



GENI

Exploring Networks of the Future

Future internet architectures - going live!

Vic Thomas
IFIP WG 10.4 – January 2011 Meeting
www.geni.net

Global networks are creating extremely important new challenges

Science Issues

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



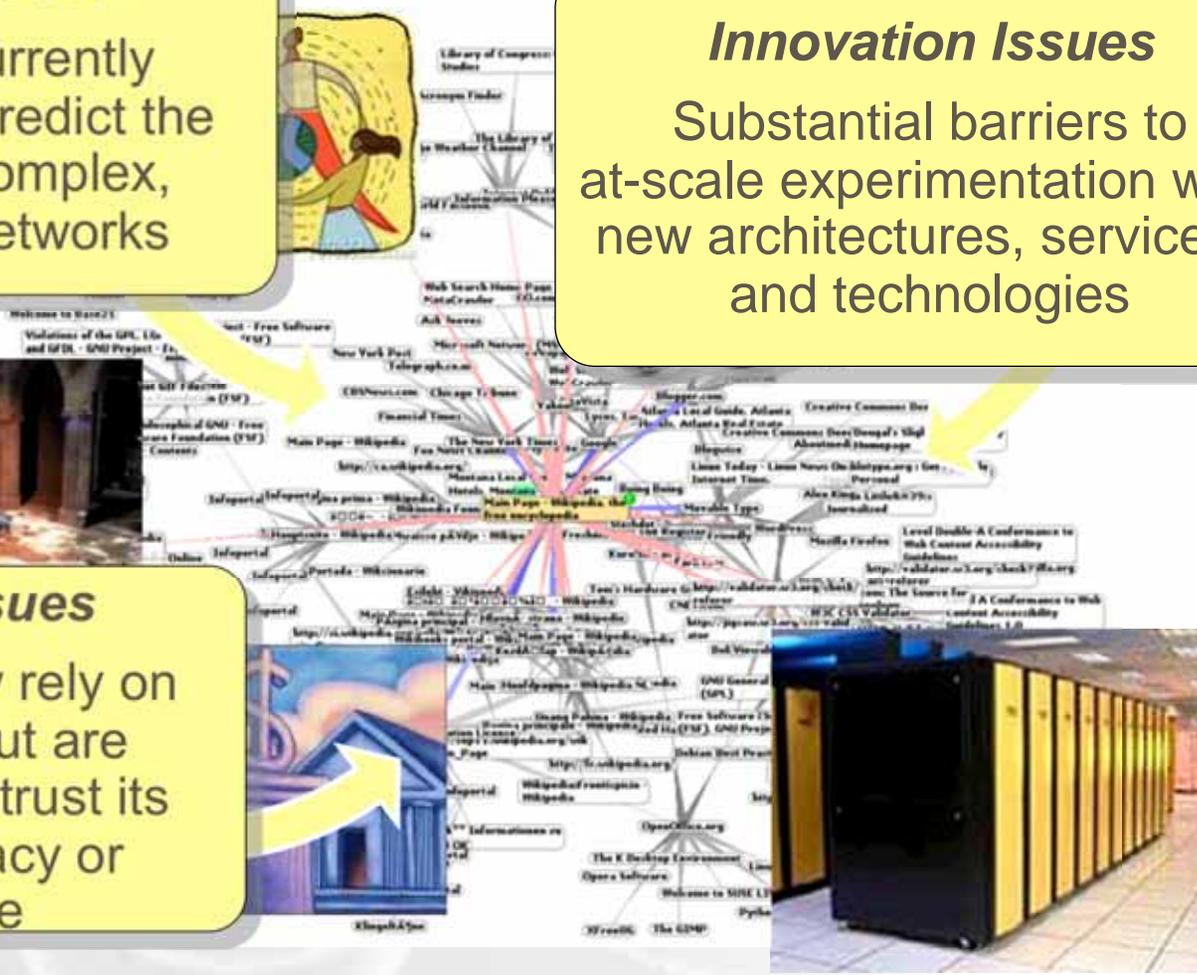
Innovation Issues

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



Society Issues

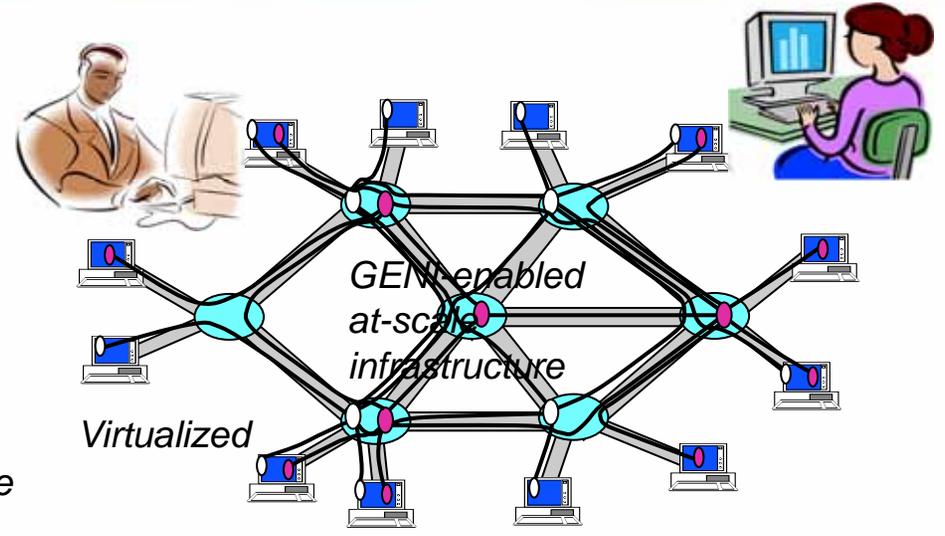
We increasingly rely on the Internet but are unsure we can trust its security, privacy or resilience



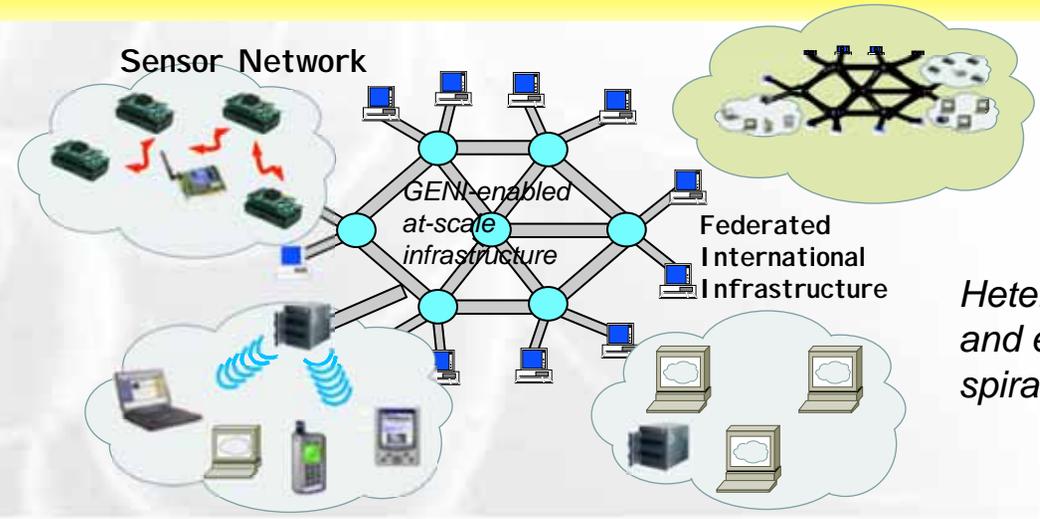
- GENI is a virtual laboratory for **exploring future internets at scale**, now rapidly taking shape in prototype form across the United States
- GENI is meant to enable . . .
 - **At-scale experiments**, which may or may not be compatible with today's Internet
 - **'Opt in' for real users** into long-running experiments
 - Excellent **instrumentation and measurement** tools
 - **Large-scale growth for successful experiments**, so good ideas can be shaken down at scale

GENI Conceptual Design

Infrastructure to support at-scale experimentation



Programmable & federated, with end-to-end virtualized "slices"



Heterogeneous, and evolving over time via spiral development

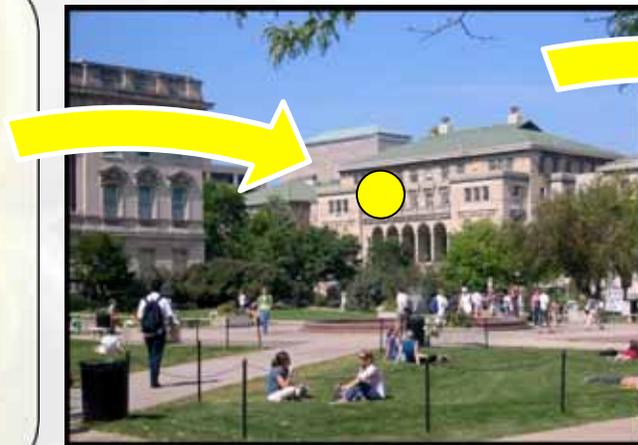
- **How can we afford / build GENI at sufficient scale?**
 - Clearly infeasible to build research testbed “as big as the Internet”
 - Therefore we are “GENI-enabling” testbeds, commercial equipment, campuses, regional and backbone networks
 - **Students are early adopters / participants in at-scale experiments**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

GENI is rapidly taking shape across the US

GENI-enabling testbeds, campuses, and backbones





Spiral 2 infrastructure examples

Building the GENI Meso-scale Prototype

OpenFlow

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

ShadowNet

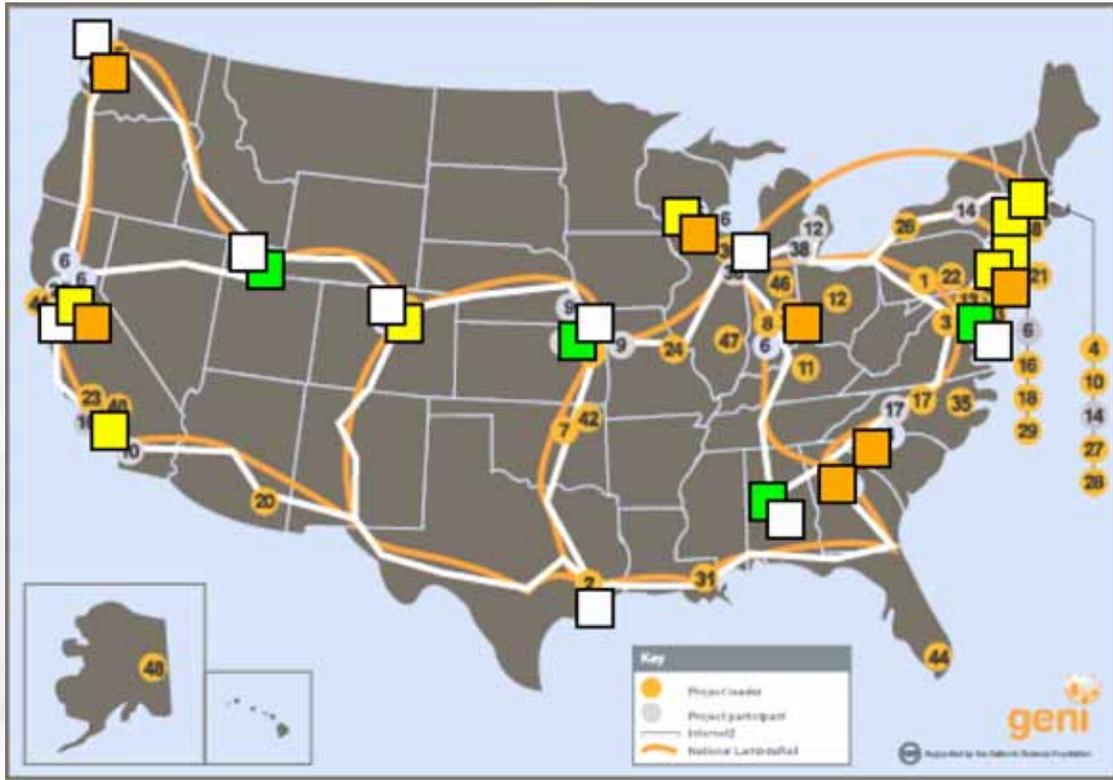
- Salt Lake City
- Kansas City
- DC
- Atlanta

WiMAX

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

OpenFlow Backbones

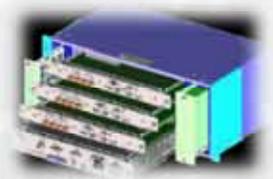
- Seattle
- Salt Lake City
- Sunnyvale
- Denver
- Kansas City
- Houston
- Chicago
- DC
- Atlanta



HP ProCurve 5400 Switch



Juniper MX240 Ethernet Services Router



NEC WiMAX Base Station



Toroki LightSwitch 4810



Arista 7124S Switch

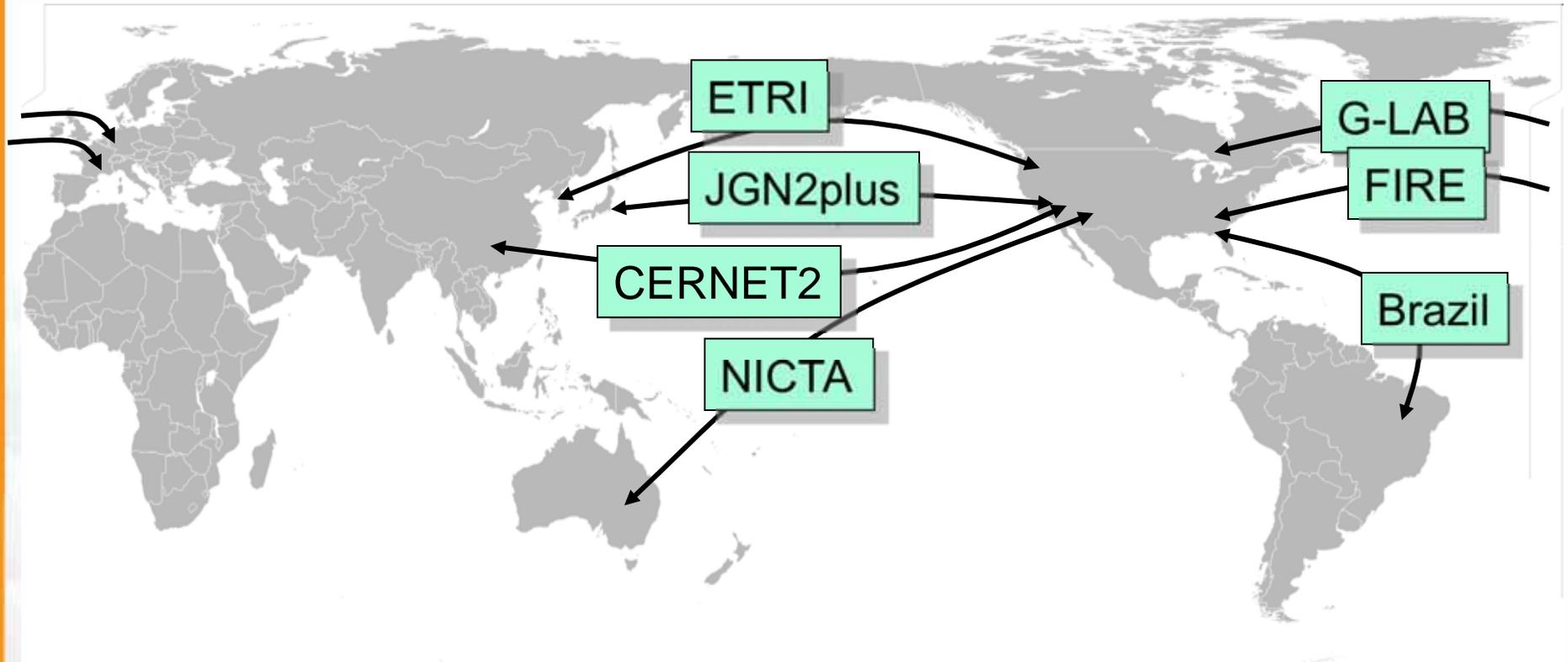


NEC IP8800 Ethernet Switch

Growing to the “at scale” GENI

- 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

These are exciting times
all around the world!



The GENI project is actively collaborating with peer efforts outside the US, based on equality and arising from direct, “researcher to researcher” collaborations.

- **Run experiments on GENI**
 - Shakedown experiments in progress
- **Affiliate your infrastructure or testbed**
 - You own / operate your testbed, and “affiliate” into GENI
- **Help design GENI**
 - Working Groups, open to all
- **Participate in a GENI Engineering Conference**
 - Open to all; Working group meetings, integrated demos, tutorials and workshops

- **Security**
 - Prevent GENI resources being used as launch pads for attacks
 - Supporting security experiments
 - Diversity of capabilities of organizations in the federation
- **Resource availability**
 - Resources often owned by research groups with no dedicated operations staff
- **Transitioning to community governance**
 - Federation of diverse organizations