



# GENI

## Welcome !

# GENI Engineering Conference 13

## UCLA, Los Angeles

Chip Elliott  
GENI Project Director  
[www.geni.net](http://www.geni.net)

- **GEC 13: THANK YOU to *Dr. Giovanni Pau, Dr. Mario Gerla & everyone involved!***
- **GEC 14: July 9-11, 2012, in Boston**
  - *With many thanks to Karen Sollins & John Wroclawski*
- Subsequent Meetings, open to all who fit in the room
  - Held at regular 4-month periods; see GENI Wiki for dates / places
  - Geographic rotation through US (central, east, west)
  - Held on / near university campuses – **volunteers?**
  - **Travel grants** for participant diversity (US academics only)

- **Dr. Vijay K. Dhir**, Dean, Henry Samueli School of Engineering and Applied Science, UCLA
- **Dr. J. Bryan Lyles**, GENI Program Director  
National Science Foundation



# NSF 12-541

J. Bryan Lyles

CISE/CNS

[jlyles@nsf.gov](mailto:jlyles@nsf.gov)

March 14, 2012

## NSF 12-541, “Campus Cyberinfrastructure - Network Infrastructure and Engineering Program (CC-NIE)”

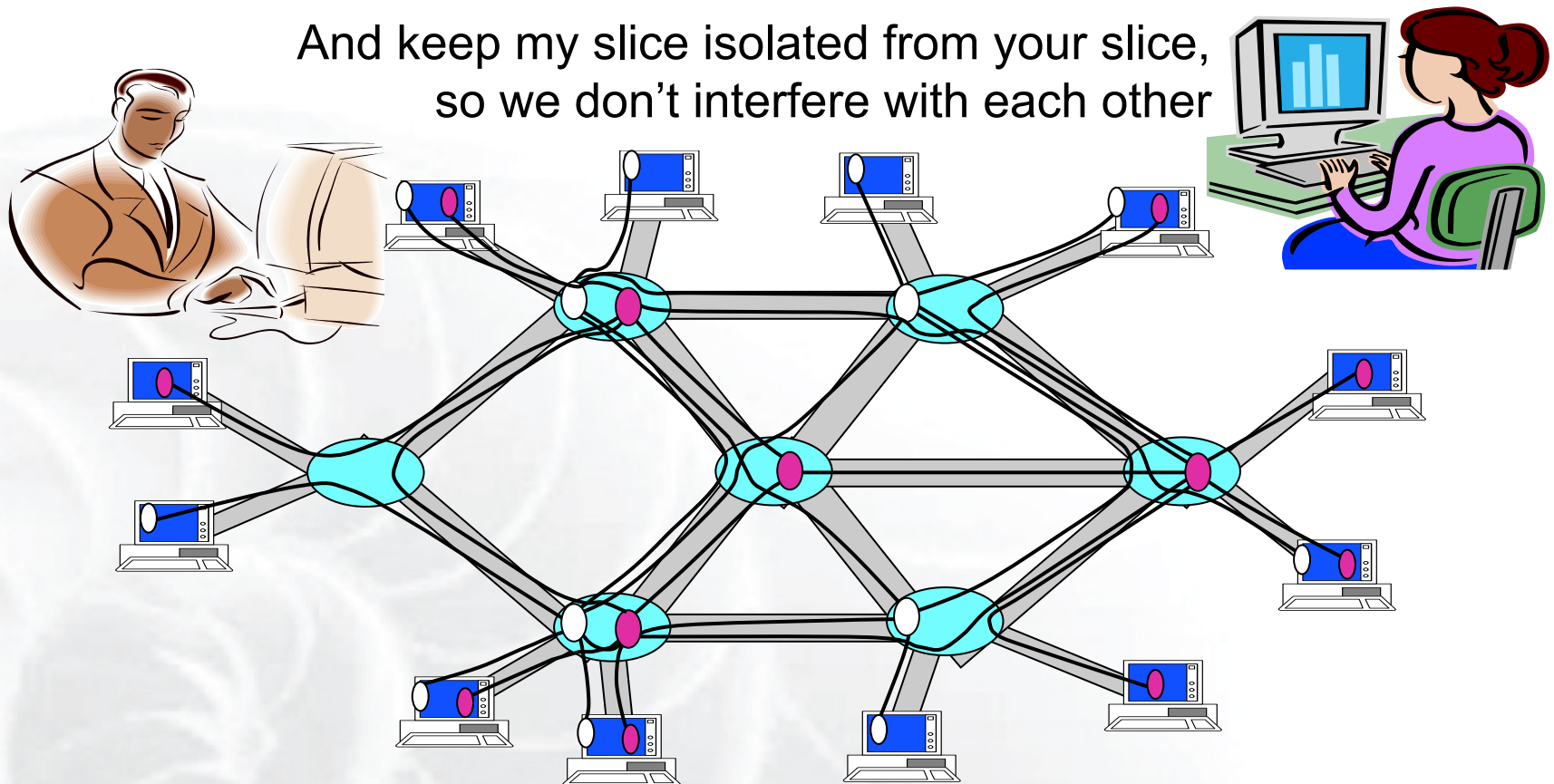
- “improvements and re-engineering at the campus level to leverage dynamic network services to support a range of scientific data transfers and movement”
- Office of Cyber Infrastructure, NOT a GENI program!
  - BUT GENI is one example of a scientific application that can use the infrastructure
- Read the solicitation carefully! “All proposals must document explicit partnerships or collaborations with the campus IT/networking organization...”
- Get to know your campus colleagues: “...as well as one or more domain scientists, research groups, and educators in need of the new network capabilities.”



# Revolutionary GENI Idea Slices and Deep Programmability

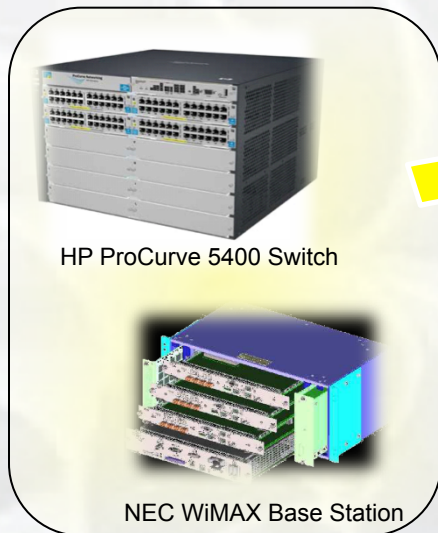
Install the software I want *throughout* my network slice  
(into firewalls, routers, clouds, ...)

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

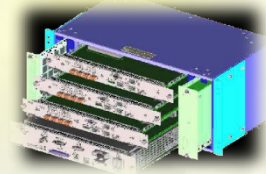


**We can run many different “future internets” in parallel**

- **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

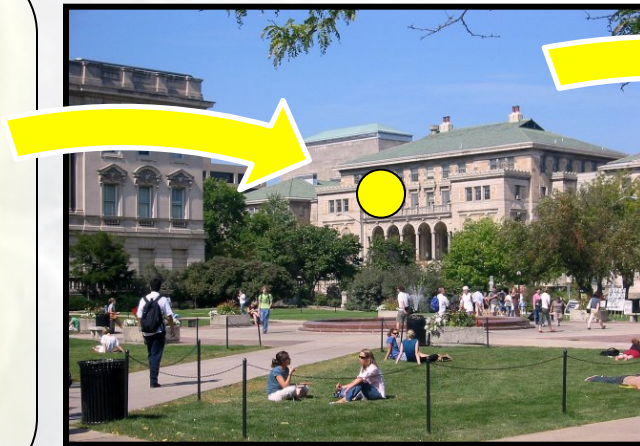


HP ProCurve 5400 Switch

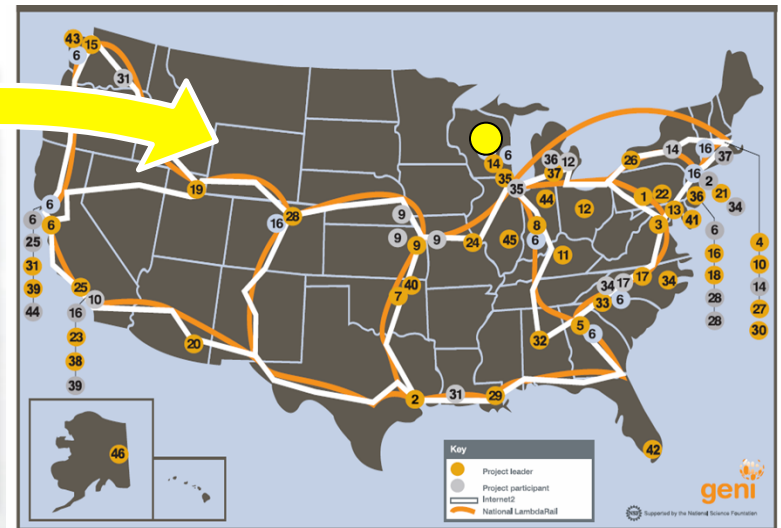


NEC WiMAX Base Station

GENI-enabled equipment

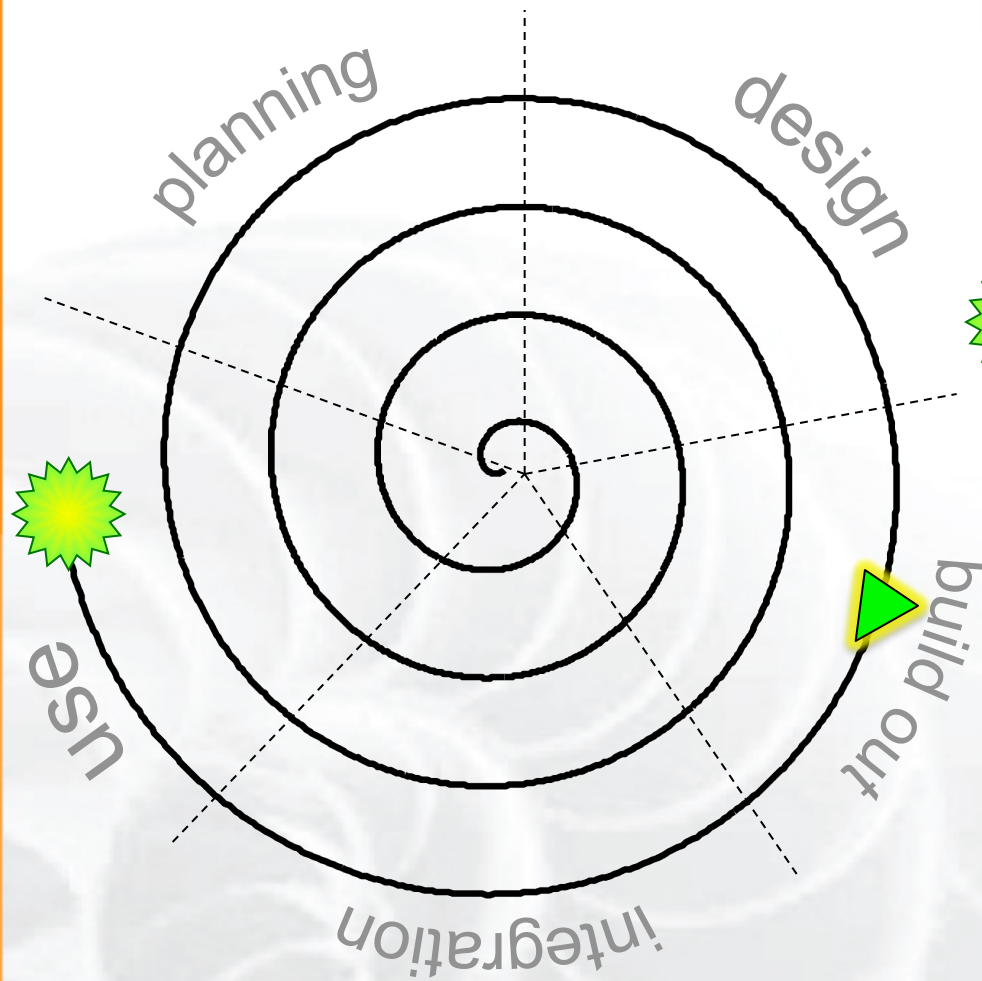


GENI-enabled campuses, students as early adopters



“At scale” GENI prototype

# Start the transition to “real GENI”



**GENI Prototyping Plan**



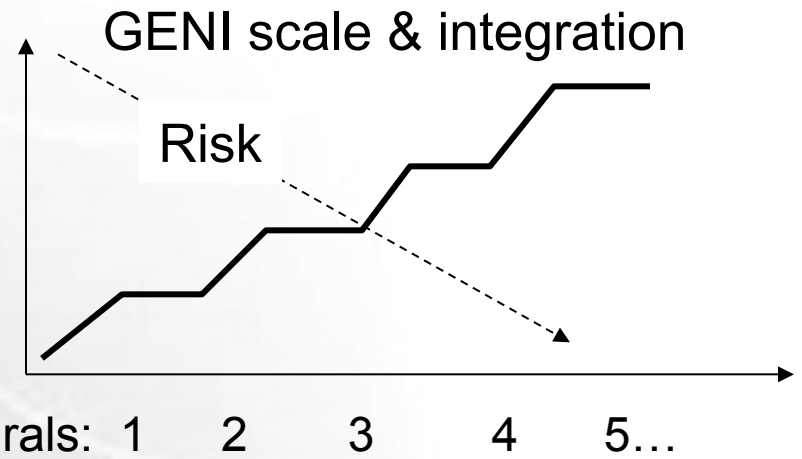
## GENI Spiral 4

Ramp up experiments, 24 x 7 support (GMOC), formalize design, add GENI racks, deploy more OpenFlow and WiMAX, create first rev of GENI instrumentation system.



## Envisioned ultimate goal

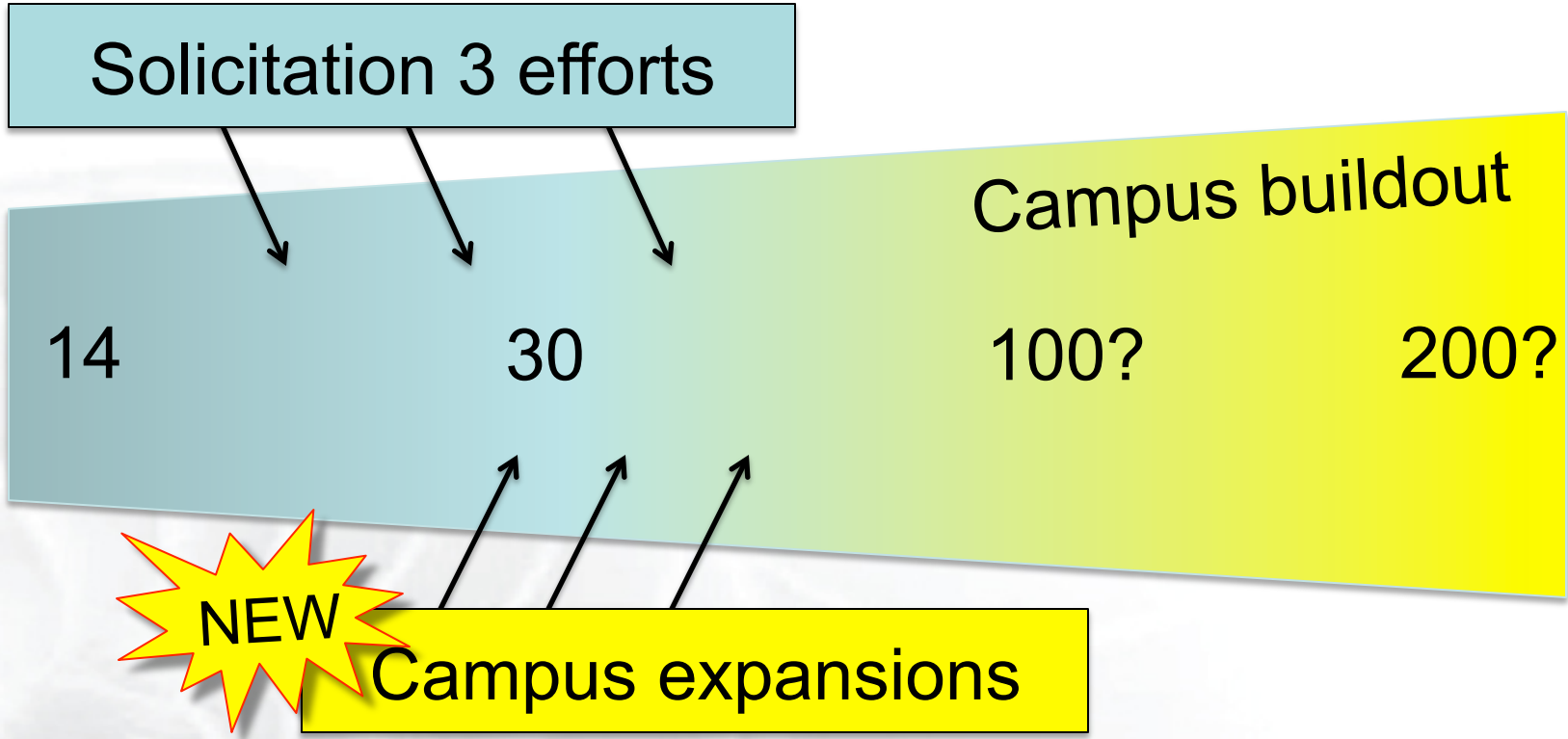
Large-scale distributed computing resources, high-speed backbone nodes, nationwide optical networks, wireless & sensor nets, etc.





# Growing GENI to 100-200 campuses

GENI racks, OpenFlow, WiMAX, training, ops



GENI racks, OpenFlow, WiMAX, training, ops

—————→  
Spiral development . . .

### Regional nets



-  Existing
-  New

### GENI WiMAX

-  Existing
-  New

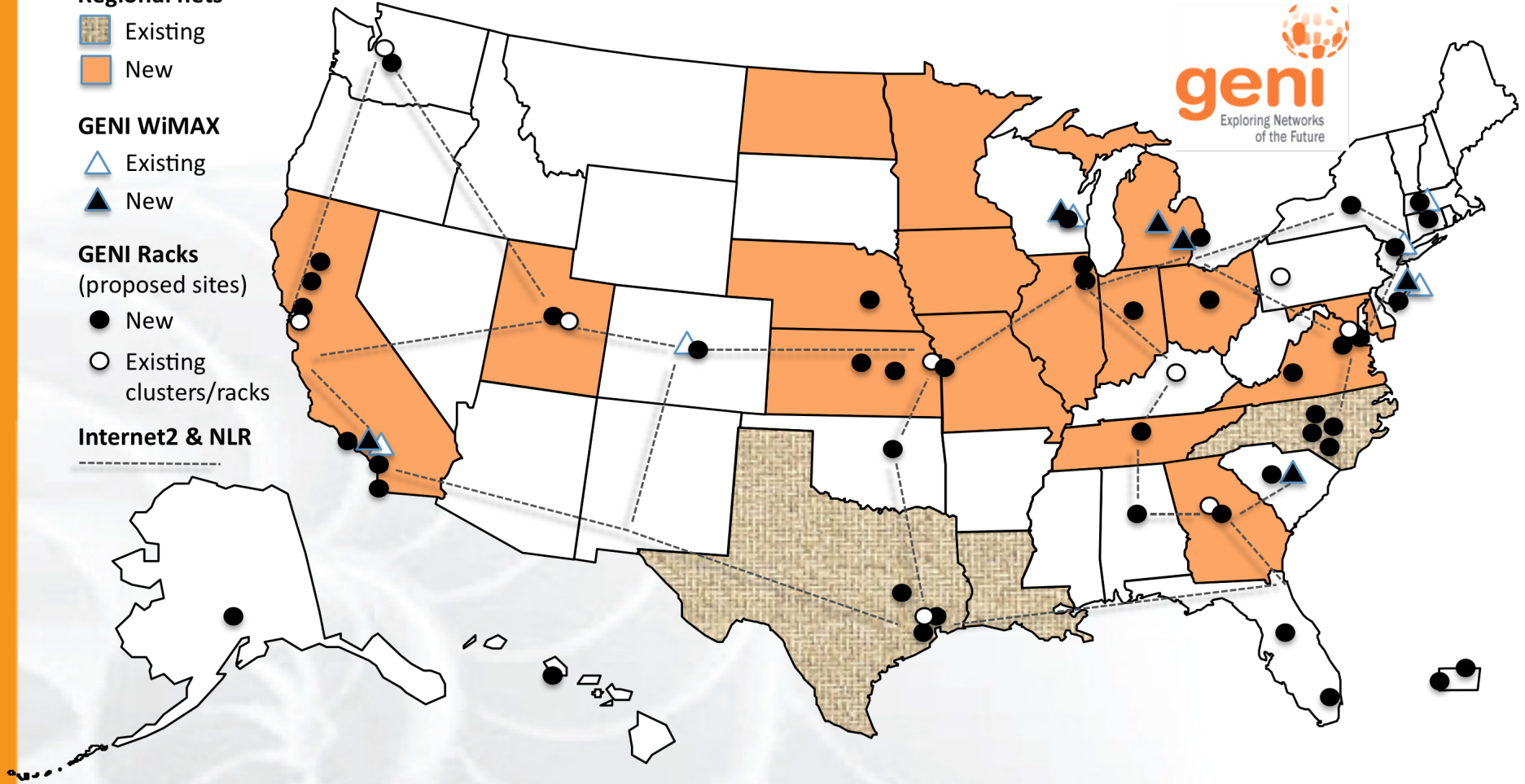
### GENI Racks

(proposed sites)

-  New
-  Existing clusters/racks

### Internet2 & NLR

-----



(as proposed; actual footprint to be engineered)

# Spiral 4 build-outs well underway

## Creating and deploying GENI racks



### ExoGENI Rack

Installed at GPO – Feb 22, 2012



**Ilia Baldine**  
**RENCI**

More resources / rack,  
fewer racks



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

Fewer resources / rack,  
more racks

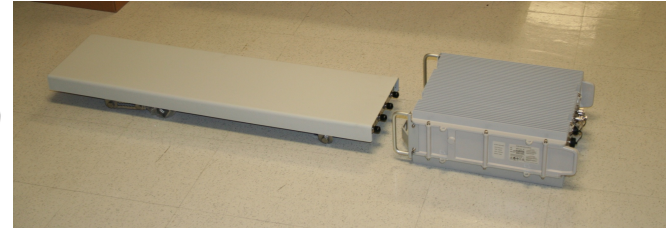


## Spiral 4 build-outs well underway GENI racks in US Ignite cities



- “Starter racks”
  - Eucalyptus based
  - Chattanooga & Cleveland
  - Up & running since Nov 2011
  - Holding the fort until real GENI Racks arrive
- **Mozilla challenge**
  - Create cool US Ignite apps !
  - Stay tuned for Ben Moscovitz of the Mozilla Foundation

# Spiral 4 build-outs well underway Lots more OpenFlow and WiMAX



Courtesy  
WINLAB

- **New OpenFlow builds through US networks**
  - **Eric Boyd**, Internet2
  - **Peter O'Neil**  
National LambdaRail
  - **Jon-Paul Herron**  
Multiple midwestern regionals
  - **David Reese**, CENIC
  - **Steve Corbato**, Utah
  - **James Sterbenz**  
Kansas
  - **Russell Clark**  
Georgia Institute of Technology,  
Southern Light Rail

- **More WiMAX, in midsize deployments**
  - **Ivan Seskar** (*ringleader*)  
Rutgers University
  - **Hongwei Zhang**  
Wayne State University
  - **Suman Banerjee**  
University of Wisconsin,  
Madison
  - **Kuang-Ching Wang**  
Clemson University
  - **Z. Morley Mao**  
University of Michigan

## GENI campus expansion



Dr. Larry Landweber, U. Wisconsin

- **“GENI-enabled” means . . .**  
OpenFlow + GENI racks, plus  
WiMAX on some campuses

- **Current GENI campuses**  
Clemson, Colorado, Columbia,  
Georgia Tech, Indiana,  
Princeton, Kansas State, NYU  
Poly, Rutgers, Stanford,  
UCLA, U MA Amherst, U  
Washington, U Wisconsin
- **CIO Initiative - 19 campuses**  
Case Western, Chicago,  
Colorado, Cornell, Duke,  
Florida International, U Kansas,  
Michigan, NYU, Purdue,  
Tennessee, U FLA, University  
of Houston, UIUC, U MA  
Lowell-Amherst, Utah,  
Washington, Wisconsin
- **Rapidly growing waitlist**



- Collaboration to **implement national-scale infrastructure**
  - sliced and deeply-programmable
  - incorporating OpenFlow/SDN switches, GENI Racks, university datacenters, etc.
  - high-speed (10-100 Gbps initially)
- With software that supports shared use by faculty, students, and campus IT organizations
- Gradual migration from today's "prototype GENI" backbone in Internet2 to a real, production system
- Scaling to an envisioned goal of 100-200 GENI campuses

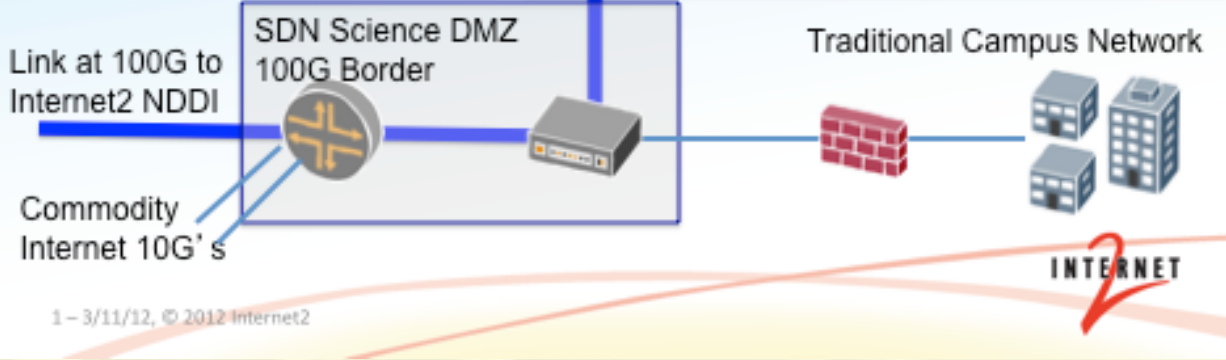
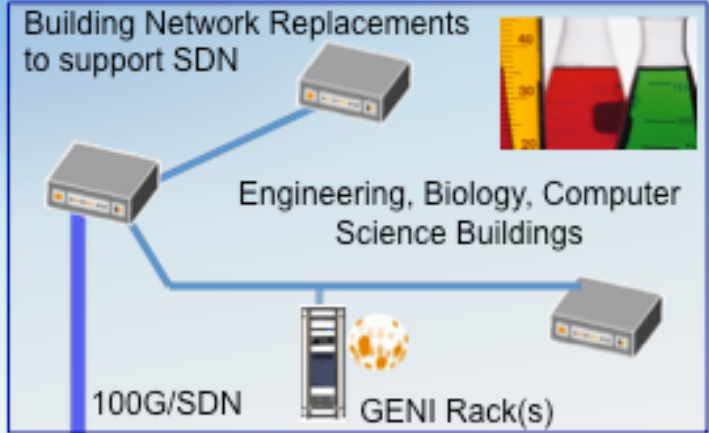
**Opens the door for "at-scale" GENI !**

Note that this agreement does not exclude either party from additional collaborations.



## Innovation Investment on the Campus

- Leading Campuses quickly positioned for OpenFlow / SDN application innovation and data intensive science delivery
- Start with SDN updates in major science buildings
- Support pervasive 100G
- Support Science-DMZ
- Begin "GENI-enabling" campus



1 - 3/11/12, © 2012 Internet2

- Funds campus cyber-infrastructure for domain science **and for computer science**
- Can fund "GENI enabling" your campus!
- Can help build a coherent, end-to-end GENI across the United States
- **Interested? Talk to your CIO !**

- See: <http://www.nsf.gov/pubs/2012/nsf12541/nsf12541.htm>
- Internet2 and GPO can help you engage with your CIO and domain scientists.
- Contacts: [rs@internet2.edu](mailto:rs@internet2.edu) or [larry.landweber@gmail.com](mailto:larry.landweber@gmail.com)





- **Architects Team Charter**

- Define and document GENI's architecture
- Ensure that GENI software implementations and deployments are interoperable & comply with this architecture

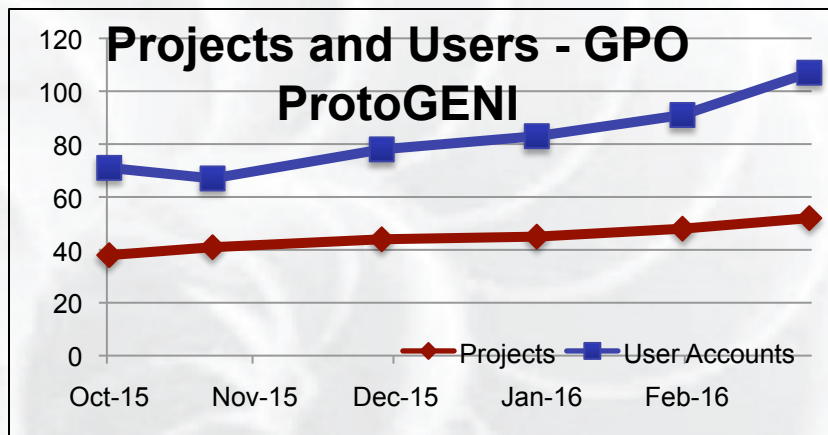
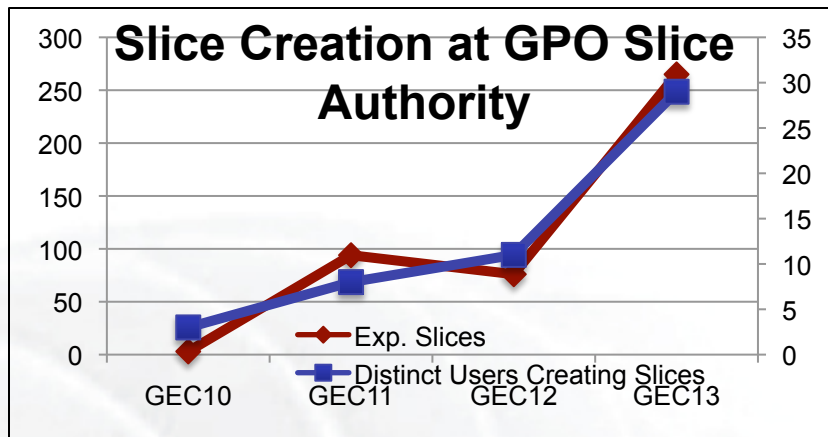
- **Logistics**

- One-year, renewable terms
- Appointed by Project Director
- Most work done between GECs
- Inputs & help encouraged
- Documents approved at formal meetings (minutes published)

- **Initial membership**

- Rob Ricci, Marshall Brinn, co-chairs
- Jeff Chase, Larry Peterson, Max Ott, Nick Bastin, Chip Elliott, voting members
- Aaron Helsinger, Tom Mitchell, non-voting members

# Using GENI for research and education



- Experiments ramping up
- Faculty starting to incorporate GENI into distributed computing and networking classes
- But right now GENI is too hard to use
- Focus: “GENI should *make easy things easy* and make hard things possible”
- Interested? come to the **Experimenter Roundtable**

# Using GENI for research and education

## Creating an experimenter “code of ethics”

Version 0.9

GENI GSAT Project

March 11, 2012

### GENI Experimenter’s Code of Ethics

Commitment to ethical professional conduct is expected of every researcher using the GENI infrastructure. All GENI participants, whether using the infrastructure for research, education, or contributing to the infrastructure development, prototyping or operations, must agree to the following guidelines:

1. Avoid conducting experiments that are harmful to other GENI participants, the GENI infrastructure, or the Internet.

Experiments with negative consequences are those intended or understood to cause loss of availability, loss of data, or destruction or modification of GENI software, hardware, or networks. Illegal activities also are harmful to GENI participants. Additionally, these experiments result in unnecessary expenditure of researcher and operator effort to determine the cause of problems and to restore the system to its proper operational state.

2. Coordinate security experiments in advance with GENI operators.

Security experiments often rely upon simulated or actual attacks against enforcement mechanisms including authentication, access control, or intrusion detection systems. Because these attacks may be detected and accidentally trigger false alarms; or in the worst case, be misdirected against operational GENI infrastructure, operators of the selected aggregates, networks, control frameworks and/or GMOC must be contacted **prior** to execution.

3. Respect the privacy and confidentiality of other GENI participants and users.

Experiment artifacts, including source code, binaries, and data stored or transmitted on GENI belong to the researchers or end-users who created them. Others should not access these artifacts until explicitly released for use.

4. Access GENI resources and services only when authorized.

Different researchers may be granted access to various parts of the GENI infrastructure, or to standard or experimental GENI services. All access to GENI resources should be through interfaces and services provided for this purpose, including GENI standard mechanisms and control framework or aggregate specific extensions or alternatives. Bypassing access controls or escalating privilege without the knowledge and consent of the operators is never permitted. Authorizing parties, operators, principal investigators and others are responsible for granting the appropriate authorizations to researchers to enable them to conduct their experiments.

Failure to follow this code will result in loss of access to GENI resources.

1

- We’ve already begun to have some issues
- Draft by Steve Schwab, ed.
- Based on PlanetLab & Emulab experience
- Discussed yesterday in Security Experimentation meeting
- All are welcome to participate in the process

<http://groups.geni.net/geni/attachment/wiki/GENISecurity/experimenters-code-of-ethics-draft-0.9.pdf>

- **Kaiqi Xiong, RIT**
  - First GENI Research and Educational Experiment Workshop
  - Thurs / Friday (here)
- **Jeannie Albrecht, Williams**
  - Curricula for Undergraduate Courses in Distributed Systems
  - before GEC 14 (Boston)
- **Nick Feamster, GA Tech**
  - “Living lab”
  - Being planned
- **ACM SIGCOMM 2012**
  - Workshop on Hot Topics in Software Defined Networking
- **ICC 2012**
  - Workshop on Software Defined Networks (SDN'12)
- **ICCCN 2012**
  - Track on Network Architectures and Clean-Slate Designs
- **TridentCom 2012**
  - Testbeds, Experimentation and Innovation for the Future Internet

Special issue on Future Internet Testbeds –  
**Computer Networks**, James P. G. Sterbenz et al, eds.

## Using GENI for education Funding GENI undergrads (REUs)

- Great opportunity to fund undergraduate research
  - You can fund your undergrads to participate in GENI
  - Typically requests support for  $\leq 2$  undergrads for 1 year
  - They must be citizens or permanent residents of the United States or its possessions
  - Rough guideline: support averages about \$8,000 per student per year, which might include \$6,400 for student stipend support and \$1,600 (or 25%) for administrative costs
- How to request funds
  - First come, first served!
  - **Eligibility** – you may submit a REU proposal to the GPO if you have a GPO subcontract under Solicitation 1 or 3 (not ARRA funding – sorry)
  - **How to** – fill in template and email to GPO (see Henry Yeh email, 3/5/12 2:55 PM)
  - **Deadline: March 16, 2012**
  - Detailed information on REU funding:  
<http://www.nsf.gov/pubs/2009/nsf09598/nsf09598.pdf>

- **US Ignite Apps Challenge**  
**Ben Moskowitz**, Mozilla Foundation
- **Probe**, **Rob Ricci**, University of Utah
- **PrimoGENI Demo**  
**Jason Liu**, Florida International University
- **Named Data Networking (NDN) Demo**  
**Patrick Crowley**, Washington University