geni
Exploring Networks of the Future

GENI

Integration of Clouds and Cyberinfrastructure

Chip Elliott
GENI Project Director
www.geni.net

Sponsored by the National Science Foundation

The world is undergoing a profound transformation

- "Cloud" becoming a planetary-scale information utility
  - Services oriented (*aaS)
  - Abstraction of infrastructure
  - Virtualized with multi-tenancy
  - Elastic & dynamic
- Looking ahead . . .
  - "the inter-cloud"
  - the cyber-physical cloud

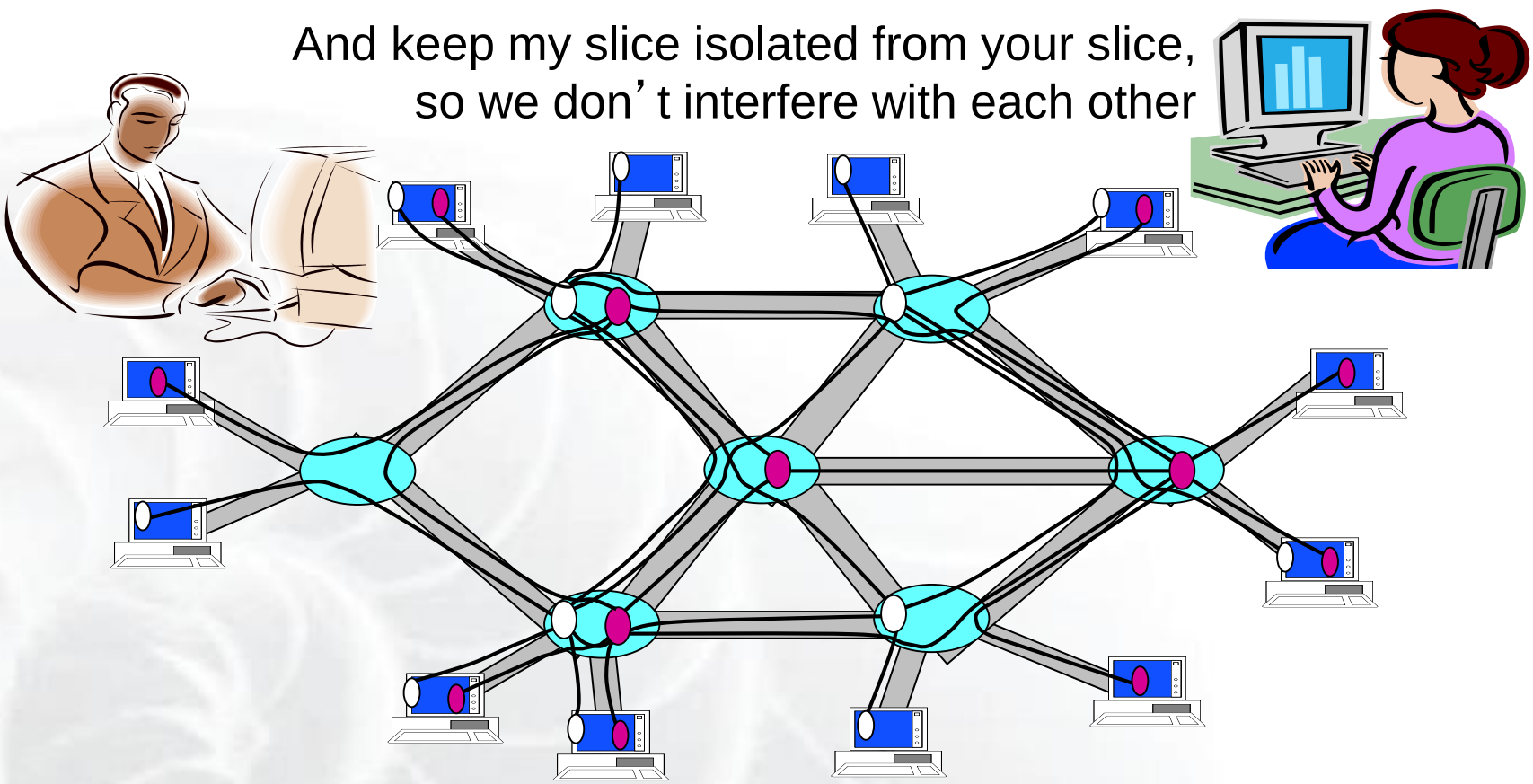
Cloud = tremendous commercial innovation
& **<u>huge challenges & opportunities</u>**

- Planetary scale will transform computer science research
- Timeline: 10-15 years to realize the full vision
- Huge new research opportunities and challenges

Slices and Deep Programmability

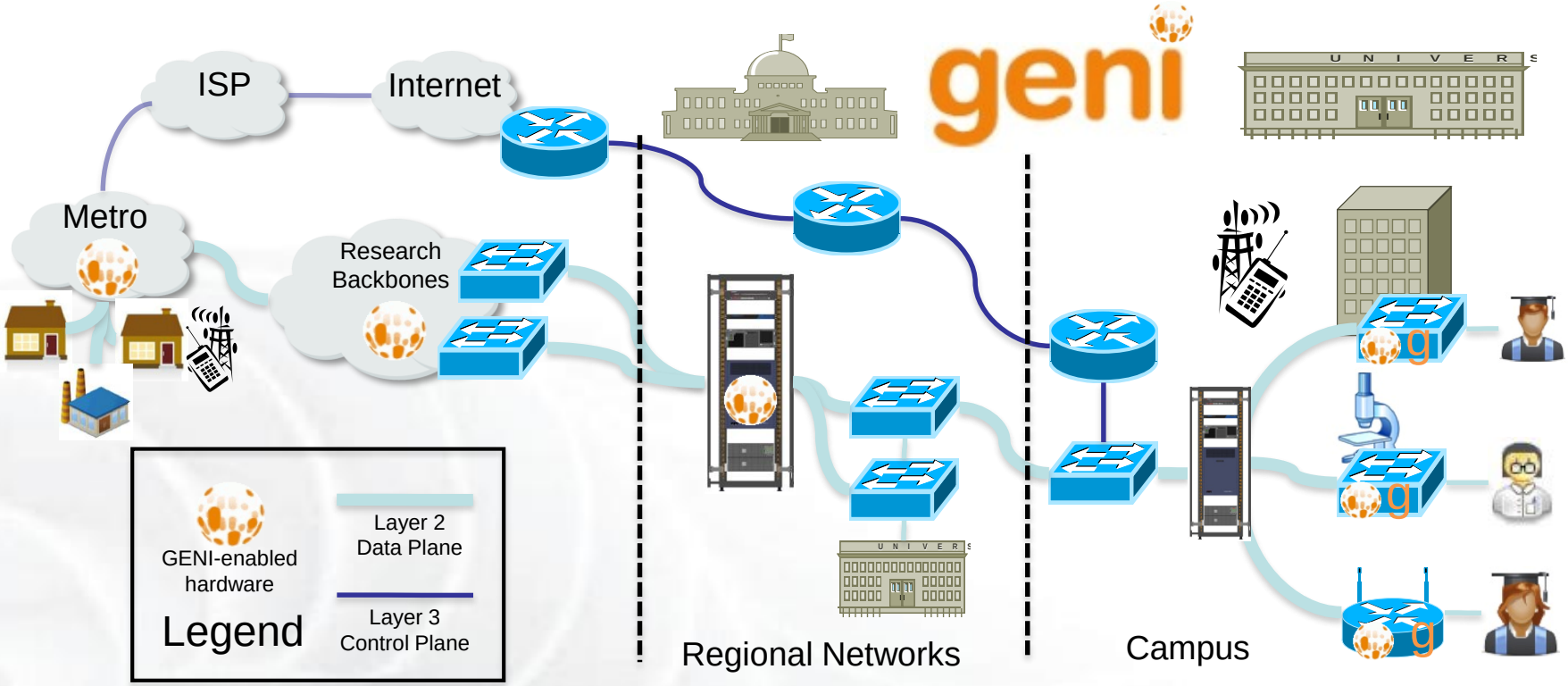
Install the software I want *throughout* my network slice (into firewalls, routers, clouds, …)

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



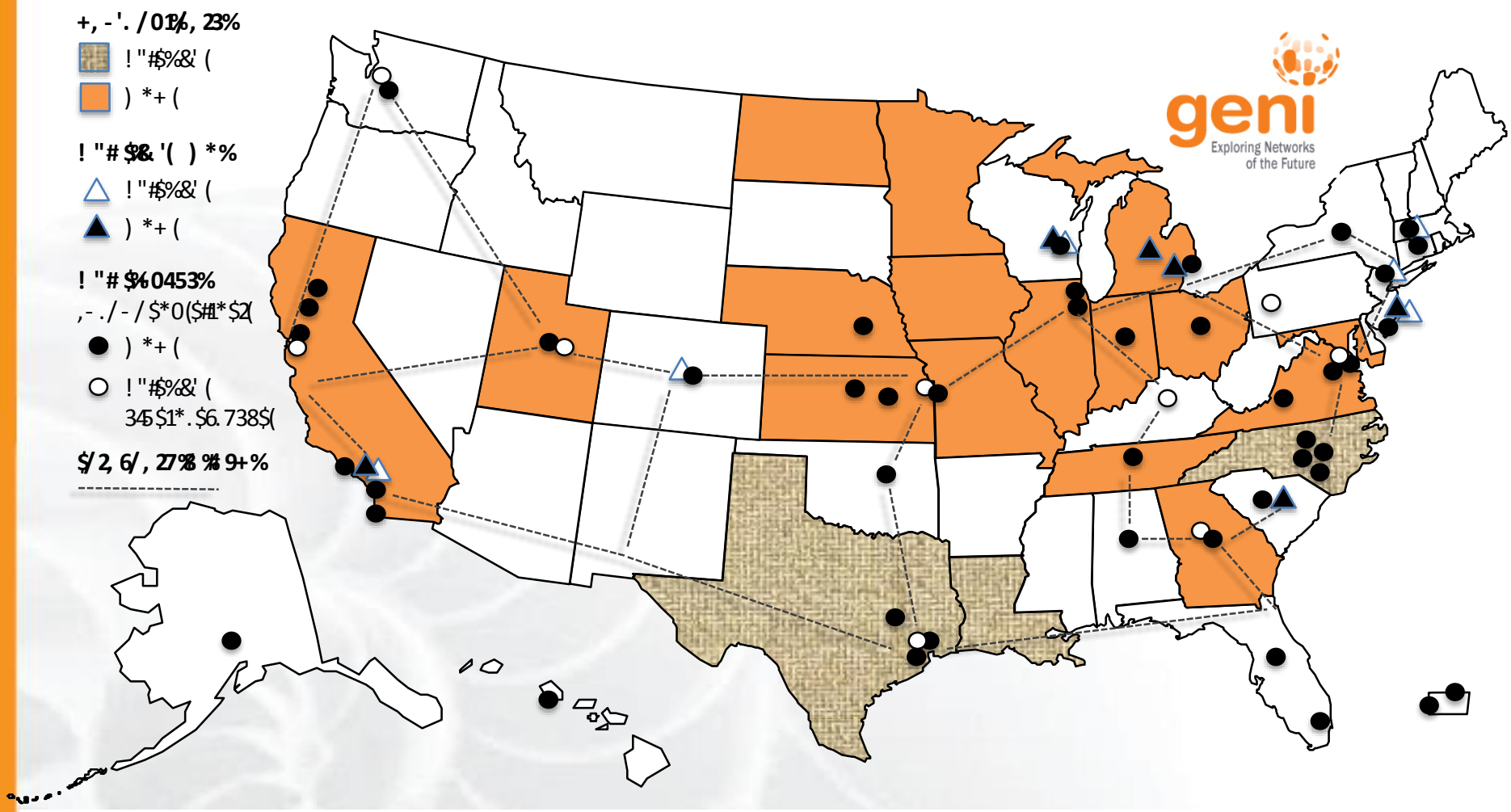
We can run many different "future internets" in parallel

Building upon the GENI federation



- 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.

Build-outs well underway
Growing GENI's footprint

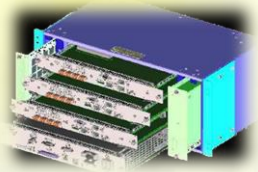


(as proposed; actual footprint to be engineered)

Key challenge: "at scale"

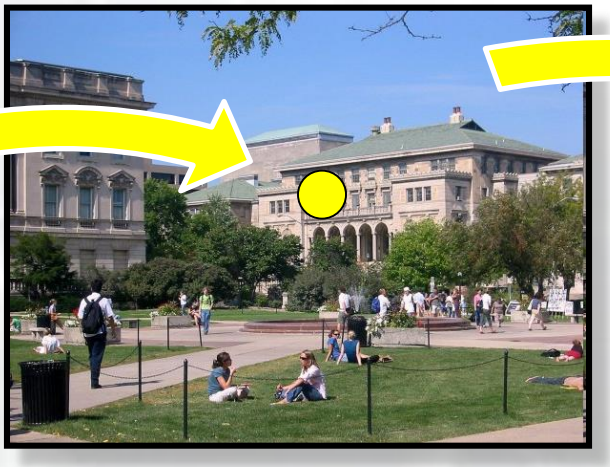
- **How can we afford / build GENI at sufficient scale?**
  - Clearly infeasible to build research testbed "as big as the Internet"
  - Therefore we are "GENI-enabling" testbeds, commercial equipment, campuses, regional and backbone networks
  - **Students are early adopters / participants in at-scale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

HP ProCurve 5400 Switch

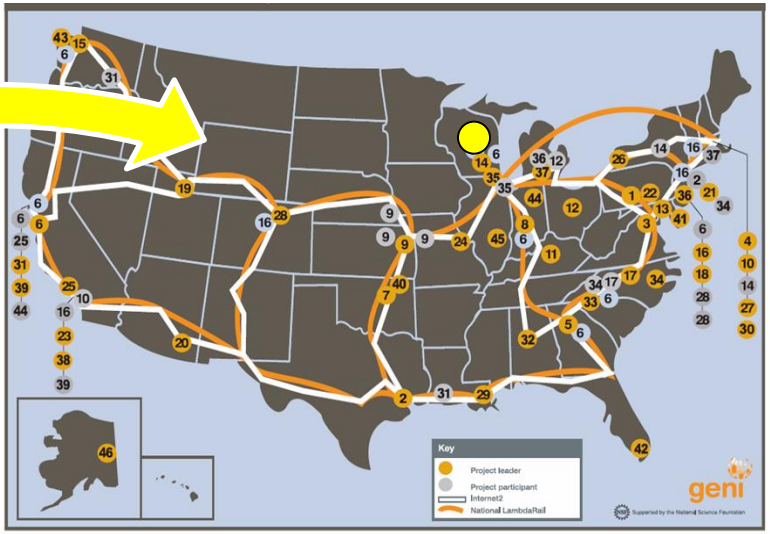


NEC WiMAX Base Station

GENI-enabled equipment



GENI-enabled campuses, students as early adopters



"At scale" GENI prototype

Rapidly growing to 100 – 200 campuses

- Planning for expansion to 100-200 campuses
- Currently engaging many university CIOs in this "campus expansion" phase
- "GENI-Enabling Campus Initiative," supported by NSF, currently has 25 participating Universities
  - education (CIO Workshops)
  - training (Network Engineer Workshops)
  - consulting (two-person mentor teams to 20 universities – CIO and researcher participation required)
- Over 35 others have indicated a strong interest in the idea of "GENI-enabling" their campuses
- Discussions underway with key companies

Backup slides

GENI enables “at scale” research in areas of critical national importance

Science Issues

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

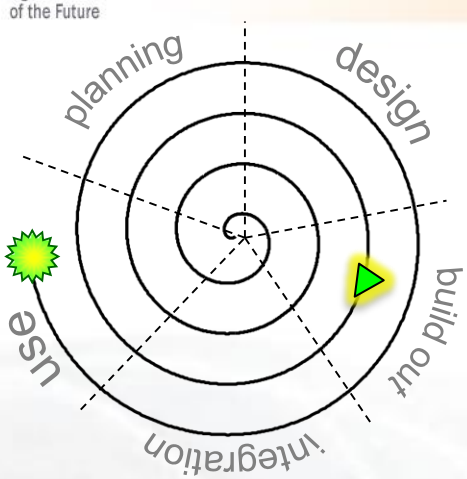
Innovation Issues

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

GPO Strategy for achieving GENI Vision



GENI Prototyping Plan

1. Create a rapid series of GENI Spirals, “co-evolving” them with experiments and the evolving research vision

2. Stimulate broad community participation within the GPO-led engineering framework

3. Build a strong academic / industrial base to prepare for at-scale buildout

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**

Ramping up experimenter workshops and training sessions for IT staff

Network Engineers “boot camp” on the day before GEC 12, organized by Larry Landweber and given by Matt Davy and Steve Wallace, Indiana University

- GPO funding 3 workshops / year by Indiana University
- Goal: train IT staff on OpenFlow and (when available) GENI racks
- At GEC 12 in Kansas City:

Case Western Reserve	Cornell
Duke	Florida International
NYU	Purdue
Univ Chicago	Univ DC
Univ Florida	Univ Houston
UIUC	Univ Colorado
Univ Kansas (Lawrence)	Univ Massachusetts, Lowell
Univ Massachusetts, Amherst	Univ Michigan
Univ Tennessee, Chatanooga	Univ Utah
Univ Washington	Univ Wisconsin, Madison

- 35 additional schools have expressed interest and are on waitlist