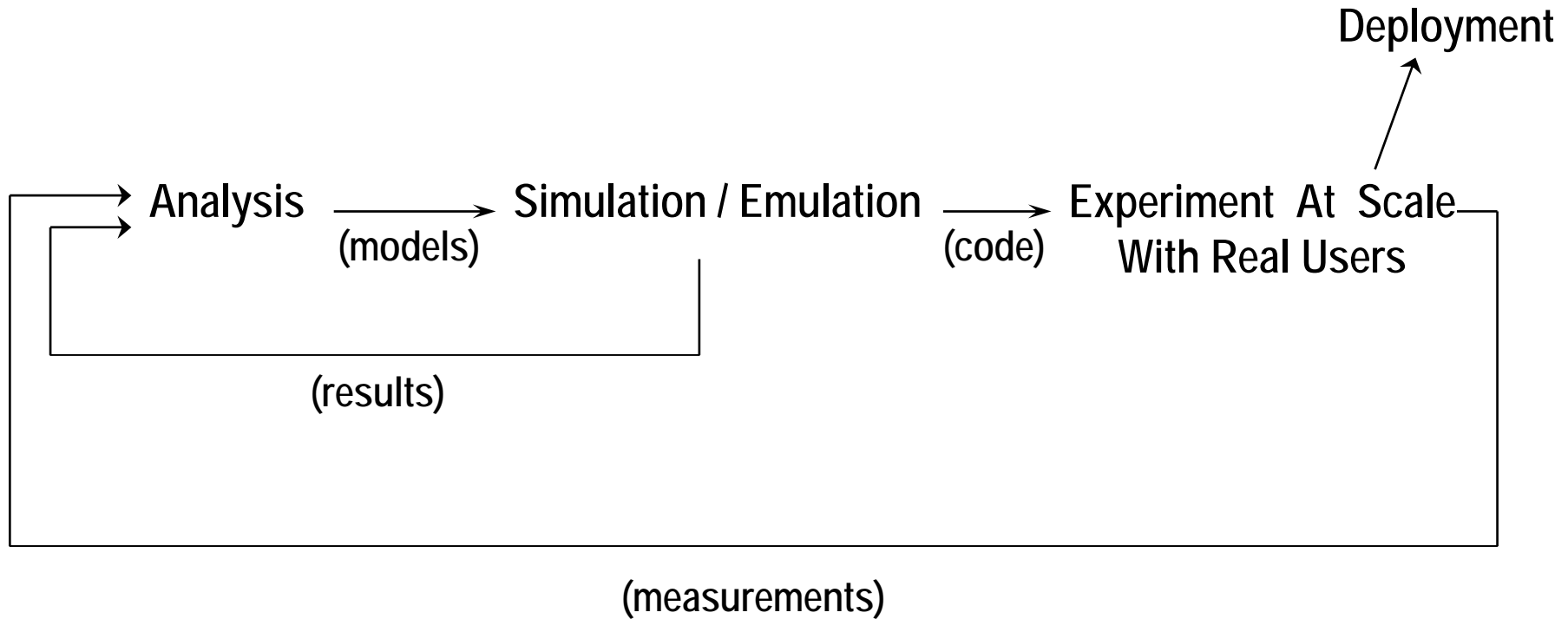


GENI Ecosystem: From Instrument to Architecture

Larry Peterson
Princeton University

June 19, 2007

Validation Gap



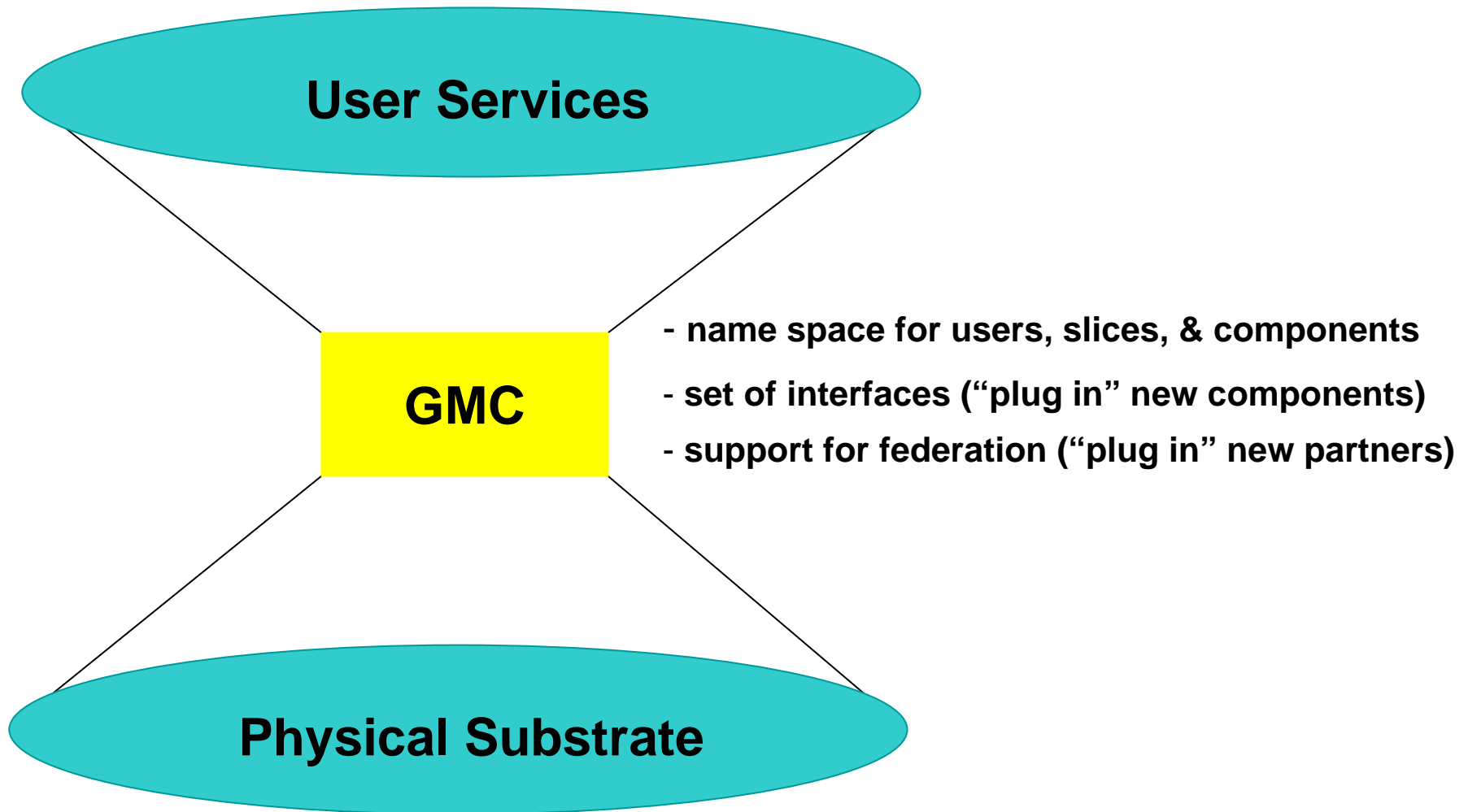
NSF Initiative

- Proposal to NSF's Large Projects Office
- There are rules...
 - first spec, then build
 - owned and operated by NSF
 - clear separation between research and facility

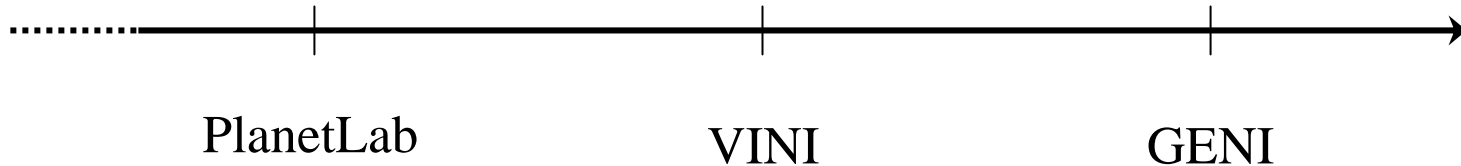
GENI Ecosystem

- Continual design process
 - evolve based on experience
- Accommodate other...
 - technology partners
 - capacity partners
 - user communities
- Research & infrastructure: two sides of same coin
 - infrastructure enables research
 - research improves infrastructure

GENI Architecture



Ecosystem in Progress



Programmability & virtualization deep in the network

Two views of PlanetLab

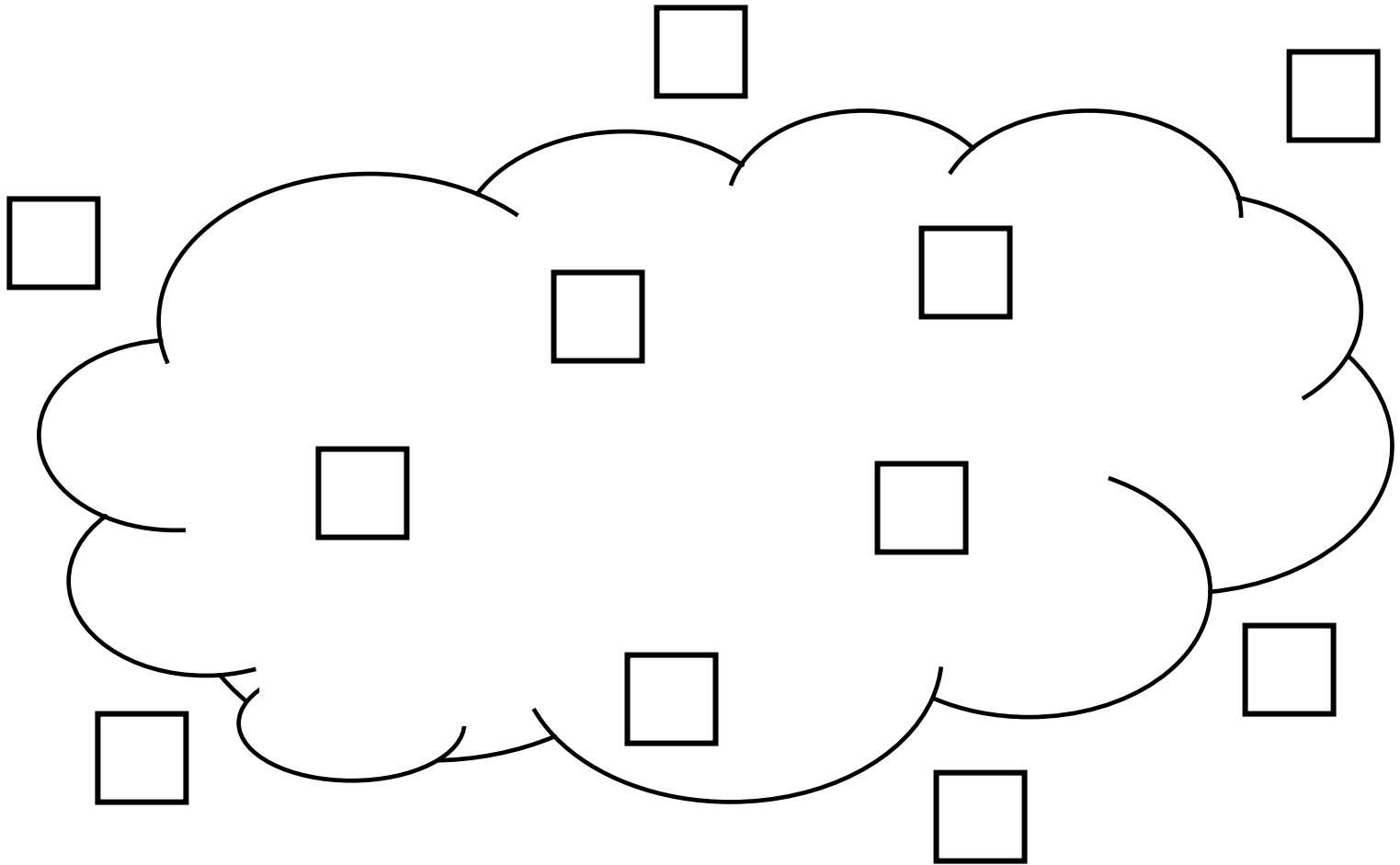
- useful research instrument
- prototype of a new network architecture

PlanetLab

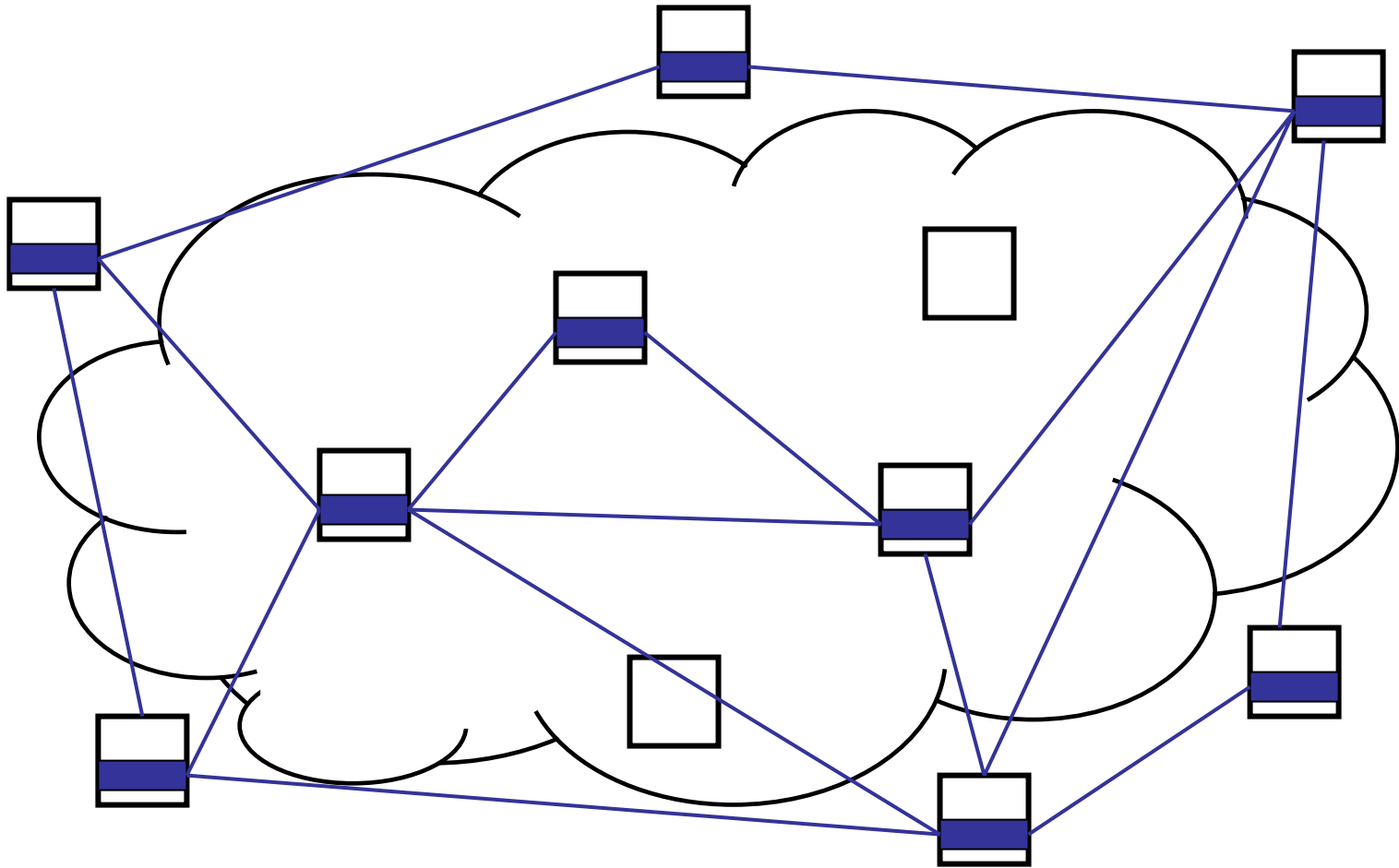


- 800 machines spanning 390 sites and 40 countries
- Supports *distributed virtualization*
each of 600+ network services running in their own *slice*

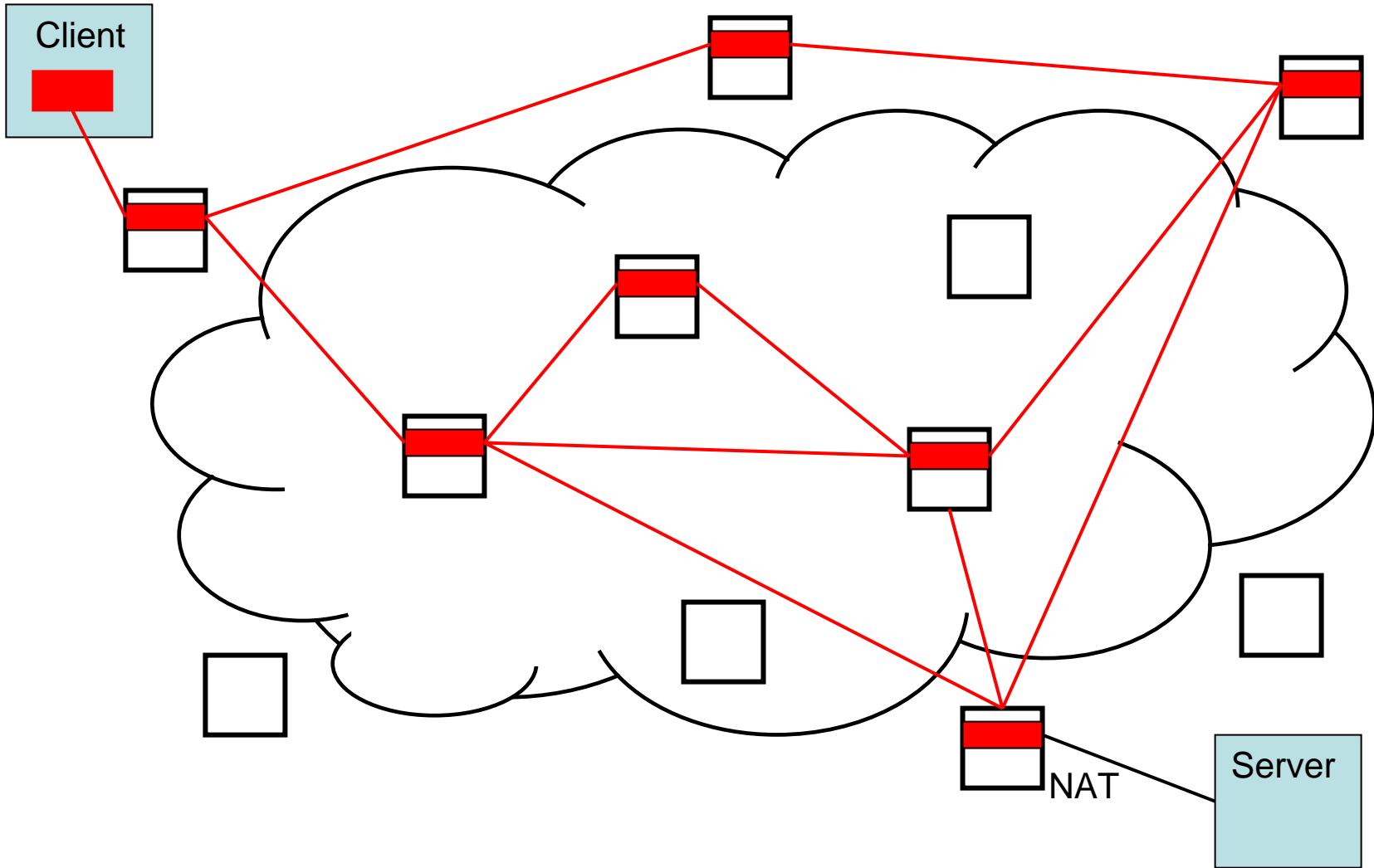
Slices



Slices



User Opt-in



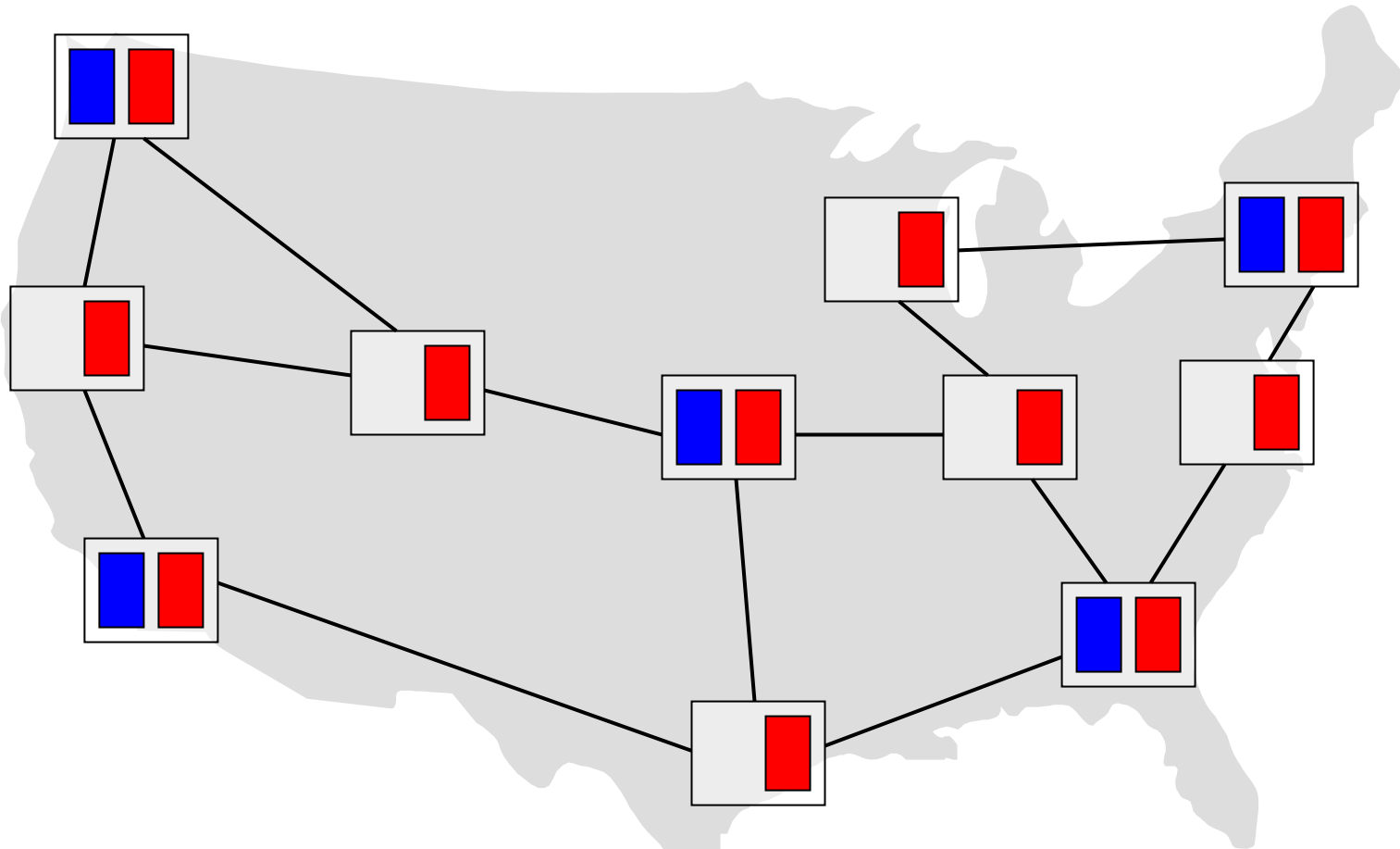
Usage Stats

- Users: 2500+
- Slices: 600+
- Long-running services: ~20
 - CDN, file download, multicast, pub-sub, routing overlays...
- Bytes-per-day: 4 TB
- IP-flows-per-day: 190M
- Unique IP-addr-per-day: 1M

Lessons Learned

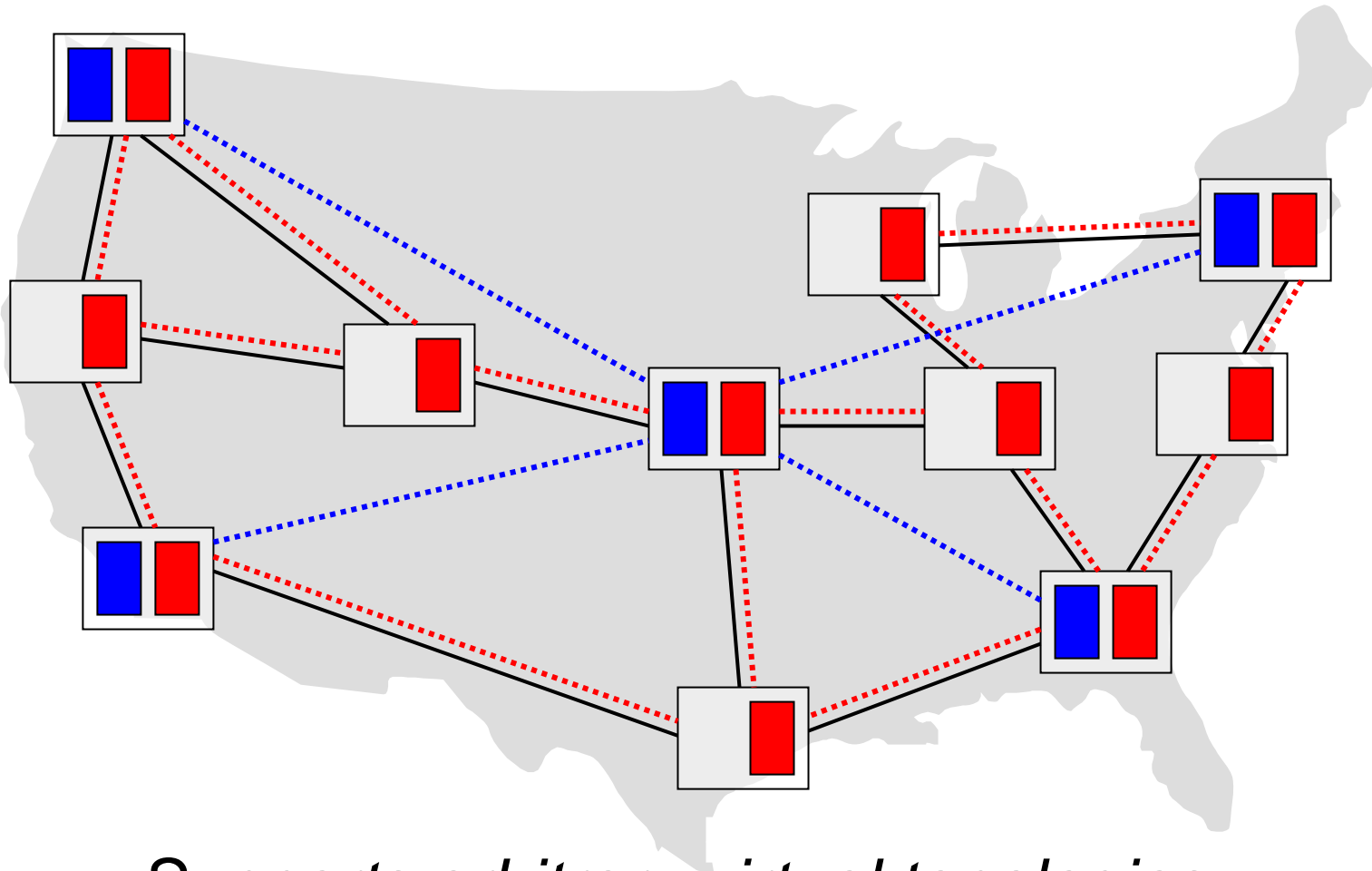
- Trust relationships
 - owners, service providers, operators
- Decentralized control
 - owner autonomy
 - delegation
 - federation
- Virtualization
 - scalability is critical
 - control plane and node OS are orthogonal
 - least privilege in support of management functionality
- Resource allocation
 - decouple slice creation and resource allocation
 - best effort + overload protection

VINI - “PlanetLab on Layer 2”



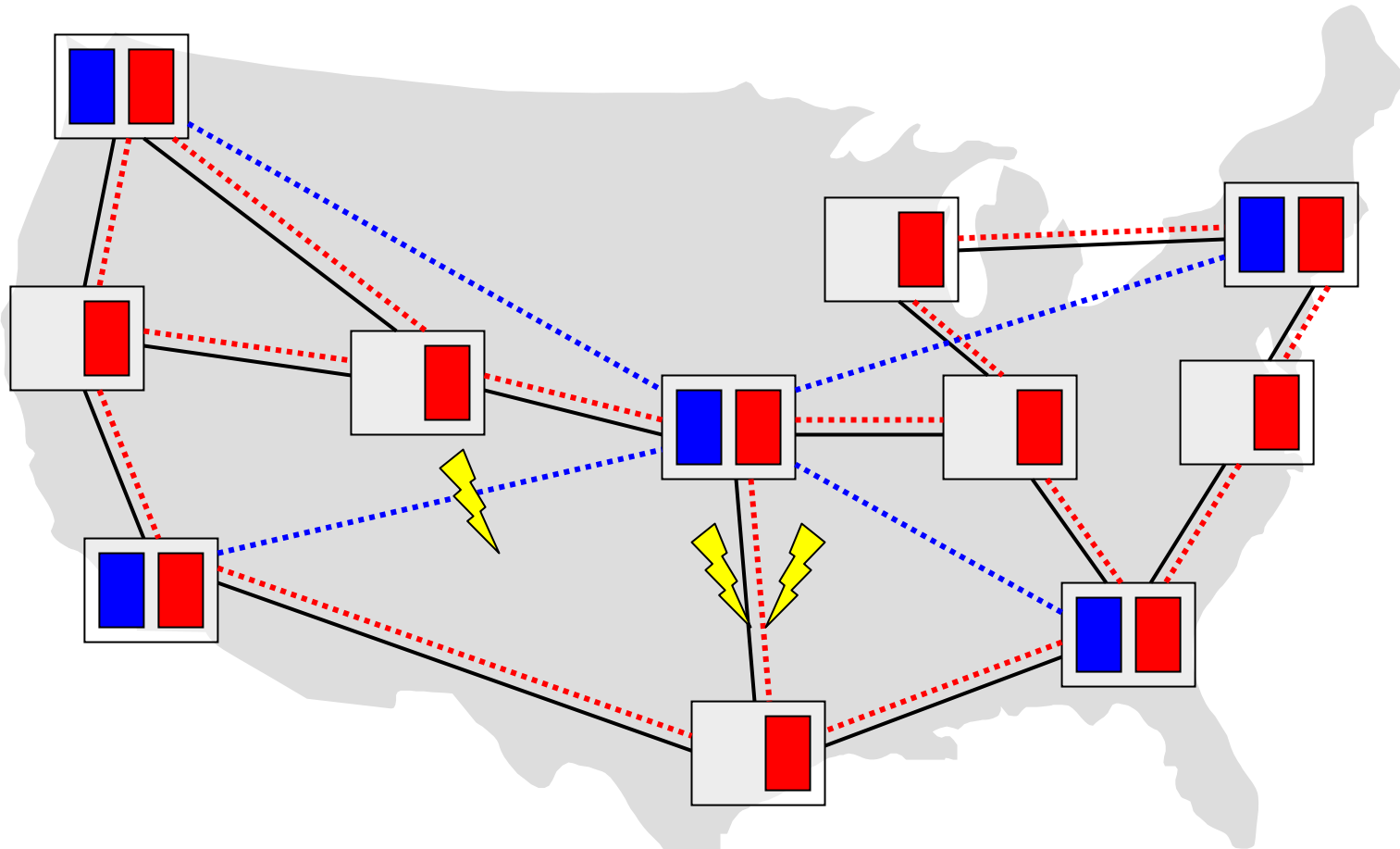
Deployed on NLR & Internet2

VINI - Flexible Topology



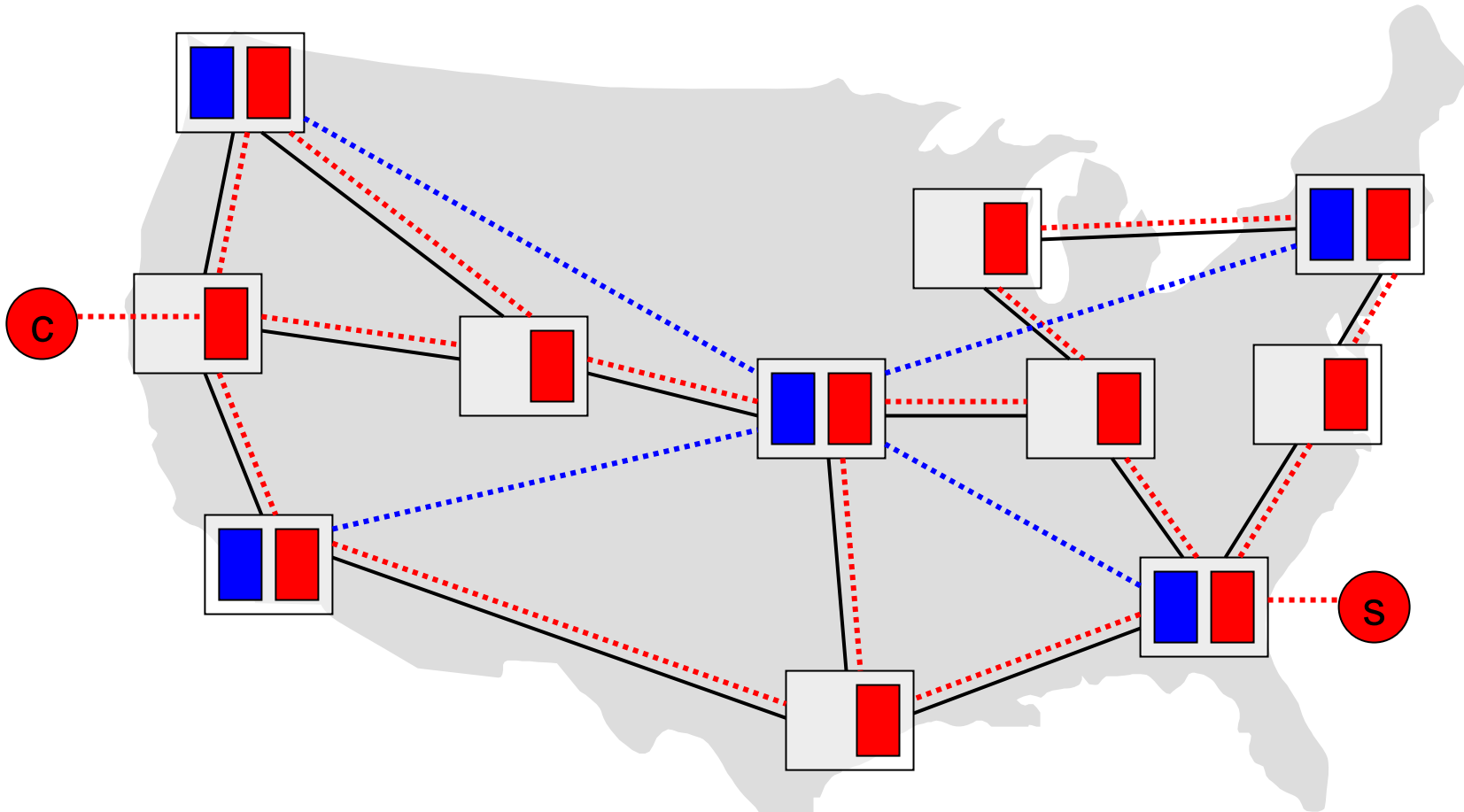
Supports arbitrary virtual topologies

VINI - Network Events



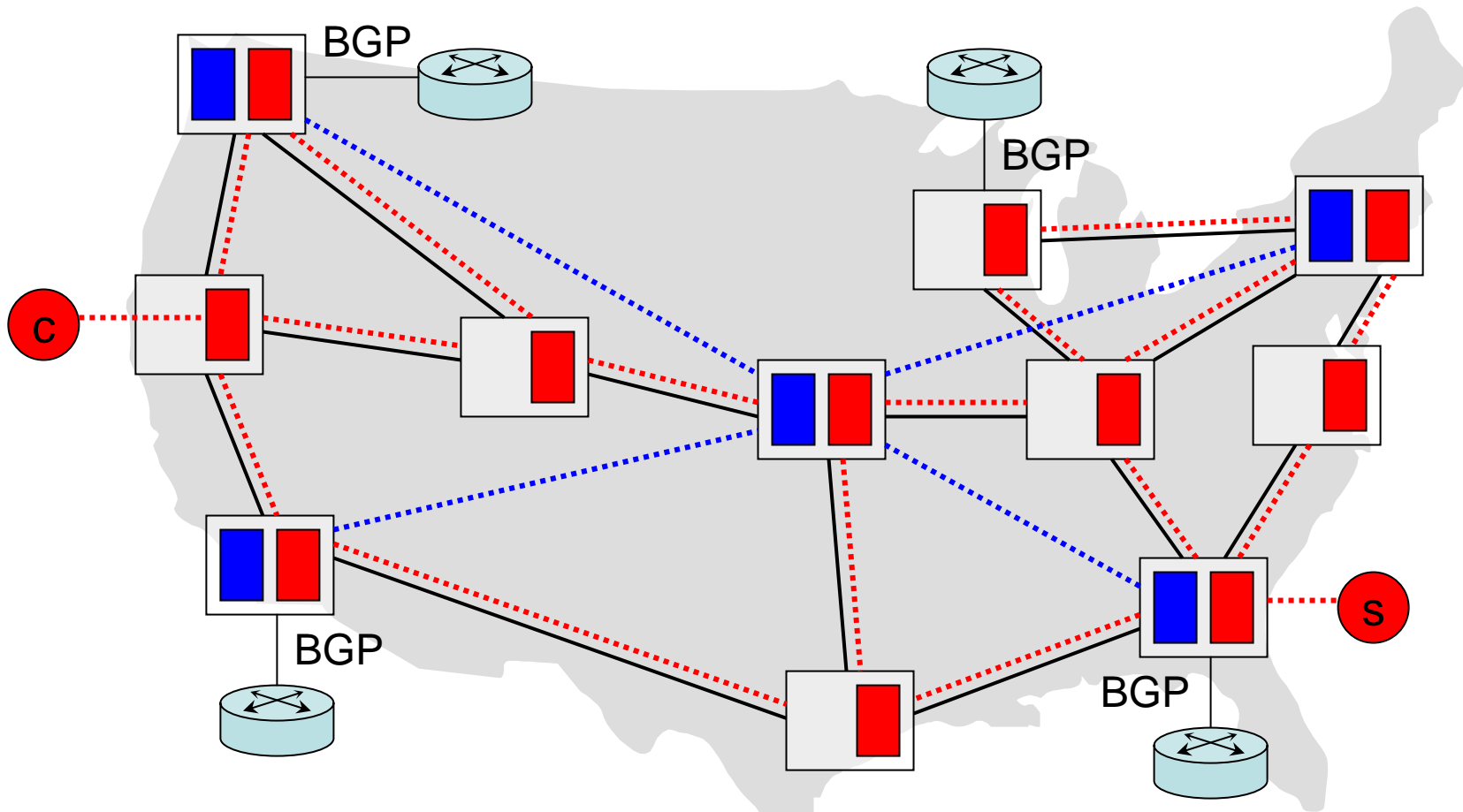
Exposes (can inject) network failures

VINI - External Connectivity



Experiments can carry traffic for real end-users

VINI - Routing Peers



Experiments can participate in Internet routing

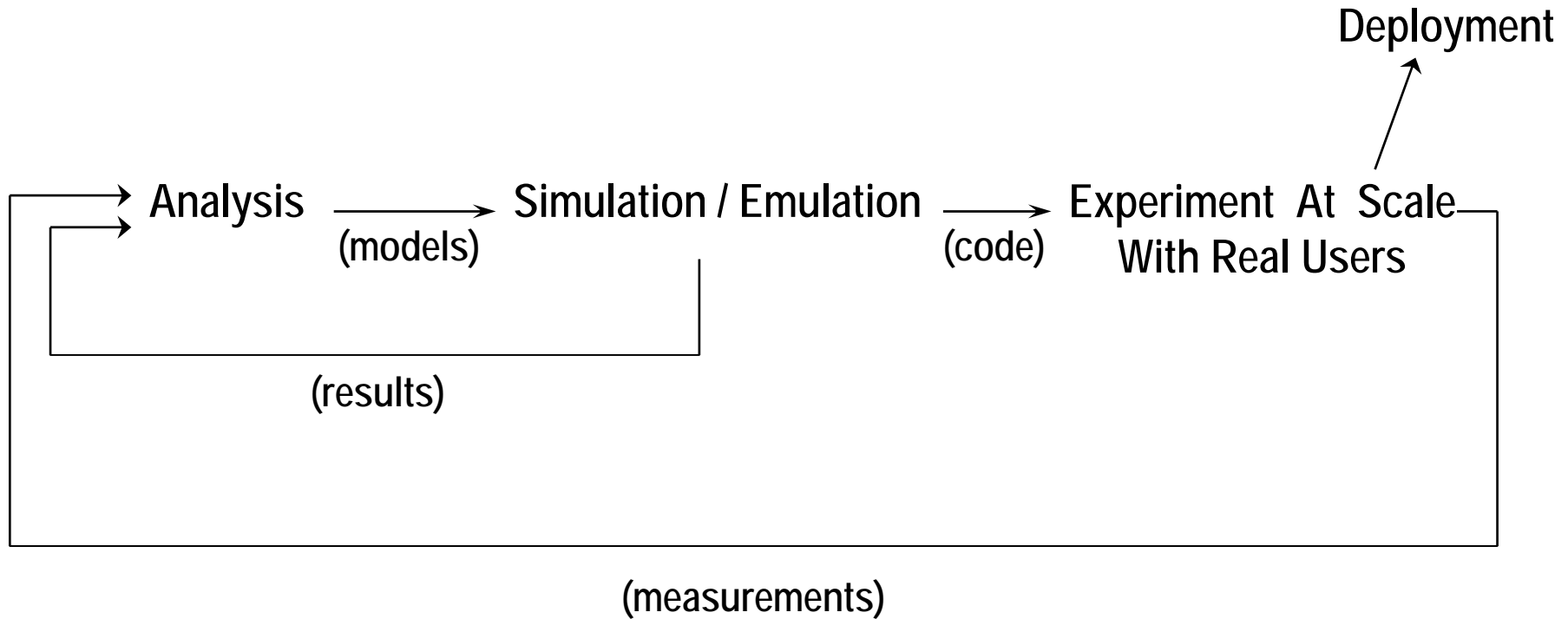
Challenges

- Virtualization
 - Protocol stack
 - BGP
- Topology Management
- Performance
 - NetFPGA (McKeown @ Stanford)
 - Blade Server + NPs (Turner @ WashU)
- Internet-in-a-Slice
 - Click data plane
 - XORP control plane

Other Activity

- Prototyping the GENI interfaces
- Interconnecting VINI and ORBIT (Rutgers)
- Interconnecting PlanetLab and Emulab (Utah)
- Federating PlanetLab and OneLab (EU)
- Replicating VINI on other backbones

Continually Reinvent



Success Scenarios

- Narrow the validation gap
 - Sound foundation for future network architectures
 - Experimental evaluation, rather than paper designs
- Create new services
 - Demonstrate new services at scale
 - Attract real users
- Aid the evolution of the Internet
 - Demonstrate ideas that ultimately see real deployment
 - Provide architectural clarity for evolutionary path
- Lead to a future global network
 - Purist: converge on a single new architecture
 - Pluralist: virtualization supporting many architectures

More Information

- PlanetLab
 - www.planet-lab.org
- VINI
 - www.vini-veritas.net
- GENI
 - www.geni.net