



Building the At-Scale GENI Testbed

Mark Berman
July 23, 2012
www.geni.net


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Panel: Building the At-Scale GENI Testbed

- Mark Berman (GENI Project Office, Cambridge)
 - Building the At-Scale GENI Testbed
- Mike Zink (University of Massachusetts, Amherst)
 - ExoGENI and GIMI: GENI Racks and Their Measurement and Instrumentation Tools

- Andy Bavier (Princeton University)
 - GENI Racks: InstaGENI Design and Deployment and Changes to the PlanetLab networking model
- Ivan Seskar (Rutgers University)
 - GENI WiMAX
- Joe Mambretti (Rutgers University)
 - Slice Around The World

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Outline: Building the At-Scale GENI Testbed

- GENI – A Quick Introduction
- Experiment Update
- Steps Toward At-Scale GENI
- Getting Involved

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What is GENI?

- 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 services
- Key GENI concepts: slices & deep programmability
 - Internet: open innovation in application programs
 - GENI: open innovation deep into the network

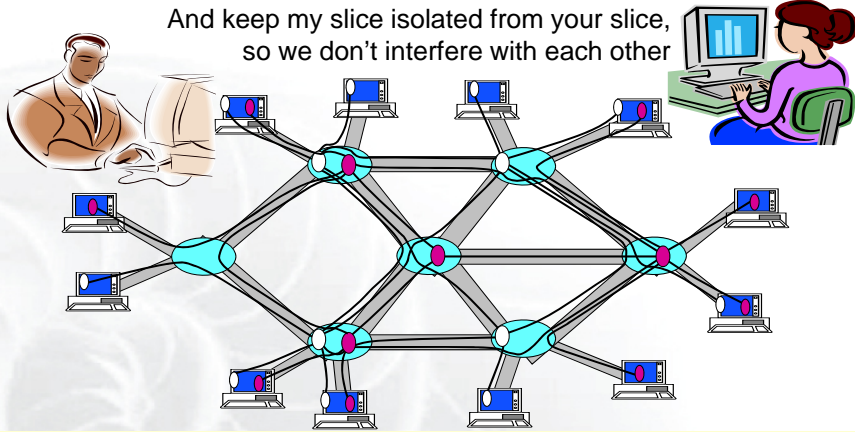
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Exploring Networks
of the Future

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

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GENI's Basic Abstraction for Experiments

What GENI gives experimenters

A constellation of general-purpose computers, connected in experimenter-specified topologies via a programmable layer two network

- Geographic diversity
- Computers may be bare metal or virtualized (multiple virtualization options)
- IP (layer three) networking available
- Internet connectivity (and opt-in users) available
- Multiple options for network virtualization

There are many additional capabilities (e.g., wireless access, instrumentation, special purpose components, ...) and some caveats.

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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!*

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GENI Enables Experiments

- 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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Rapid Growth in Experimentation (and Consistent Experimenter Wish List)

- **GENI is gaining traction with experimenters.**
 - More experimenters are signing up for credentials.
 - More experimenters are actively using GENI.
- **Experienced experimenters are pushing up against some limits. They want access to more GENI resources.**
 - More deeply programmable sites
 - More compute resources
 - Long-lived slices




Planned GENI expansion significantly enhances experiment opportunities.

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Sample Experiment – Novel Routing: Pathlet Architecture

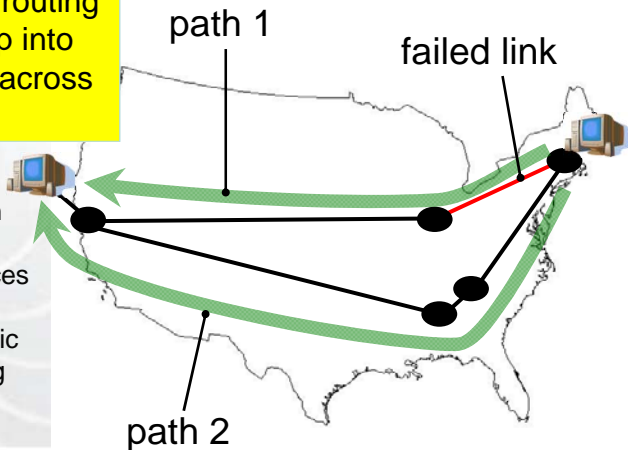


Resilient Routing in the Pathlet Architecture

Ashish Vulimiri and Brighten Godfrey
University of Illinois at Urbana-Champaign

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




path 1

failed link

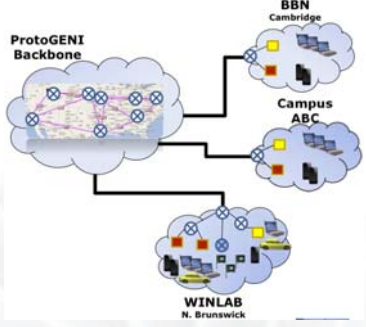
path 2

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Exploring Networks of the Future


Sample Experiment – Future Internet Protocols: Mobility First Future Internet Architecture



Experiment topology mapped onto GENI slice

Validate key algorithms over layer two network

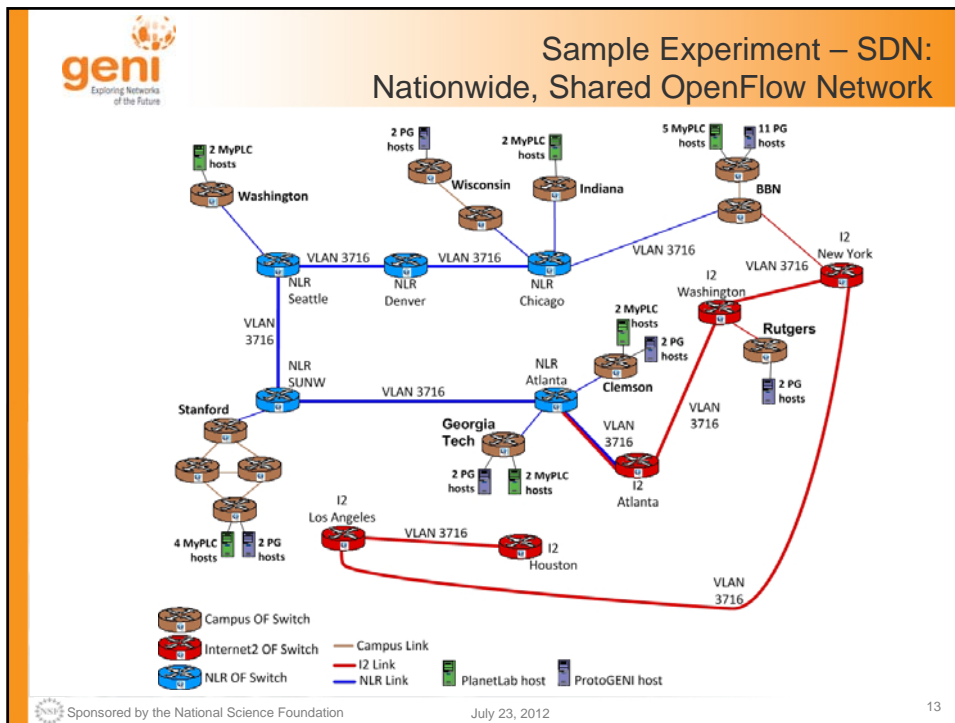
- Realistic RTTs
- Variety of link speeds and access network technologies




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GENI Spiral 4

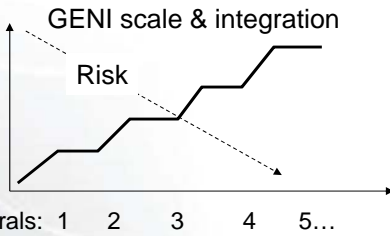
Start the transition to "real GENI"



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.

GENI scale & integration




Spirals: 1 2 3 4 5...

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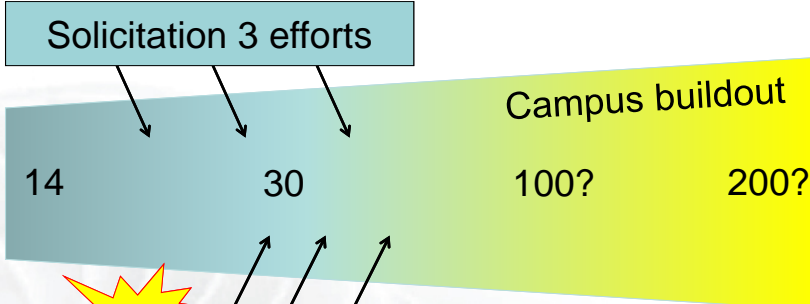
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Growing GENI to 100-200 campuses

GENI racks, OpenFlow, WiMAX, training, ops

Solicitation 3 efforts



14
30
100?
200?

NEW

Campus expansions

GENI racks, OpenFlow, WiMAX, training, ops

Spiral development . . .

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Spiral 4 build-outs well underway Growing GENI's footprint


(as proposed; actual footprint to be engineered)

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Spiral 4 build-outs well underway Creating and deploying GENI racks

ExoGENI Rack
Installed at GPO – Feb 22, 2012




Ilia Baldine
RENCI
ExoGENI
More resources / rack,
fewer racks






Rick McGeer
HP Labs
InstaGENI
Fewer resources / rack,
more racks





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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


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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
- **Ongoing CIO initiative to identify new campuses for GENI-enabling**
- **Rapidly growing waitlist**


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 GENI Engineering Conferences
We welcome your participation in creating GENI


- **15th meeting, open to all:
October 23-25, 2012, Houston, Texas**
 - Tutorials
 - Planning & discussion for experimenters, software, infrastructure
 - Continue planning for ongoing international collaboration (Paul Müller is a co-chair of this group)



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Start Your Experiment!

Learn how to use GENI


- Attend tutorials
- Visit the wiki:
 - <http://groups.geni.net/geni/wiki/GeniExperimenterWelcome>

Get an account

- Instructions on wiki


Start experimenting

- Try a sample experiment
- Help is available
 - help@geni.net



Welcome GENI Experimenters!
 The Global Environment for Network Innovations - GENI - is a suite of research infrastructure rapidly taking shape in prototype form across the United States. It is sponsored by the National Science Foundation, with the goal of becoming the world's first laboratory environment for exploring future internets at scale, thereby promoting innovations in network science, security, technologies, services and applications.
You are why GENI is here.
 Remember that GENI is a virtual laboratory, and what's a laboratory without experiments? So, thank you for using GENI for your experiments.
Resources for experimenters
 We're here to help. If you have questions or get stuck, please e-mail us at help@geni.net.
 Here are some pointers to GENI information that may help you get started.


- If you need GENI credentials, follow the instructions at [SignHelp](#).
- If you are new to GENI, you may want to check the new [Experimenter Q&A](#).
- The page [UnderstandingGENI](#) has information about how you can get started and run your experiment in GENI, including a catalog of resources.
- A community support mailing list for experimenters can be found [here](#).



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