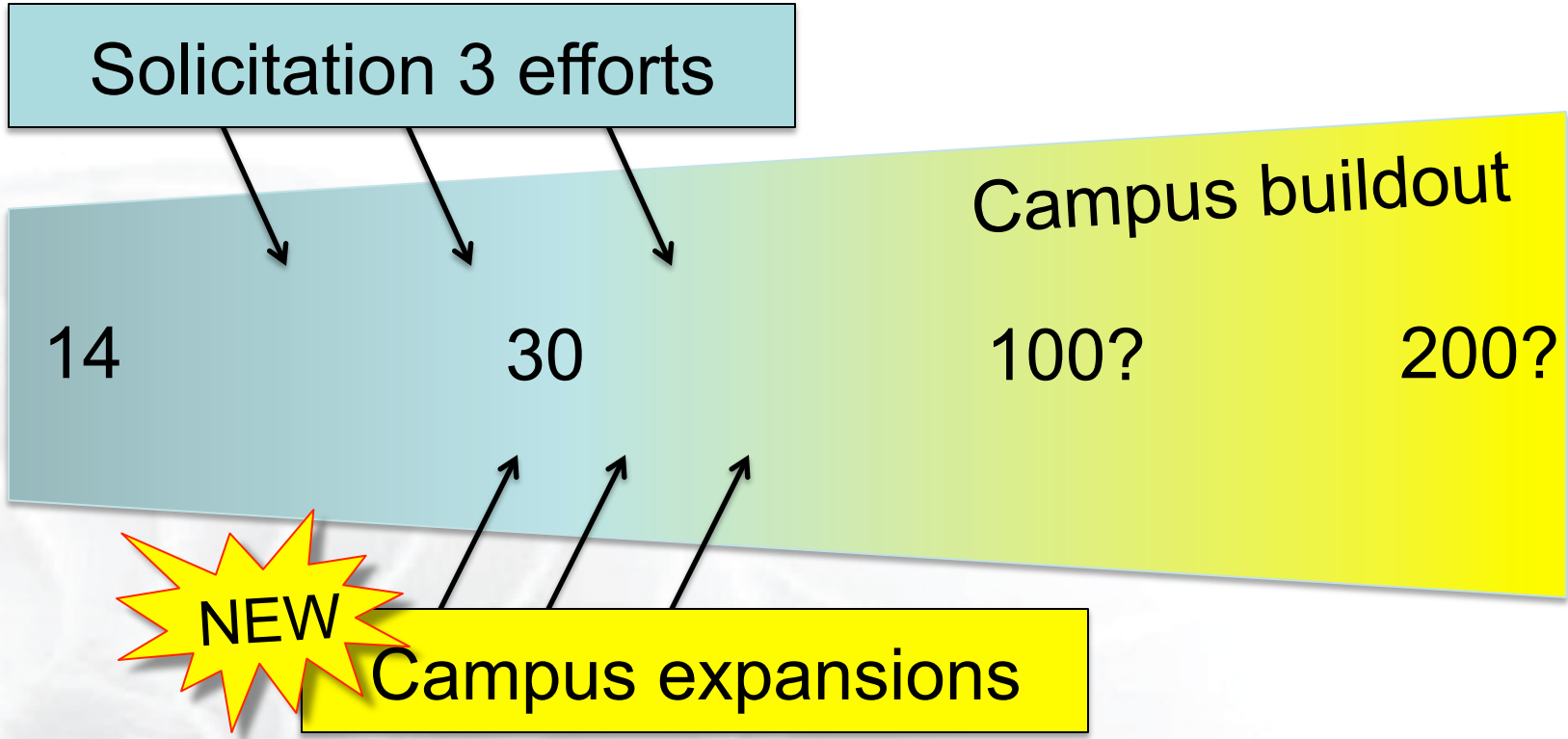
- Suggest 100-200 US campuses as target for “at scale”
  - Both academia and national labs
  - GENI-enable the campuses
  - Their students, faculty, staff can then “live in the future” using both today’s Internet and many experiments
  - Build out backbones, regionals, and shared clouds to support the campuses
- Grow via ongoing spiral development
  - Identify, understand, and drive down risks
  - Learn what is useful and what is not
  - Early GENI campuses can help later ones
- Transition to community governance



- Flexible network / cloud research infrastructure
- Also suitable for physics, genomics, other domain science
- Support “hybrid circuit” model plus much more (OpenFlow)
- Distributed cloud (racks) for content caching, acceleration, etc.

# Growing GENI to 100-200 campuses

GENI racks, OpenFlow, WiMAX, training, ops



GENI racks, OpenFlow, WiMAX, training, ops

—————→  
Spiral development . . .

- **GENI Solicitation 3**
  - More **WiMAX base stations** with Android handsets
  - GENI-enable 5-6 **regional networks**
  - Inject more **OpenFlow switches** into Internet2 and NLR
  - 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

## A new solicitation coming GENI-enabling 20+ campuses

- Growing to 20+, then 100-200 campuses
  - Plan roughed out at 2<sup>nd</sup> CIO workshop, July 7, 2011 (thank you EDUCAUSE)
  - “Buddy system” for each meso-scale campus to guide 2-3 new campuses
  - Increase GENI-enabled campuses from 14 to 40-50 in a staged manner, over several years
- GENI candidate campuses are now being lined up
  - Two-person teams will visit candidate campuses this fall, helping campus CIOs draw up plans and proposal material
  - “Campus expansion” solicitation expected ~ Dec 2011
- ***Create a proposal to GENI-enable your campus***

Larry Landweber is organizing this effort: [larry.landweber@gmail.com](mailto:larry.landweber@gmail.com).

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- **GENI and US Ignite**
- Accelerating the build-out

- US Ignite is an initiative to spark the development of **gigabit applications and services**
- **in areas of national priority:** advanced manufacturing, health, education, energy, economic development, transportation, and public safety/emergency preparedness
- **on an ultra high speed, deeply programmable, and sliceable network testbed.**

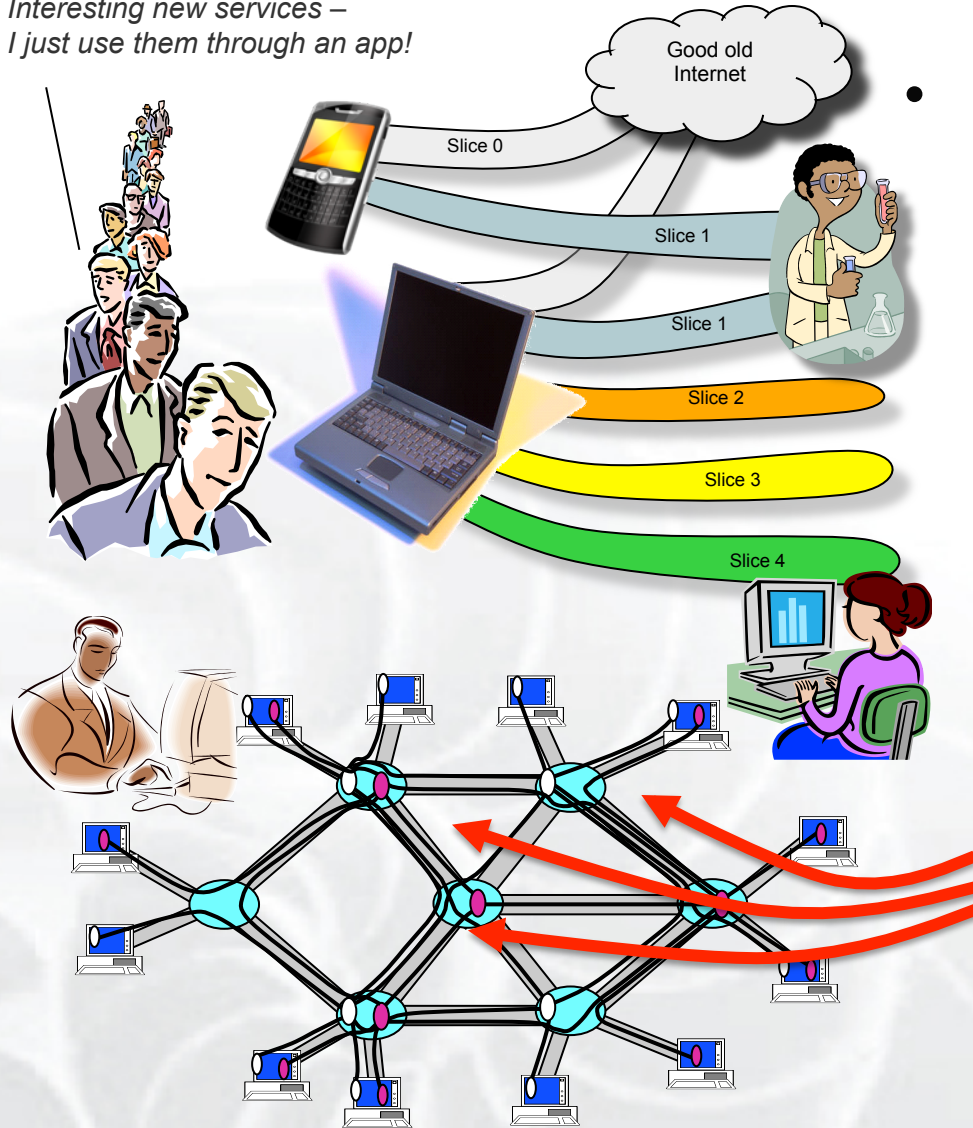


- Very strong interest from 6 US cities to date
  - Chattanooga, Cleveland, Lafayette LA, Philadelphia, Salt Lake City region, Washington DC
  - Their citizens will be able to “live in the future”
- Cities can be GENI-enabled very rapidly
  - We have visited all 6 cities for surveys, discussions
  - GENI rack, OpenFlow, and Layer 2 connectivity appear quite feasible
  - Can be federated into GENI very quickly
- Can support experimental, gigabit applications in GENI slices through cities
  - Creates **tremendous** new research opportunities



# What would it look like? “Cities living in the future”

Interesting new services –  
I just use them through an app!



## • Citizens’ view

- Great new applications
- New content services . . .
- New weather services . . .
- New health services . . .
- New energy services . . .
- New government services . . .

## Entrepreneurs’ view

- Next-generation applications can be cheaply & rapidly rolled out
- “My software goes HERE”
- Create and try out new apps that exploit deep programmability
- Experiment with cities “living in the future” to gain market edge

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# Experimentation with GENI: Workflow

## Experiment Planning

Find resources &  
tools

Get account/  
credentials

Develop software

## Experiment Deployment

Present  
credentials

Acquire resources

Install software

## Experiment Execution

Control  
experiment

Instrument and  
measure

Teardown  
experiment

A flourishing ecosystem of tools is emerging to support this workflow.

# Finding Resources and Tools

- Experimenter Portal page on GENI wiki lists available aggregates (resources) and tools
- Click on an aggregate name for more information on resources

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



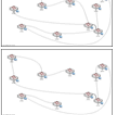


ExperimenterPortal - GENI: geni - Trac

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

8 GENI Aggregates Currently Available to Experimenters

### 8.1 Backbone Networks

Network	Description	Network Map
Internet2	Internet2 provides the U.S. research and education community a dynamic hybrid optical and packet network. GENI experimenters have access to 1Gbps of dedicated bandwidth from Internet2. Experimenters may create their own topologies using Layer 2 VLANs.	
National LambdaRail (NLR)	NLR provides the testbed for advanced research at over 280 universities and private and U.S. government laboratories. GENI experimenters have access to up to 30Gbps of non-dedicated bandwidth on NLR. Experimenters may create their own topologies using Layer 2 VLANs.	
GENI OpenFlow Core	GENI network core is a set of OpenFlow-capable switches in NLR and Internet2. There are currently two standing VLANs (3715 and 3716) carried on ten switches in the core. Experimenters may use these standing VLANs within the GENI core network without having to coordinate with NLR or Internet2. Experimenters will however have to coordinate with their campus and/or regional networks to connect to the GENI core. The two standing VLANs in the network core also bridge between the Internet2 and NLR networks.	

### 8.2 Programmable Hosts

Aggregate	Description	Compute Resources	Programmable Network	Accepts GENI Credentials	Network Connectivity	Experimenter Tools
PlanetLab	Testbed consisting of 1090 nodes at 513 sites around the world	Virtual machines on PlanetLab nodes	No	Yes	Internet	Gush, Omni, Raven, SFI
GPO Lab myPLC	PlanetLab installation consisting of 5 multi-homed nodes	Virtual machines on PlanetLab nodes	No	Yes	Internet2: IP; NLR: IP; Internet	Gush, Omni, SFI
Utah ProtoGENI	Over 500 co-located PCs that can be loaded with an experimenter specified OS image and connected in arbitrary topologies. Includes 60 nodes with 2 WiFi cards each, plus software-defined radio peripherals (USR2)	Complete PCs or virtual machines on PCs	PCs can be set up as routers, plus experimenter-controllable switches (HP ProCurves)	Yes	Internet2: IP and Layer 2; Internet	ProtoGENI Tools, Gush
Kentucky ProtoGENI	Over 50 co-located PCs that can be loaded with an experimenter specified OS image and connected in arbitrary topologies. Strong instrumentation capabilities	Complete PCs or virtual machines on PCs	PCs can be set up as routers	Yes	Internet2: IP and Layer 2; Internet	ProtoGENI Tools, Instrumentation Tools
Million Node GENI	Over 500 co-located PCs that can be loaded with an experimenter specified image and connected in arbitrary topologies	Complete PCs	PCs can be set up as routers	Yes	Internet2: IP and Layer 2; NLR: IP and Layer 2; Internet	ProtoGENI Tools, Gush
Million Node GENI	Compute resources on thousands of platforms donated by individuals and institutions. Platforms may be mobile and/or behind firewalls and NATs.	Experimenter software, written in a subset of Python, runs in sandboxes on Million Node GENI platforms.	No	No	Internet	ProtoGENI Tools, Million Node GENI Tools

GENI Aggregate Providers: Please report errors and omissions in the table above to [Vic Thomas](#)

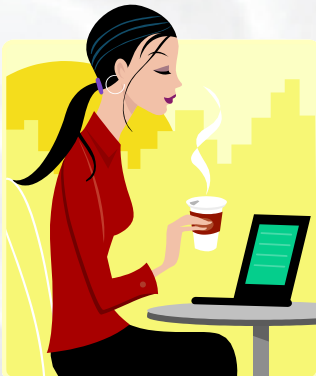
### 8.3 Programmable Networks

Aggregate	Description	Compute Resources	Accepts GENI Credentials	Network Connectivity	Experimenter Tools
Supercharged PlanetLab Platform (SPP) Nodes	Five high-performance PlanetLab nodes at Internet2 co-location sites. Nodes incorporate high-performance server and network processor blades to support service delivery over high speed overlay networks.	Experimenters program the General-Purpose Processing Engines (GPEs) and Network Processor Blades (NPE) of the SPP nodes.	No	Internet2	
ProtoGENI Backbone Nodes	Nodes at 5 Internet2 co-location sites. The ProtoGENI backbone runs Ethernet on a 1Gbps Internet2 wave, and slices it with VLANs. Researchers select the topology of VLANs on this infrastructure.	No	Yes	Internet2: Layer 2 and IP; Internet2 ION service (incl. many ProtoGENI sites); 1 Gbps to GPENI and Wisconsin ProtoGENI site, 10 GBps to Utah ProtoGENI site and Mid-Atlantic Crossroads; connected to SPP and ShadowNet nodes	ProtoGENI Tools
	BGP-session multiplexer that provides stable, on-demand access to global BGP route feeds. Arbitrary and even				

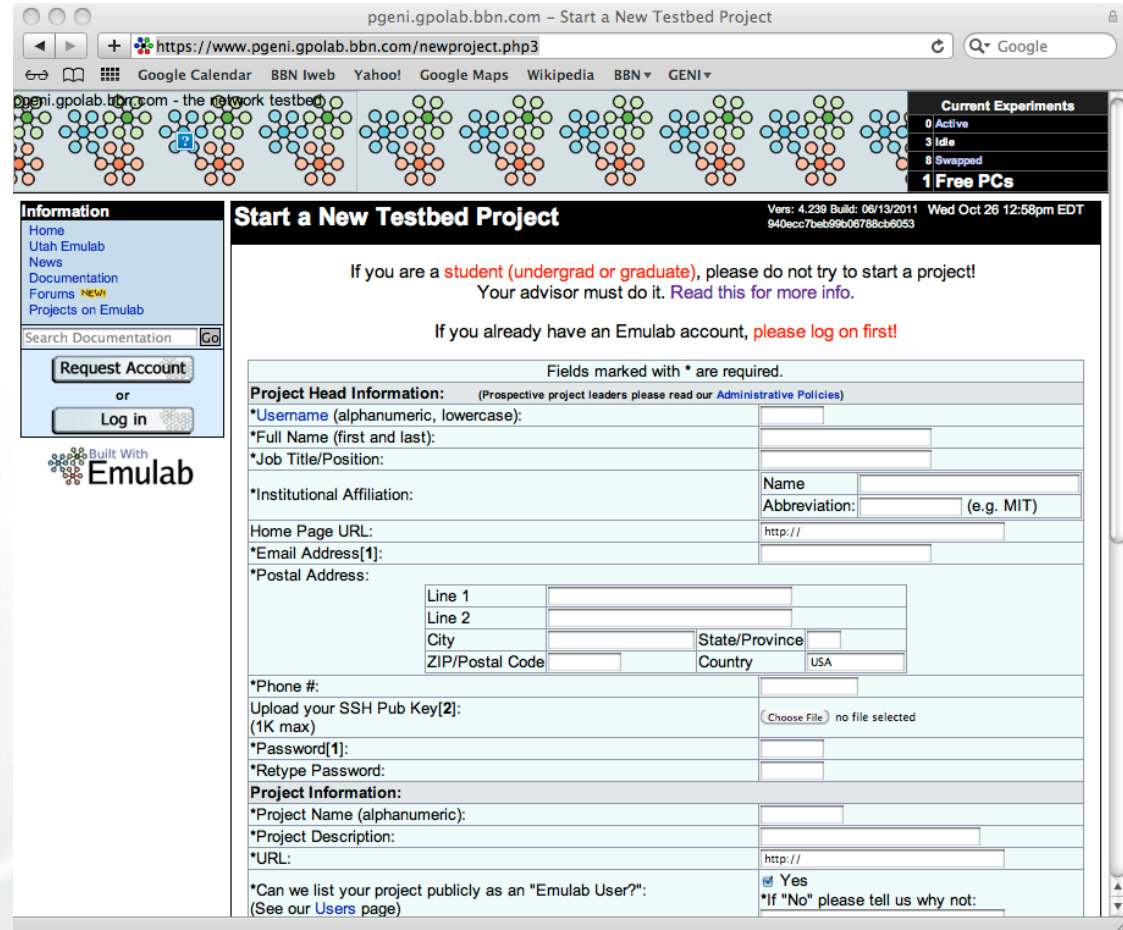
# Obtaining a GENI Account



**In person:** - GPO GEC Help Desk  
- GEC coding sprint on Fri.



**Email:** [help@geni.net](mailto:help@geni.net)



Start a New Testbed Project

If you are a **student (undergrad or graduate)**, please do not try to start a project!  
Your advisor must do it. [Read this for more info.](#)

If you already have an Emulab account, **please log on first!**

Fields marked with \* are required.

**Project Head Information:** (Prospective project leaders please read our [Administrative Policies](#))

\*Username (alphanumeric, lowercase):

\*Full Name (first and last):

\*Job Title/Position:

\*Institutional Affiliation:

Name	<input type="text"/>
Abbreviation:	<input type="text"/> (e.g. MIT)

Home Page URL:

\*Email Address[1]:

\*Postal Address:

Line 1	<input type="text"/>	<input type="text"/>	<input type="text"/>
Line 2	<input type="text"/>	<input type="text"/>	<input type="text"/>
City	<input type="text"/>	State/Province	<input type="text"/>
ZIP/Postal Code	<input type="text"/>	Country	USA

\*Phone #:

Upload your SSH Pub Key[2]: (1K max)  no file selected

\*Password[1]:

\*Retype Password:

**Project Information:**

\*Project Name (alphanumeric):

\*Project Description:

\*URL:

\*Can we list your project publicly as an "Emulab User?":  Yes  
\*If "No" please tell us why not:

**Online:** <https://www.pgeni.gpolab.bbn.com/newproject.php3>

**Student accounts need to be approved by a professor.**

- Software tools and languages used are typically aggregate specific
  - E.g. Compute resources may require software developed for a Linux environment
- For help on programming resources:
  - Guides and examples on aggregate provider web pages
    - Follow links from aggregate information pages in the Experimenter Portal

Tutorials on programming aggregates:

- PrimoGENI at 10.30am today

- DiCloud at 3pm today.

## Experiment Planning

Find resources &  
tools

Get account/  
credentials

Develop software

## Experiment Deployment

Present  
credentials

Acquire resources

Install software

## Experiment Execution

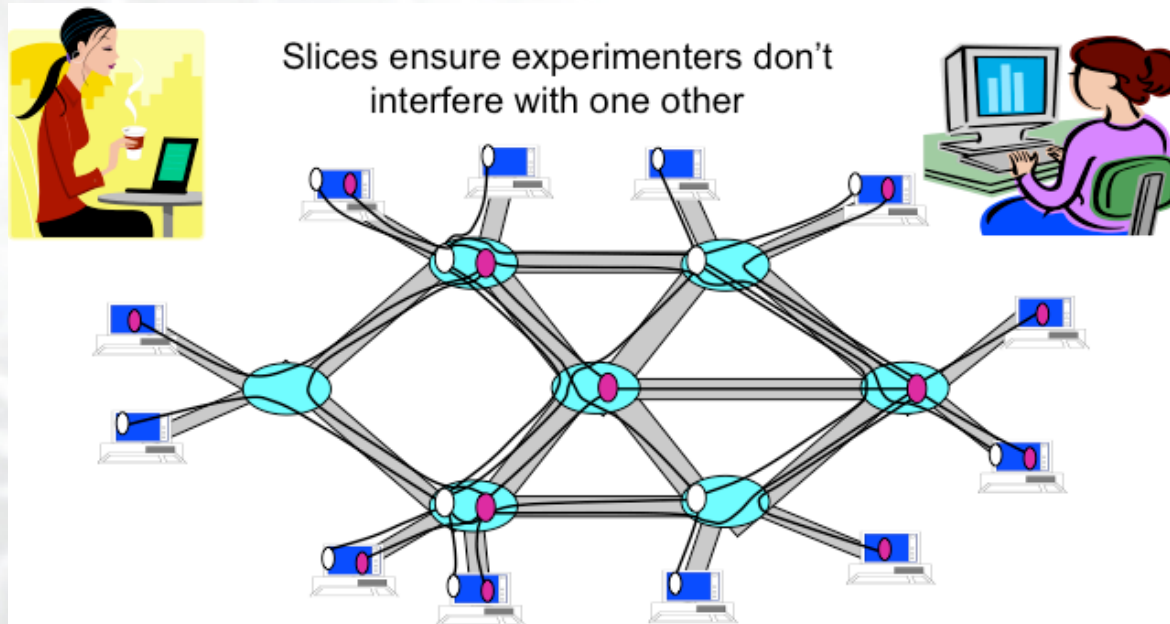
Control  
experiment

Instrument and  
measure

Teardown  
experiment

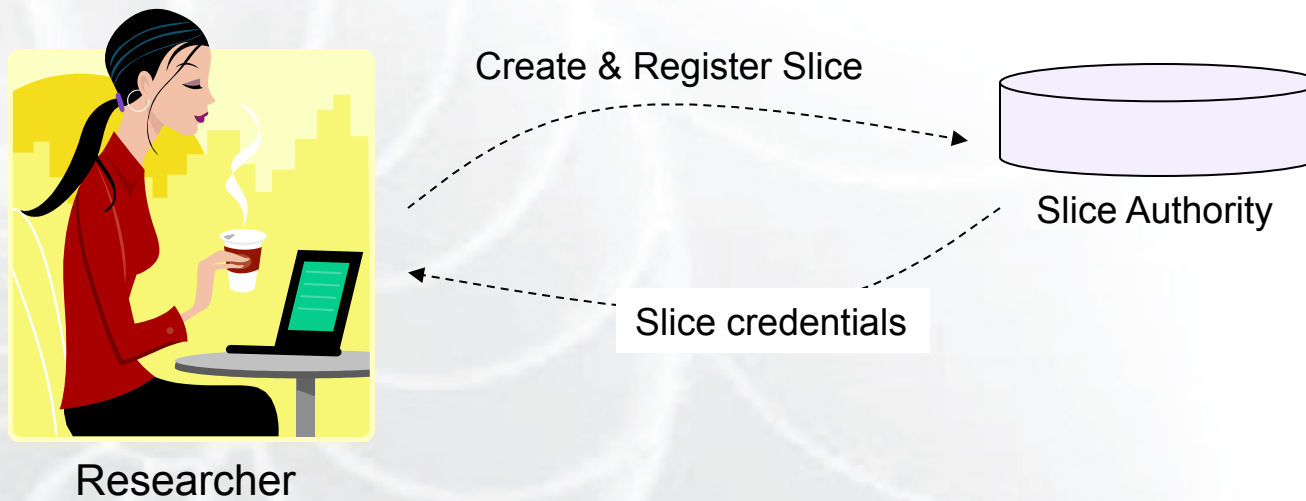
## Deploying an Experiment: Slice Creation

- 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: GENI entity that creates and registers slices
- GENI currently has multiple slice authorities
  - PlanetLab, ProtoGENI, GPO Lab



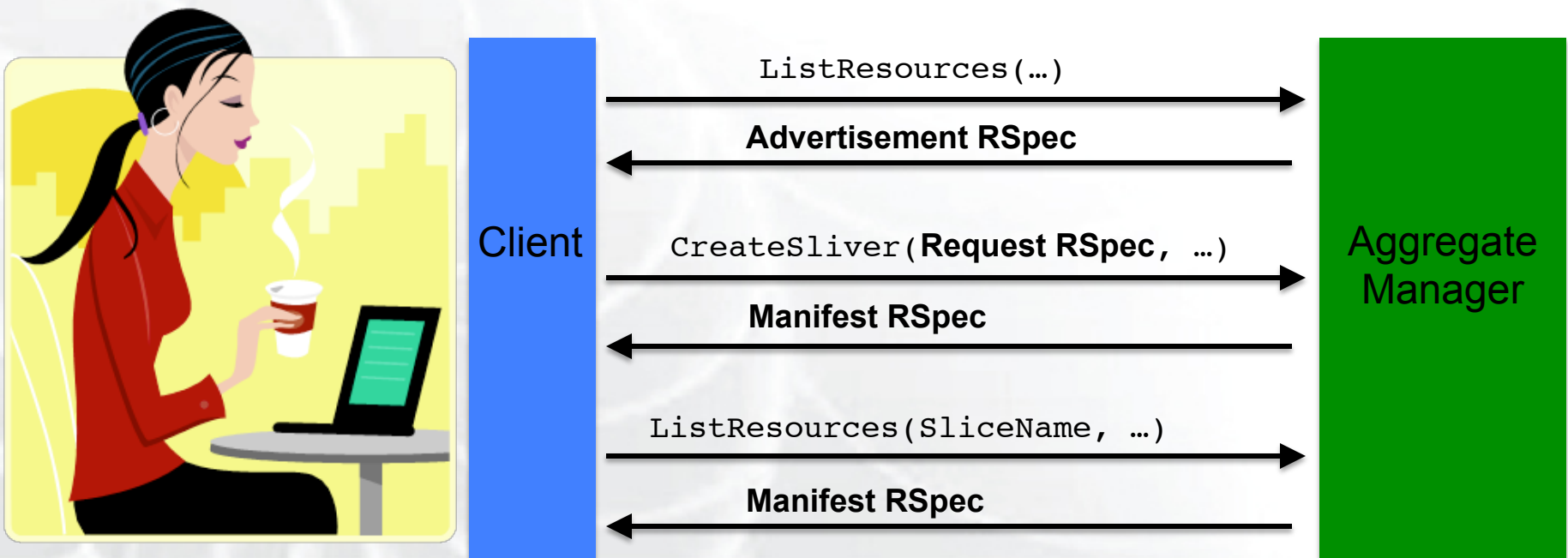
- Sliver: A resource unit assigned to a slice by an aggregate
  - A virtual machine on a compute node
  - A VLAN on a backbone network
- RSpecs: Lingua franca for describing and requesting resources
  - “Machine language” for negotiating resources
  - Experimenter tools eliminate the need for most experimenters to write or read RSpecs

```
<?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**

# Using RSpecs to Add Slivers to a Slice

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



- Manifest RSpec has information about allocated resources
  - Hostnames, IP addrs, interface names, MAC addrs, ...
  - Information used to install software
- Manual installation...
  - ssh into individual virtual machines/nodes and install software
- ...and/or using experimenter tools
  - Gush, Raven and Flack tools automate installation
    - Useful for large experiments
  - Raven automatically updates slivers if new versions of software become available
    - Useful for long running experiments

**Flack tutorial at 10.30am today.**

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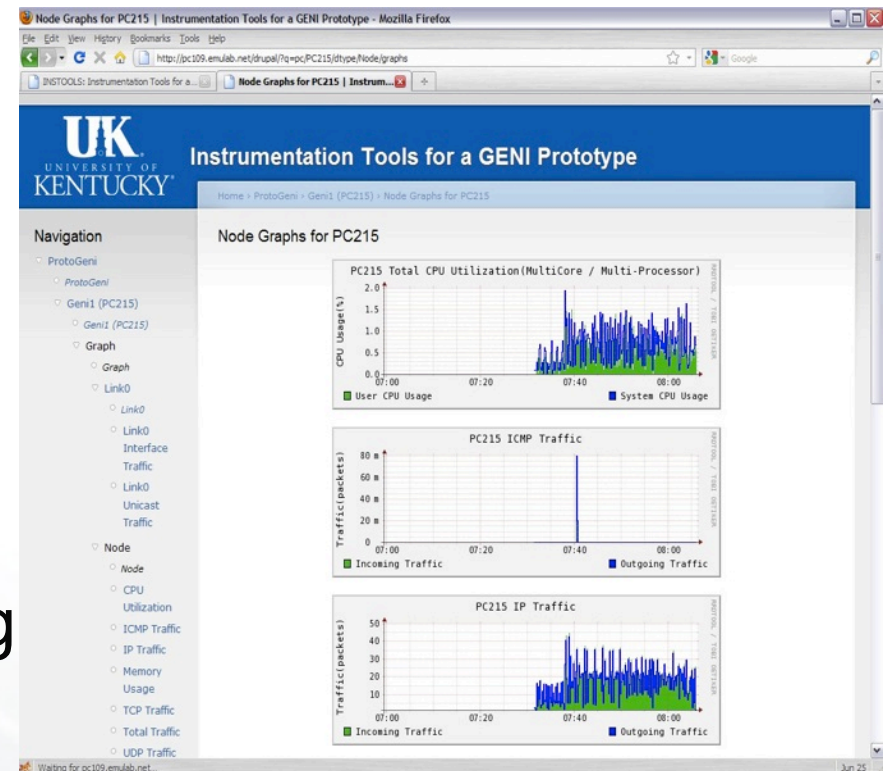
Control  
experiment

Instrument and  
measure

Teardown  
experiment

- Gush experiment control tool allows experimenters to
  - Start, pause, resume and stop experiments
  - Specify barriers for synchronizing a distributed experiment
  - Monitor experimenter software on slivers for failures and specify failure handlers
- The GENI AM API provides calls to
  - Inquire about the status of a sliver (`SliverStatus`)
  - Stop and deallocate a sliver (`DeleteSliver`)

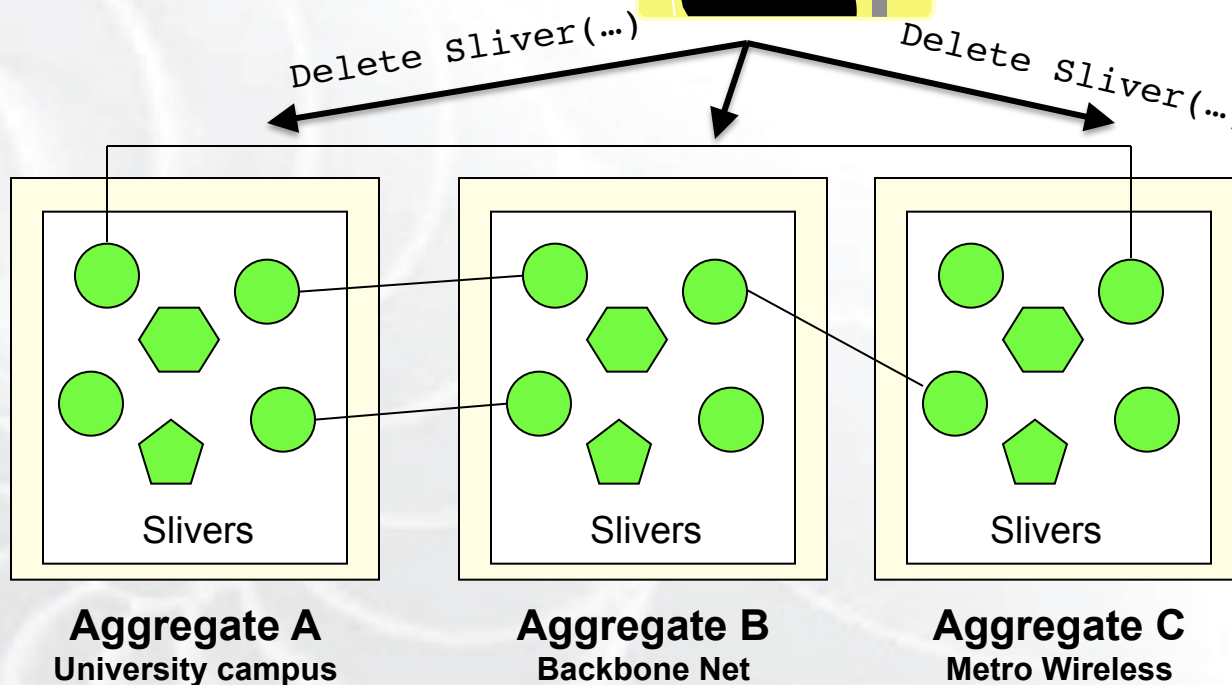
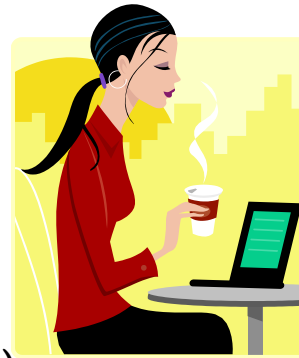
- GENI instrumentation tools
  - Instrumentation Tool: Integrated with ProtoGENI
  - OnTimeMeasure: Active measurement tool
  - MeasurementSystem: Packet capture based measurements
  - LAMP: Infrastructure measurement tool
- GENI Solicitation 3 is funding two large projects for unified I&M tools



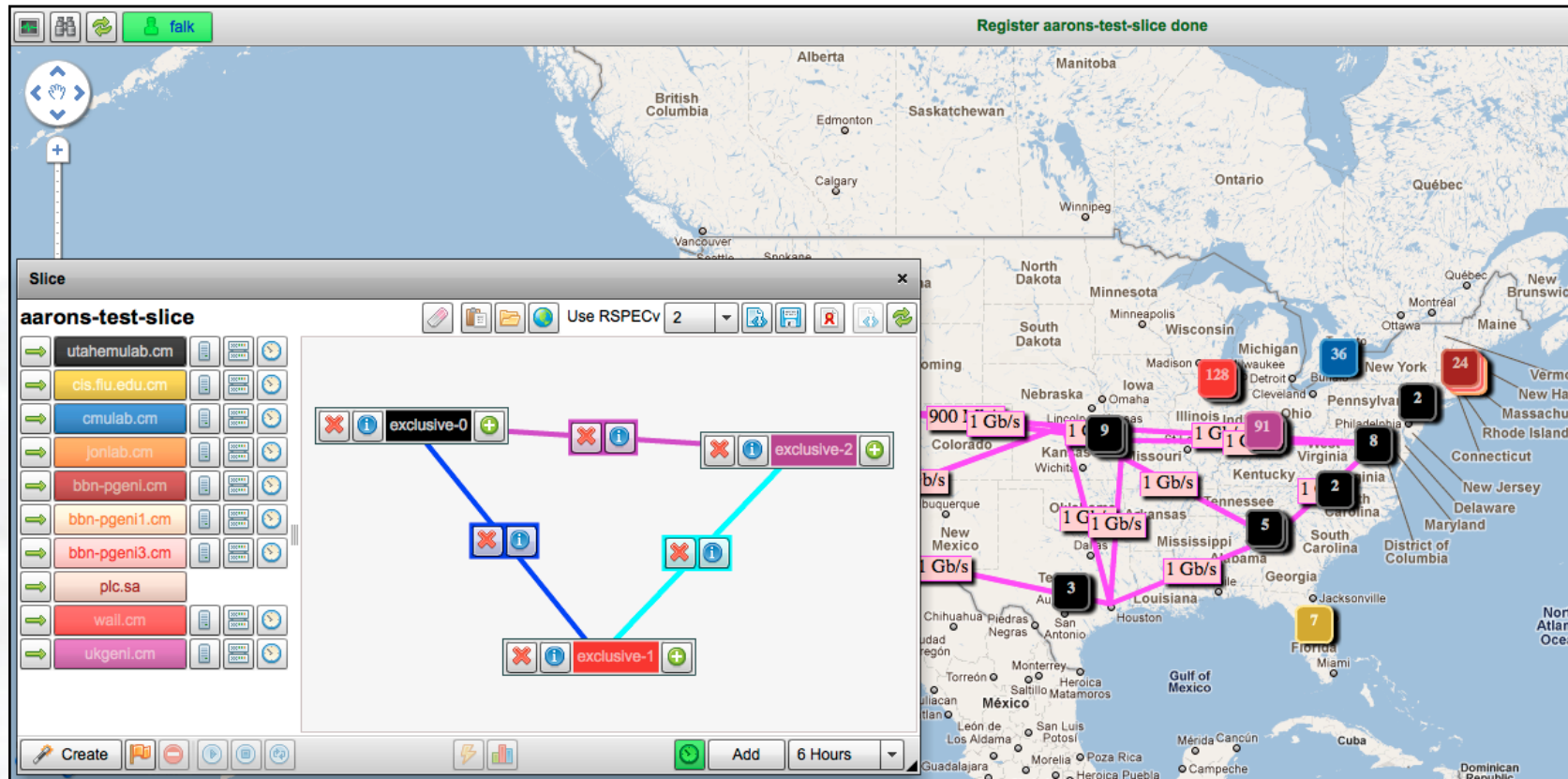
## Tutorials:

Instrumentation Tool: 10.30am today (joint with Flack tutorial)  
Measurement System: 1pm today.

- DeleteSliver stops sliver and deallocates associated resources







The screenshot displays the GENI Experimenter Tool (Flack) interface. At the top, a green bar indicates the user 'falk' and a status message 'Register aarons-test-slice done'. The main area is a map of North America with various nodes and links. A 'Slice' window is open, showing a network diagram for 'aarons-test-slice'. The slice window includes a list of participating labs (e.g., utahemulab.cm, cls.fiu.edu.cm, cmulab.cm, jonlab.cm, bbn-pgeni.cm, bbn-pgeni1.cm, bbn-pgeni3.cm, plc.sa, wall.cm, ukgeni.cm) and a 'Create' button. The network diagram shows nodes like 'exclusive-0', 'exclusive-1', and 'exclusive-2' connected by links. The map shows nodes with labels like '900 1 Gb/s' and '1 Gb/s'.

Graphical tool that hides the complexities of Rspecs and the GENI AM API

Flack tutorial at 10.30am today.



# GENI Experimenter Tool: Omni

```
$ omni.py createsliver aliceslice myRSpec.xml
INFO:omni:Loading config file omni_config
INFO:omni:Using control framework pgeni
INFO:omni:Slice urn:publicid:IDN+pgeni.gpolab.
        expires within 1 day on 2011-07-07
INFO:omni:Creating sliver(s) from rspec file
INFO:omni:Writing result of createsliver for
INFO:omni:Writing to 'aliceslice-manifest-rspe
INFO:omni: -----
INFO:omni: Completed createsliver:

Options as run:
    aggregate: https://www.emulab.
    framework: pgeni
    native: True

Args: createsliver aliceslice myRSpec.xml

Result Summary: Slice urn:publicid:IDN+pgeni
Reserved resources on https://www.emulab.net/p
Saved createsliver results to aliceslice-man
INFO:omni: =====
```

**Command line tool that hides the complexities of the GENI AM API**

**Omni tutorial at 8.30am Friday.**

# GENI Experimenter Tools: Gush & Nebula

**Gush: Command line tool for greater control over experiments**

```

jeannie@sysnet:~/gush/trunk$ ./gush -P 15000
gush: Gush has learned about the slice williams.gush.

gush
gush: prefer williams
gush: prefer ucsd
gush: prefer planetlab1
gush:
gush: load tests/simple.xml
Project "simple" is selected.
Experiment "simple" is selected.
gush:
gush:
gush: run
Starting experiment run.
Running experiment simple...
gush: The configuration matcher has finished matching.
The resource allocator has finished successfully.
williams.gush@planetlab1.williams.edu:15413 has joined the mesh.
The file transfer of Package to planetlab1.williams.edu has been completed.
The software installation of Package on planetlab1.williams.edu was successful.
williams.gush@planetlab1.ucsd.edu:15413 has joined the mesh.
The file transfer of Package to planetlab1.ucsd.edu has been completed.
The software installation of Package on planetlab1.ucsd.edu was successful.
williams.gush@planetlab1.williams.edu:15413,7370: Hello World

williams.gush@planetlab1.ucsd.edu:15413,20638: Hello World

The experiment has ended.

gush
gush: info mesh
Mesh:
williams.gush@planetlab1.ucsd.edu:15413: connected; (fds=7,7 last_heard=1299692920)
williams.gush@planetlab1.williams.edu:15413: connected; (fds=6,6 last_heard=1299692891)
Summary: 2 mesh members; 0 nodes connecting.
gush:
gush: info control
Experiment Controller State(0x8495d0):
+ Experiment simple
Experiment: simple Controller: jeannie@sysnet:15000
Component: Cluster Controller: jeannie@sysnet:15000
Matching id 1299692167,1.default.jeannie@sysnet:15000
Component requests 2 hosts.
1 matchings known:
1299692167,1.default.jeannie@sysnet:15000,
Node status (2):
williams.gush@planetlab1.ucsd.edu:15413: running;
williams.gush@planetlab1.williams.edu:15413: running;
Num not failed: 2
Exceptions (0):
Process: cat
Controller: Status:
williams.gush@planetlab1.ucsd.edu:15413 : done;
williams.gush@planetlab1.williams.edu:15413 : done;

gush: disconnect
gush: williams.gush@planetlab1.williams.edu:15413 has decided to leave the mesh.
williams.gush@planetlab1.ucsd.edu:15413 has decided to leave the mesh.

gush:

```



**Nebula: Graphical front-end to Gush**

Sface: SFA Interface

PlanetLab Federation GUI Go to: [Main Window](#) [Configure](#) [Help](#)

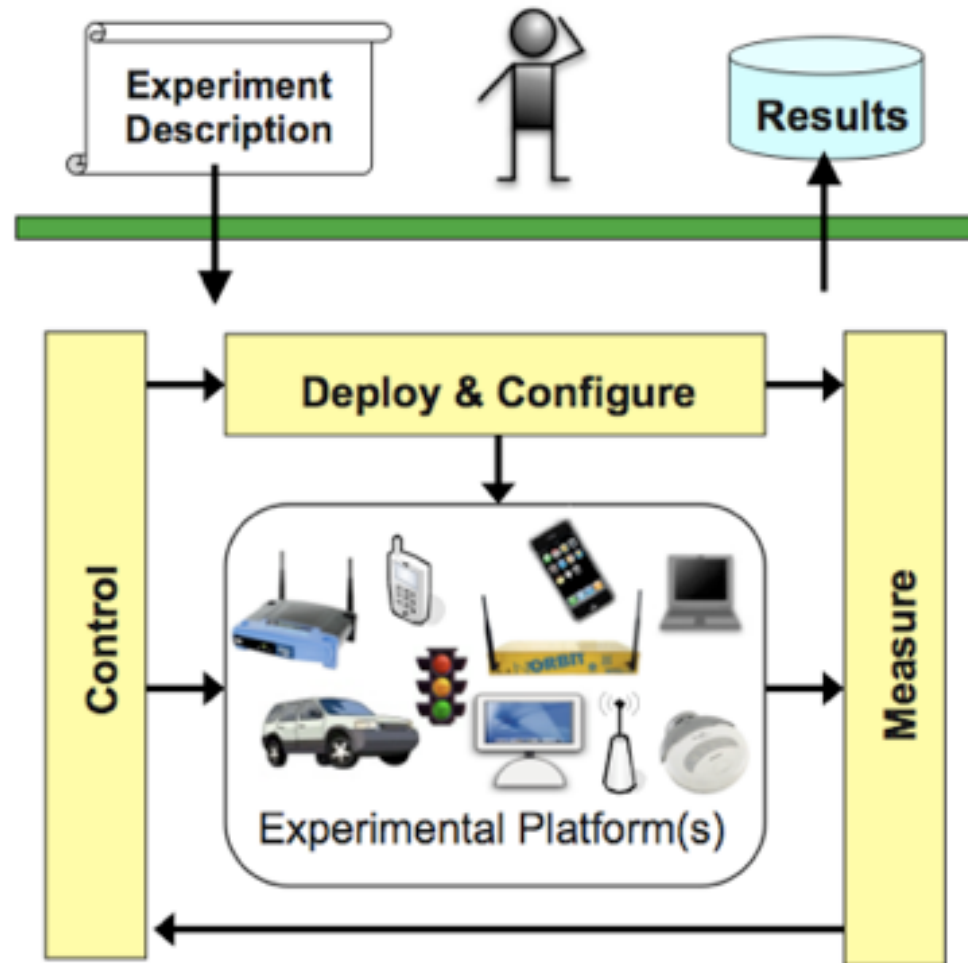
Slice : plc.princeton.iias Search:

Hostname or Tag	Status
▶ plc	571 Nodes 3 Selected
▶ plc.gpeni	36 Nodes 1 Selected
▶ plc.vicci	2 Nodes 0 Selected
▶ plc.vini	28 Nodes 9 Selected
▶ ple	206 Nodes 0 Selected
▼ ppk	9 Nodes 0 Selected
Default tags for ppk	
kaistnode1.planet-lab.kr	Not Selected
kaistnode2.planet-lab.kr	Not Selected
lanadaplanetlab.kaist.ac.kr	Not Selected
ktnode1.planet-lab.kr	Not Selected
ktnode2.planet-lab.kr	Not Selected
ppk1.nm.gist.ac.kr	Not Selected
ppk2.nm.gist.ac.kr	Not Selected
nianode1.planet-lab.kr	Not Selected
nianode2.planet-lab.kr	Not Selected

Slice data last updated on Wed Apr 27 15:14:20 2011 [Show RSpec](#) [Show Log](#)

**Graphical tool that hides the complexities of Rspecs and the GENI AM API**

# GENI Experimenter Tool Suite: OMF



**A suite of tools for experiment deployment, control and measurement.**

start time	Day 1: Wed Nov 2				Day 2: Thurs Nov 3				Day 3: Fri Nov 4			
	Experimenter Track	Campus Track	Software Track	Spare Track	Experimenter Track	Campus Track	Software Track	Ignite Track	Experimenter Track	Campus Track	Software Track	Ignite Track
7:30 AM	Break fast (7:30 - 8:30)											
8:00 AM	Break fast (7:30 - 8:30)											
8:30 AM	★ GENI Concepts & Resources		Project Highlights	I & M Working Session	Plenary Session: GENI Updates				★ Tutorial: OMNI & Topologies	Experimenter Roundtable (w/SW track)	ORCA Cluster	Ignite Workshop (by invite only)
9:00 AM					Break (9:30 - 10:00)					Meso-scale Networking: Looking Ahead	ProtoGENI Cluster	
9:30 AM					Plenary Session: Ignite				Break (10:30 - 11:00)			
10:00 AM	Break (10:00 - 10:30)											
10:30 AM	★ Tutorial: Introduction to GENI using Flack and the Instrumentation	GENI Deployment Updates	Control Framework Topics	I & M Working Session (continue)	Lunch (noon - 1:00)				Outbriefs / Feedback / Wrap-up			
11:00 AM					Lunch (noon - 1:00)				Ignite Workshop (by invite only)			
11:30 AM					Lunch (noon - 1:00)				Lunch (noon - 1:00)			
12:00 PM	Lunch (noon - 1:00)											
12:30 PM	Lunch (noon - 1:00)											
1:00 PM	GPO Office Hours	★ Tutorial: Measurement System	OpenFlow update	AM API	★ Tutorial: PrimoGENI	Plenary Session: Experimentation				WIMAX Campus Deployment & Experimentation		Coding Sprint for Developers and Experimenters
1:30 PM			Managing GENI Resources									
2:00 PM												
2:30 PM												
2:30 PM	Break (2:30 - 3:00)											
3:00 PM		Managing GENI Resources (continue)	Authorization	New Projects: Experimenter Support and Training	Break (3:00 - 3:30)							
3:30 PM	Tutorial: DI Cloud	1st Bus leaves at 3:30 for those who need to setup demos			Adv. Tutorial: NetServ	Meso-scale Monitoring	Cloud Computing in GENI	Ignite Workshop (by invite only)				
4:00 PM												
4:30 PM	END EARLY TO TRAVEL TO DEMO (4:30 - ...)											
5:00 PM	END EARLY TO TRAVEL TO DEMO (4:30 - ...)											
5:30 PM	Demo & Networking Event											
6:00 PM	Demo & Networking Event											
6:30 PM	Demo & Networking Event											
7:00 PM	Demo & Networking Event											
7:30 PM	Self-Organized BoF Dinners (start times vary)											

★ Recommended for newcomers

REVISION: 19Oct11

**Most tutorials require a VirtualBox VM with tools and credentials pre-installed. Stop by GPO Help Desk if you don't have one.**

# GENI Engineering Conferences

We welcome your participation in creating GENI

- **13th meeting, open to all:  
March 2012, Los Angeles, CA**
  - 3 tracks: software, campuses, experimenters
  - Tutorials and workshops
  - **Travel grants** to US academics for participant diversity

