

Looking Beyond the Internet

(Next Steps)

thanks to



National Science Foundation
WHERE DISCOVERIES BEGIN

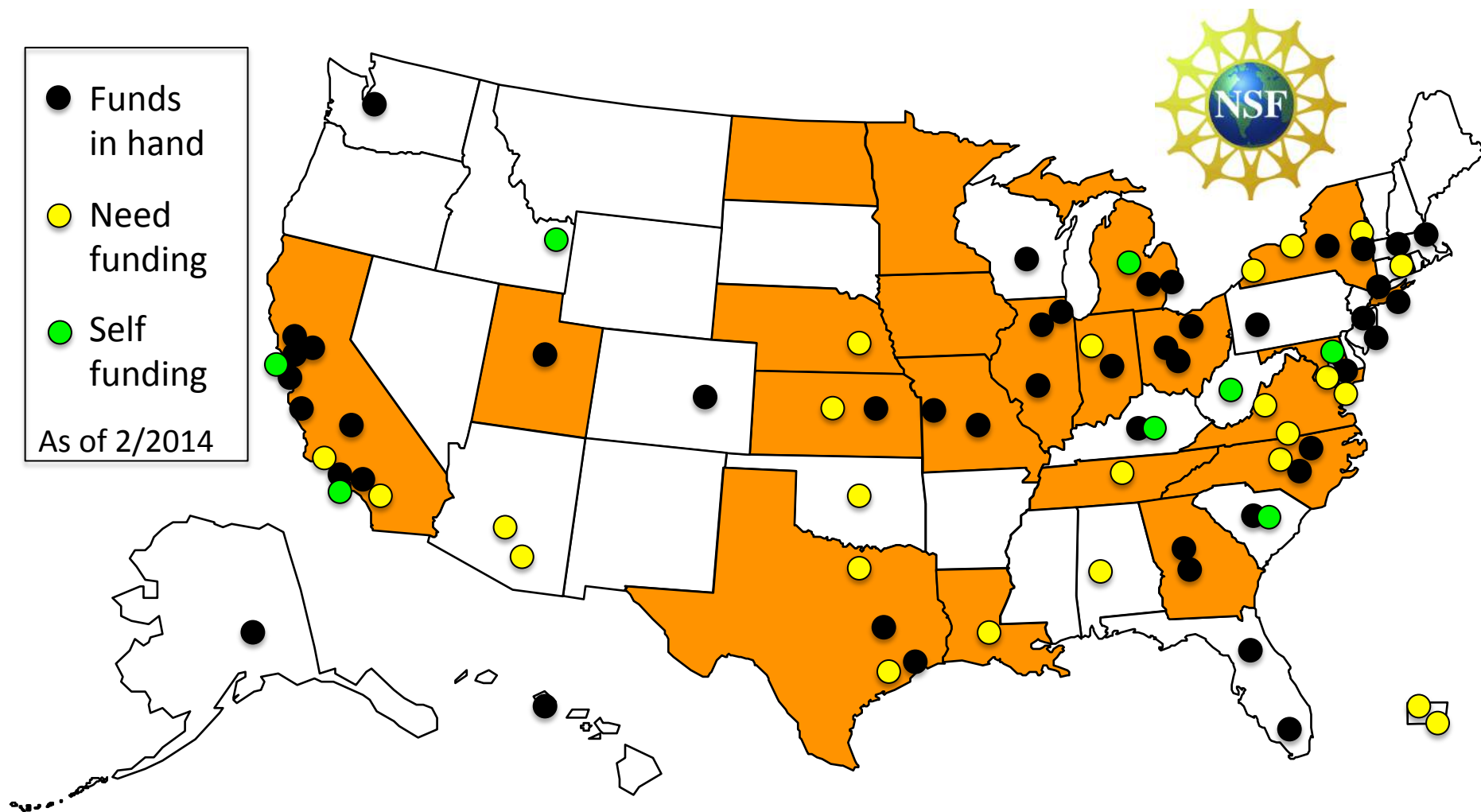
Chip Elliott, BBN

celliott@bbn.com

My thesis

- Software Defined Networking (SDN) was just an opening act
- A major transformation of the Internet has begun . . .
- Research planning is underway in the US

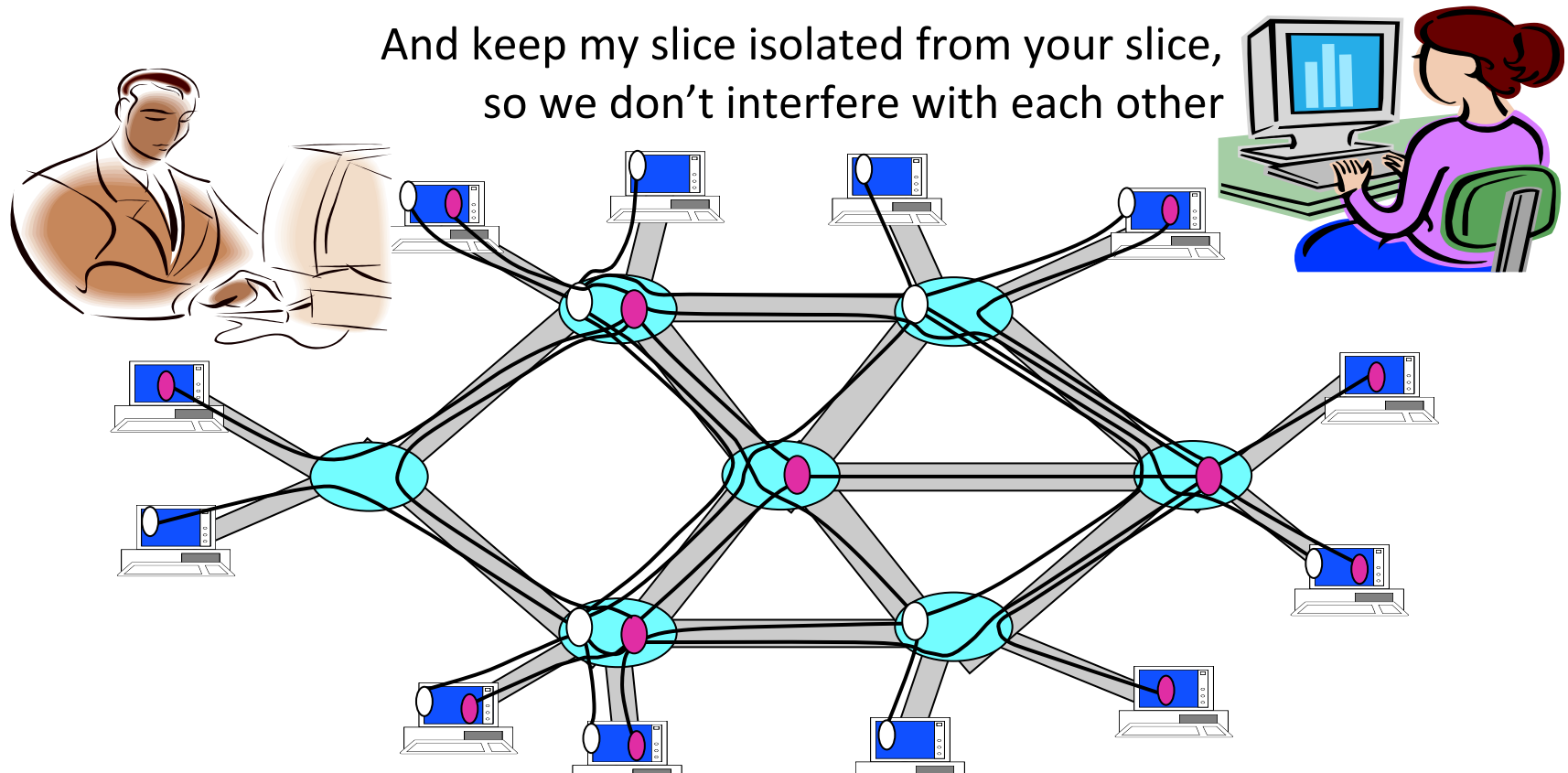
Where I am coming from - GENI



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

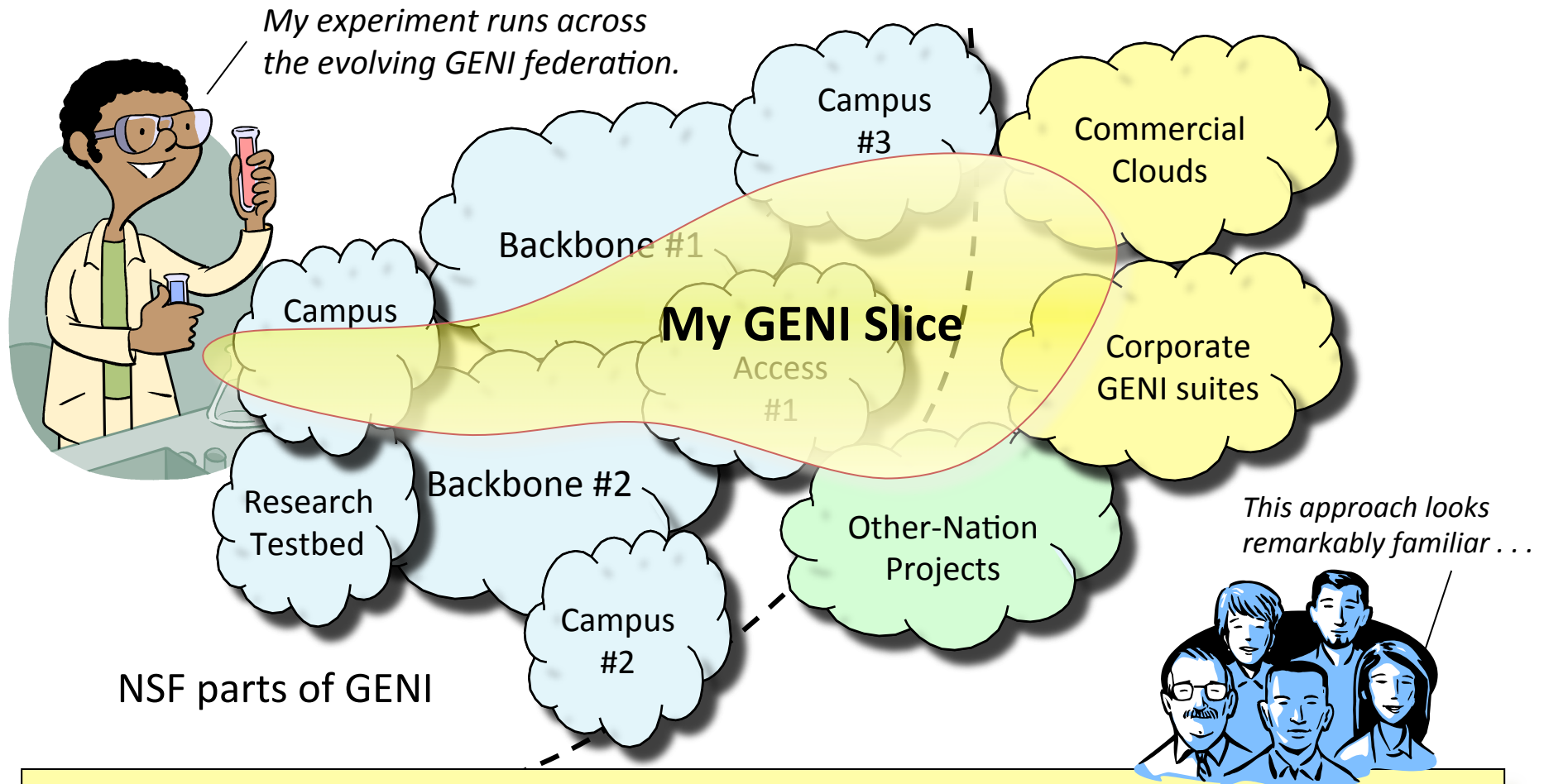
Agile, deeply programmable infrastructure

- Emerging technologies that enable coherent network / processor / storage virtualization provide a great basis for agile cyber infrastructure.



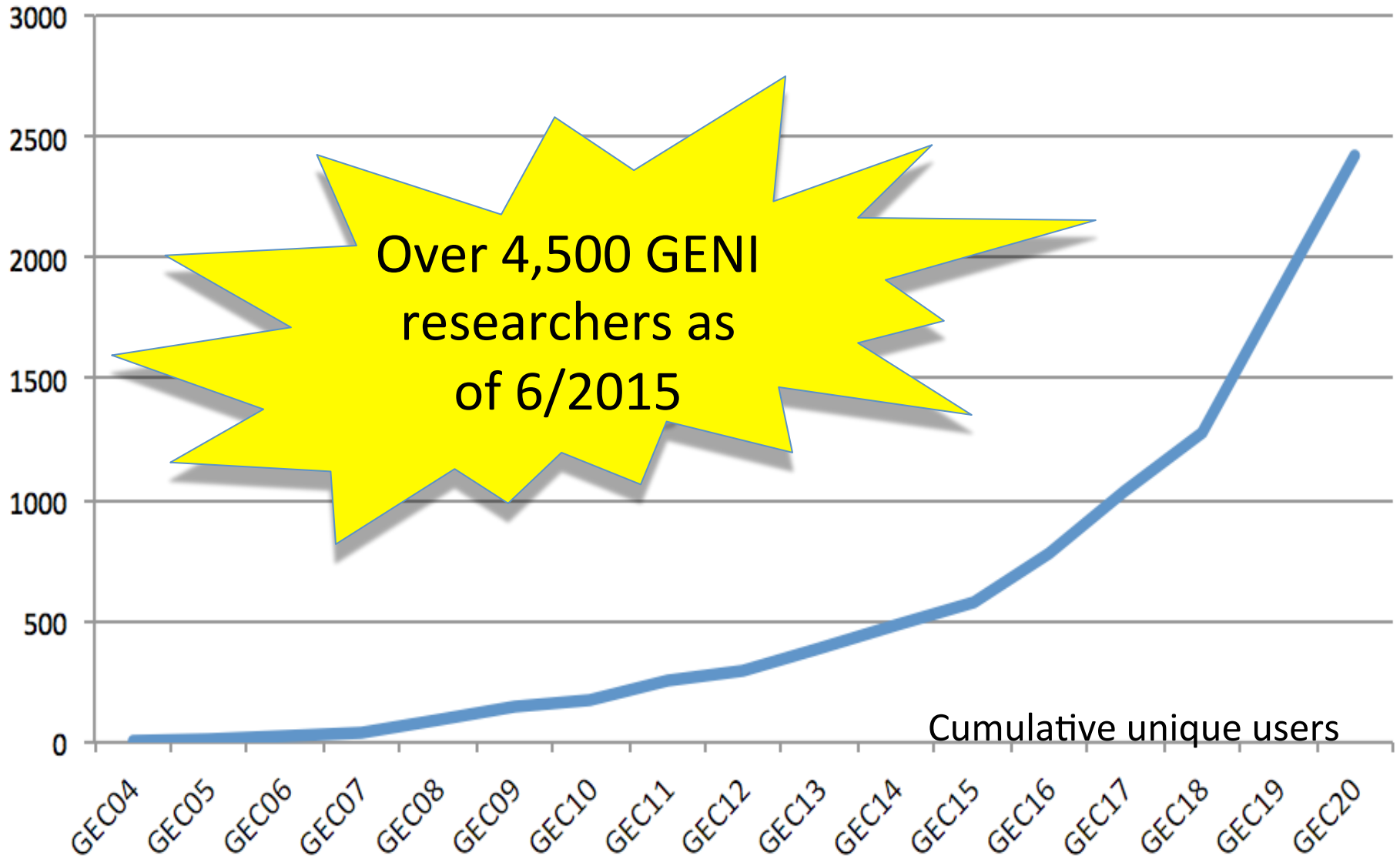
GENI Rack – OpenFlow switch with sliced compute and storage

Slices span many organizational boundaries

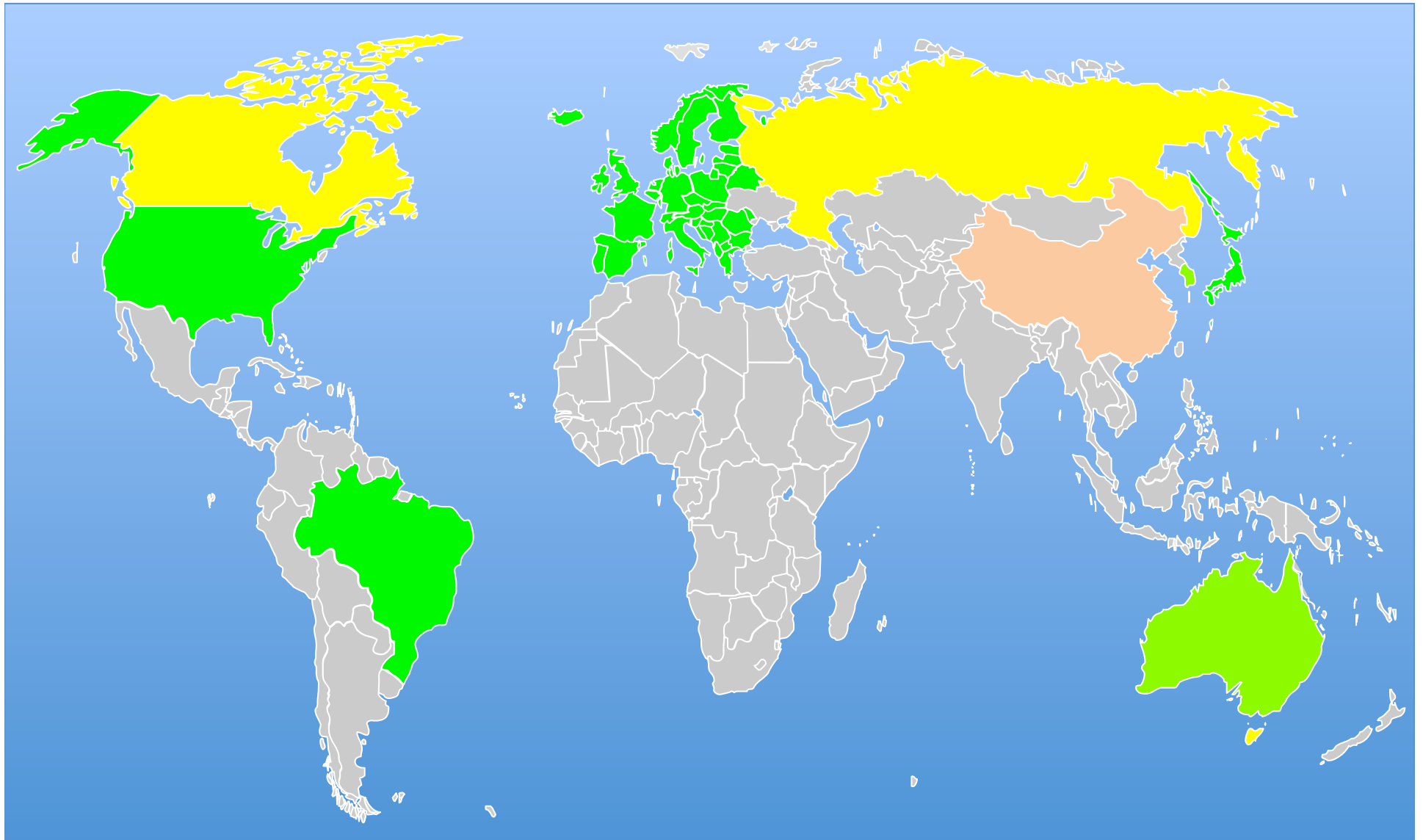


Goals: avoid technology “lock in,” add new technologies as they mature, and potentially grow quickly by incorporating existing infrastructure into the overall “GENI ecosystem”

And it works! GENI is seeing heavy use



Macro-scale: the Rise of Global Interoperability



Now underway – NSF Future Cloud

CloudLab

Chameleon



Rob Ricci

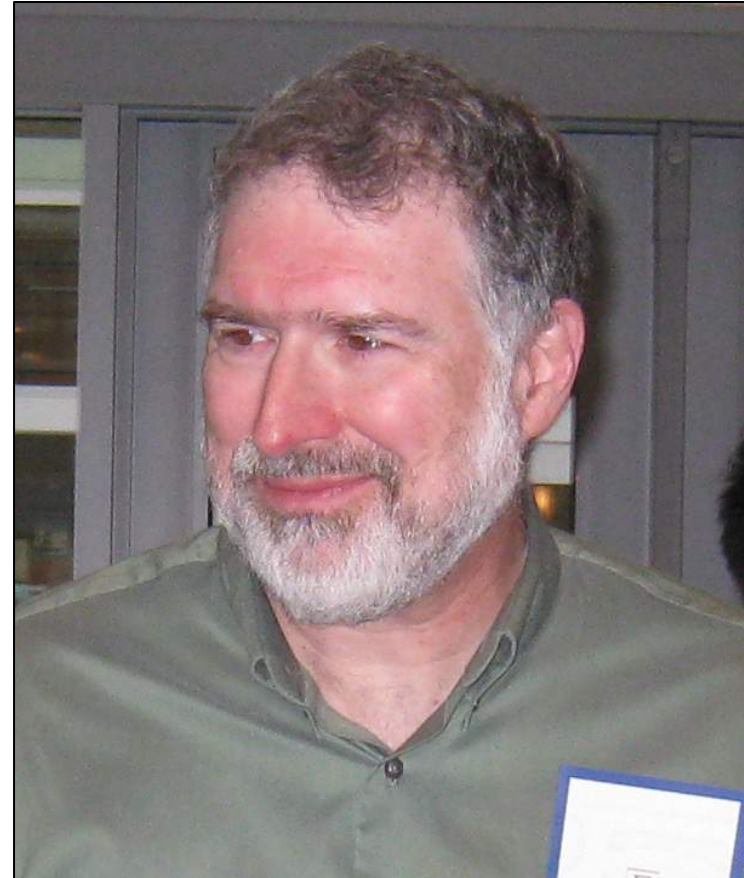


Kate Keahey

And ramping up in cities – US Ignite

- September 14, 2015: \$6 Million in funding from National Science Foundation Project to jumpstart a critical mass of smart city gigabit applications in 15 communities
- Participating communities include:

Burlington, VT; Chattanooga, TN; Cleveland, OH; Flint, MI; Kansas City, KS MO; Madison, WI; the North Carolina Next Generation Network (NCNGN); Richardson, TX; Utah Wasatch Front cities including Salt Lake City and Provo, UT; Lafayette, LA; Urbana-Champaign, IL; and Austin, TX.

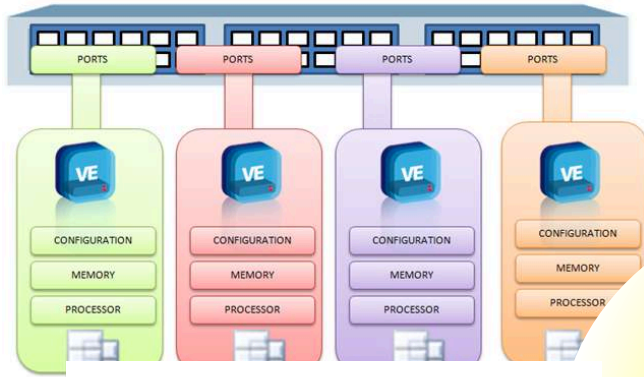


Glenn Ricart

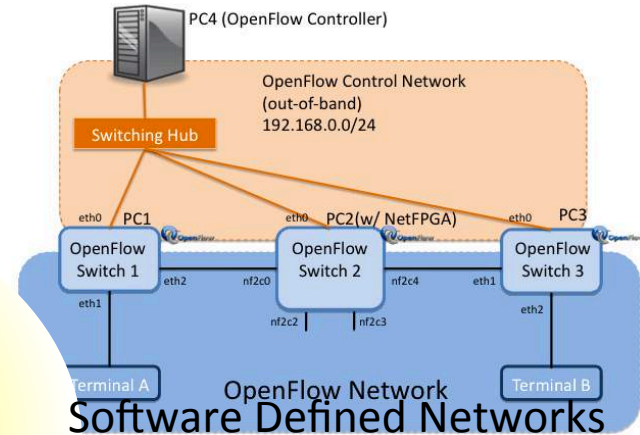
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Major trends are converging



Multi-tenant Datacenters
ARCHITECTURAL MULTI-TENANCY



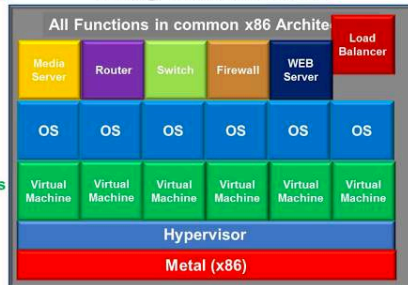
OpenFlow Network
Software Defined Networks

**Software
Defined
Infrastructure**

Network Functions Virtualization (NFV)

- Standard Hardware
- Less Complex
- Very Flexible
- Reduced Power
- Lower CapEx
- Lower OpEx
- Test new apps
- Low risk
- Reduced TTM
- Open Market to Software suppliers

Using Virtualization

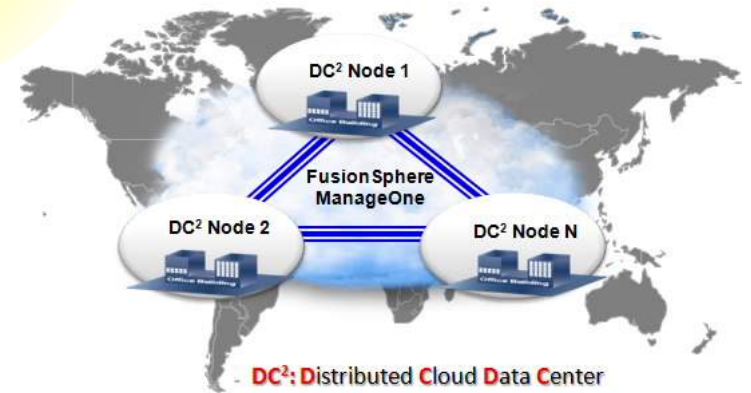


SPIRENT PROPRIETARY

5
SPIRENT

Network Functions Virtualization (NFV)

Looking Beyond the Internet

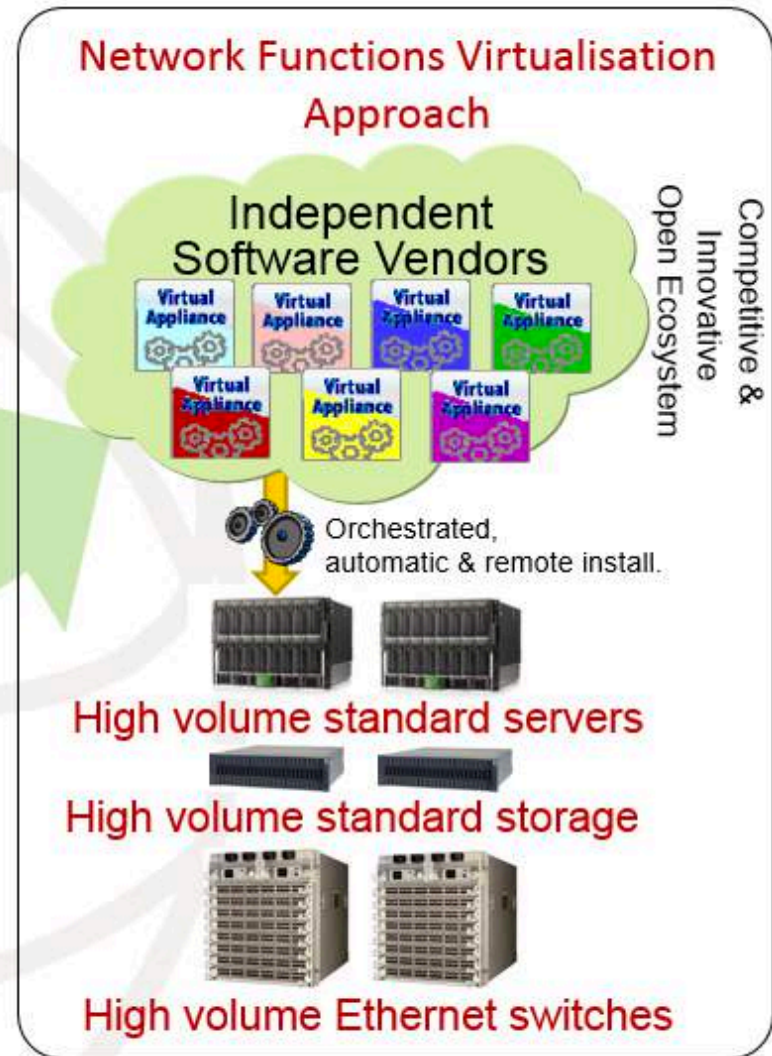
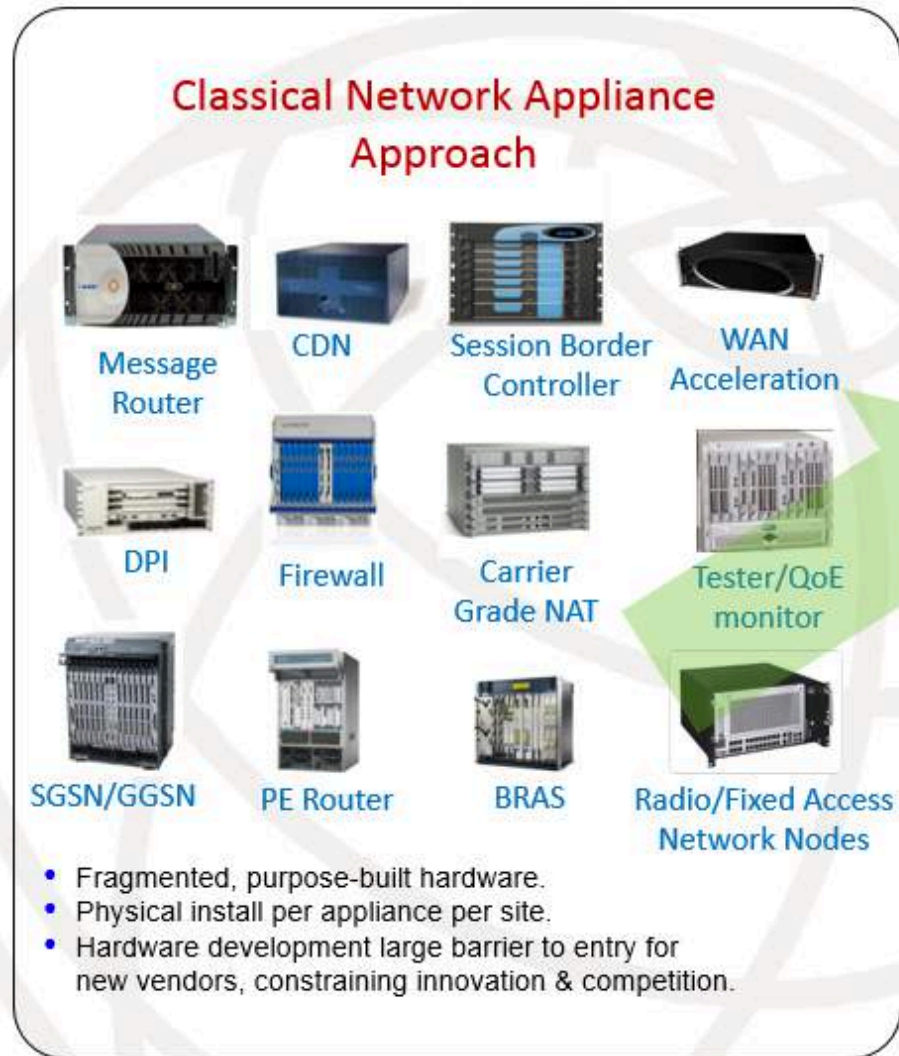


Distributed Datacenters

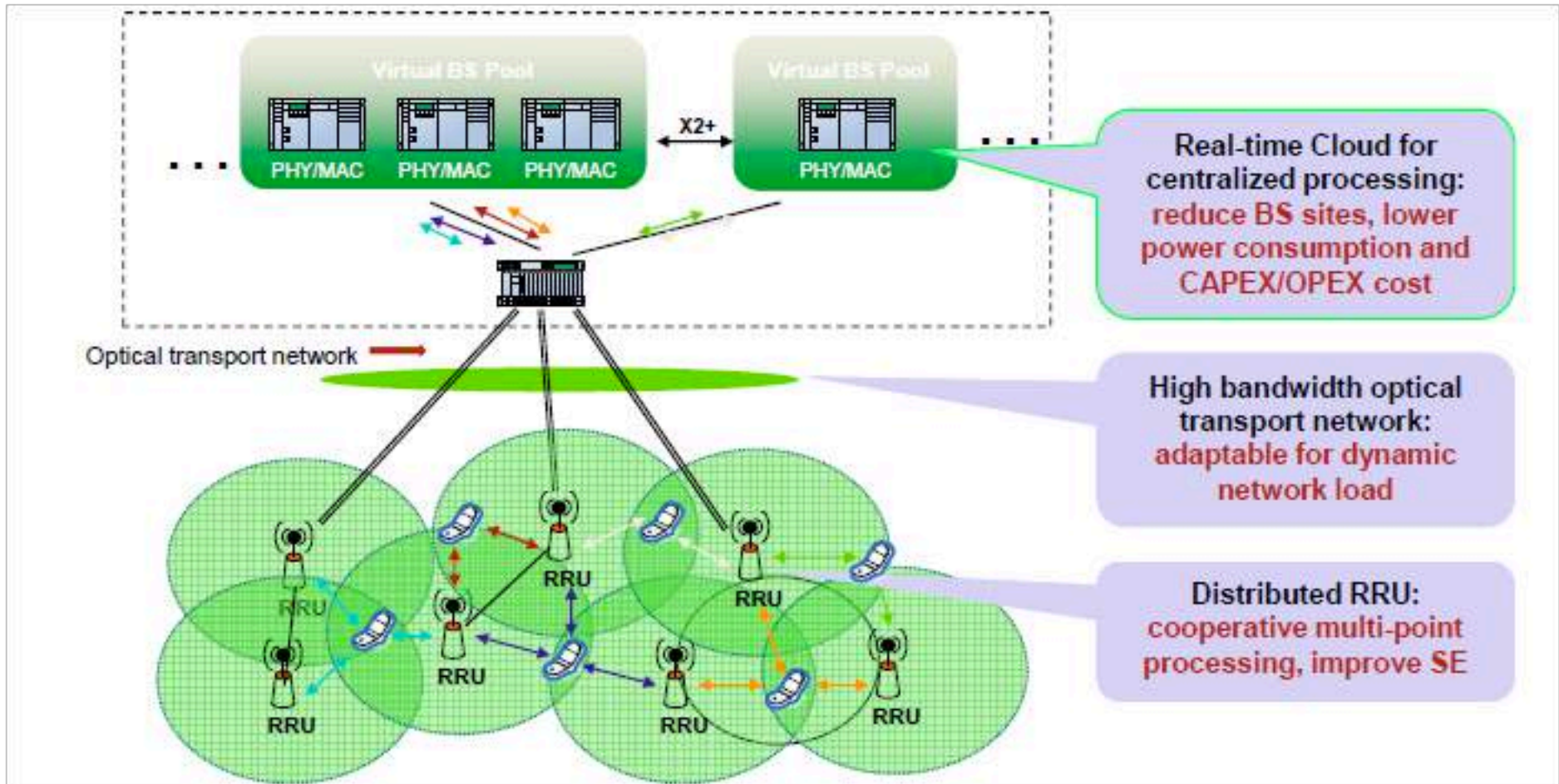
- DC²: Distributed Cloud Data Center
Physically dispersed, logically centralized

Chip Elliott <celliott@bbn.com>

Network Functions Virtualization (NFV)

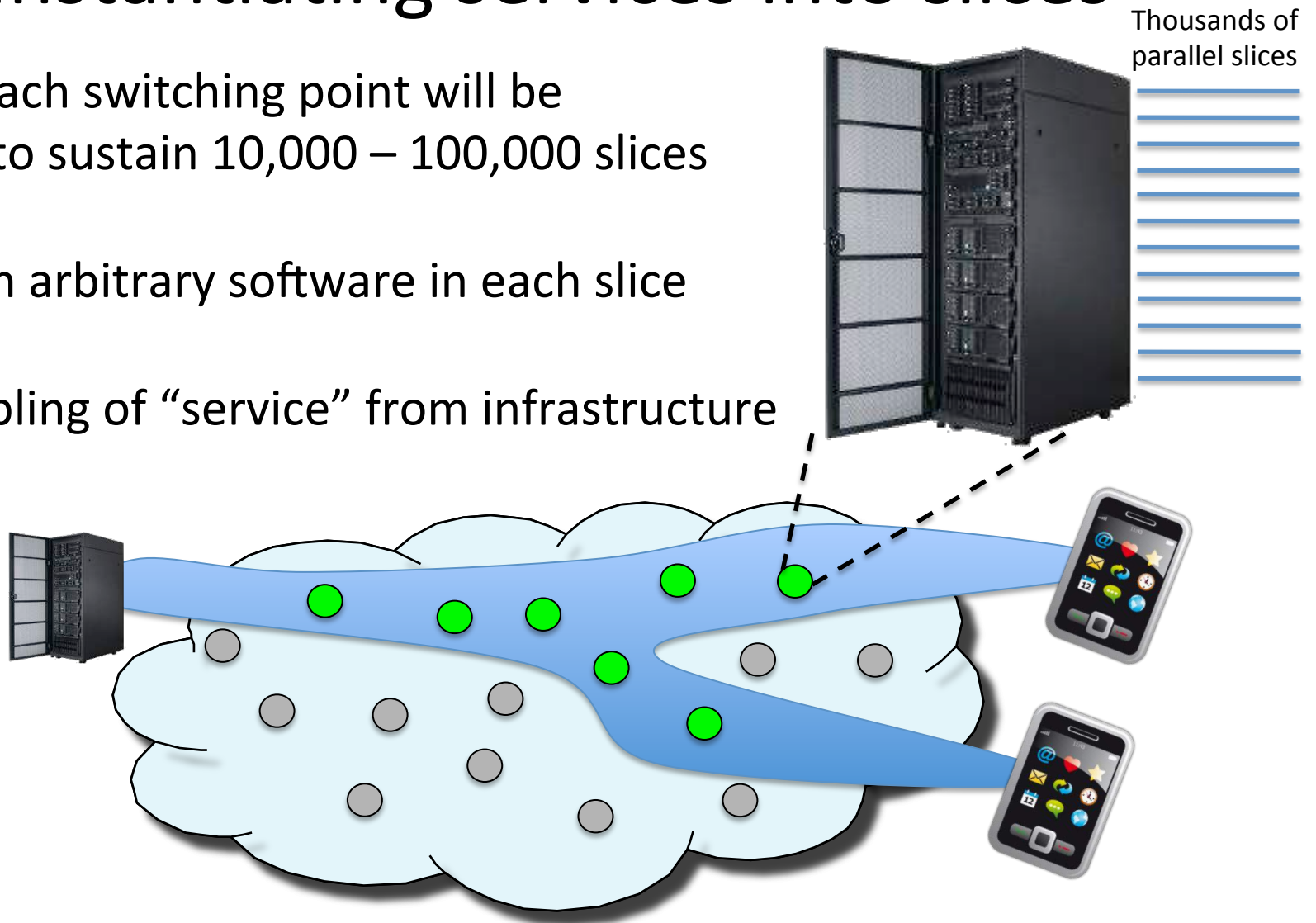


Cloud Radio Access Networks (C-RANs)



Instantiating services into slices

- Soon each switching point will be able to sustain 10,000 – 100,000 slices
- Can run arbitrary software in each slice
- Decoupling of “service” from infrastructure

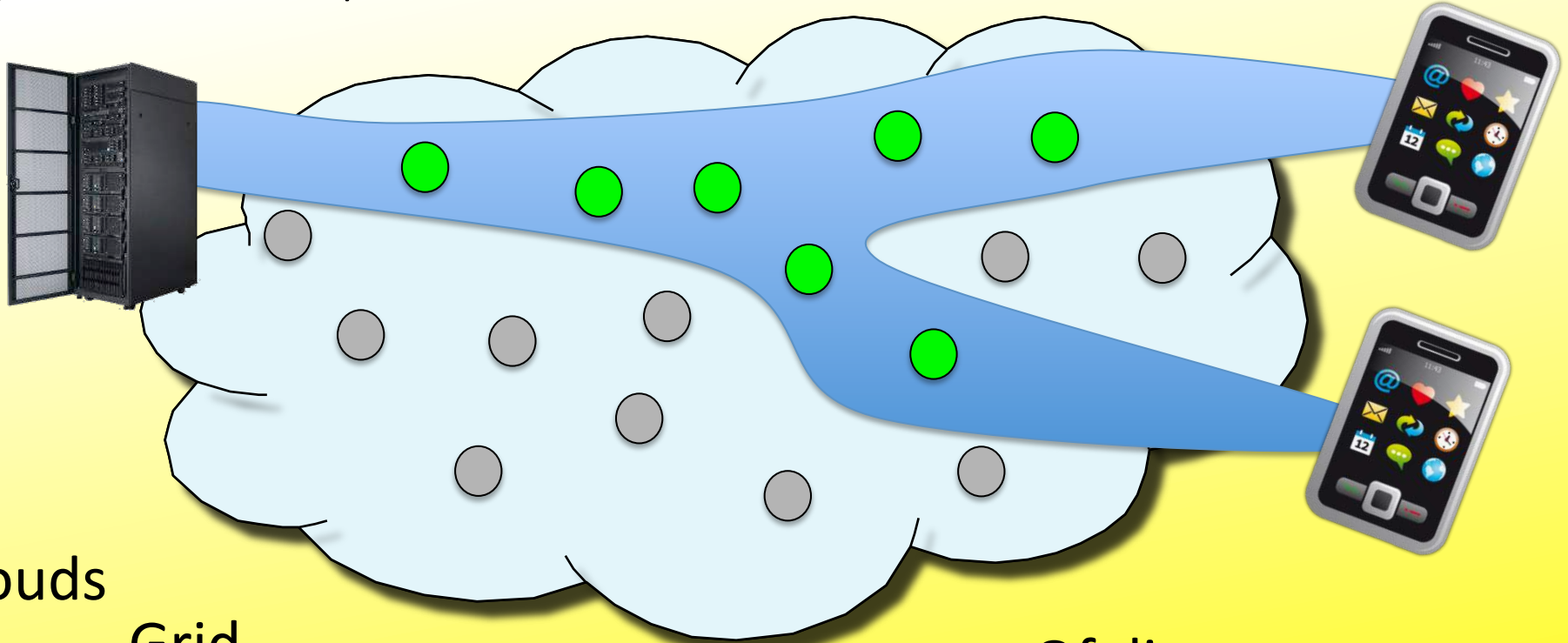


Software Defined Infrastructure

We're all heading to the same place

Rapidly create entire "sliced" cyberinfrastructure / networks on demand

Fast spin new protocols, switching strategies, virtual machines



Clouds

Grid

Software defined
networks

Vnode

Ofelia

US Ignite

Network functions
virtualization

Distributed Clouds

Wivi

FLARE

GENI

Software Defined Infrastructure

Looking beyond the Internet

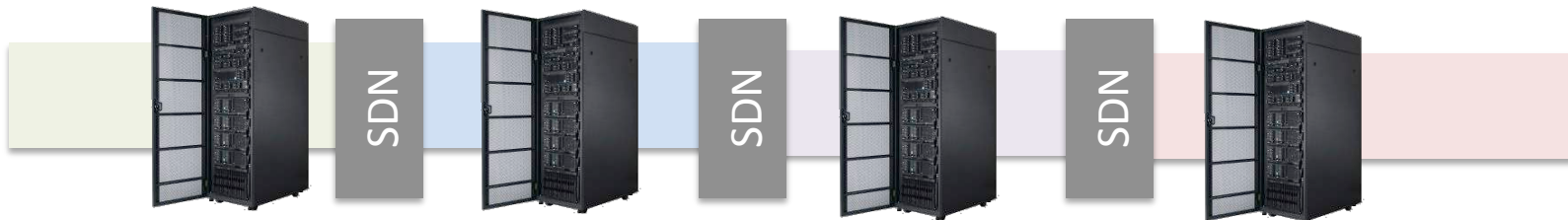
SDI apps



SDI apps from many players

Software Defined Infra.

Federated, authenticated control plane (software)



Multiple, federated sites with interconnected Software Defined Infrastructure

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A vision for NSF CISE Experimental Midscale Infrastructure

A common vision:

Is there a need for midscale infrastructure? *Yes!!*

“A nationwide, multi-tiered system (national/regional R&E backbones, data centers, campuses) that is sliced, deeply programmable, virtualized, and federated so that research experiments can run `end to end` across the full suite of infrastructure.”

- ❖ *multi-tiered system (national/regional R&E backbones, data centers, campuses):* core/edge networking, computation, clouds
- ❖ *sliced, virtualized:* one (logically shared) physical infrastructure
- ❖ *programmable:* platform for innovation
- ❖ *federated:* organic growth, skin-in-the-game business model

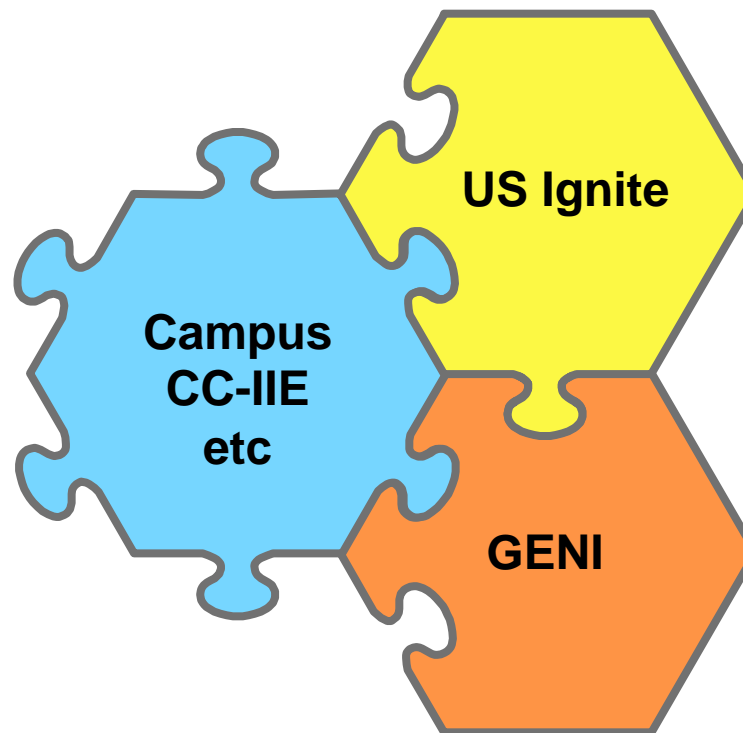
“Midscale infrastructure investments to support computing research”, 2013.
Committee chaired by Jim Kurose, this slide by Steve Corbató et al.

c. 2010



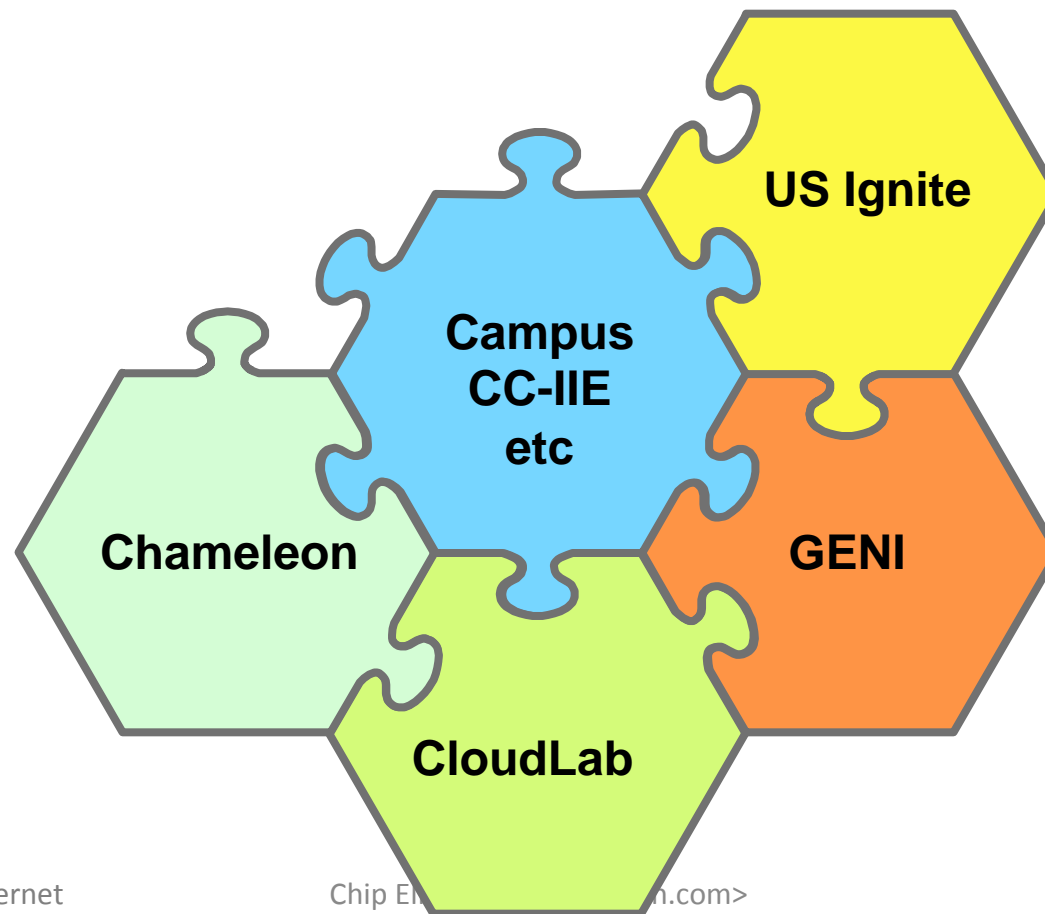
Interoperable systems supporting end-to-end slices

c. 2013



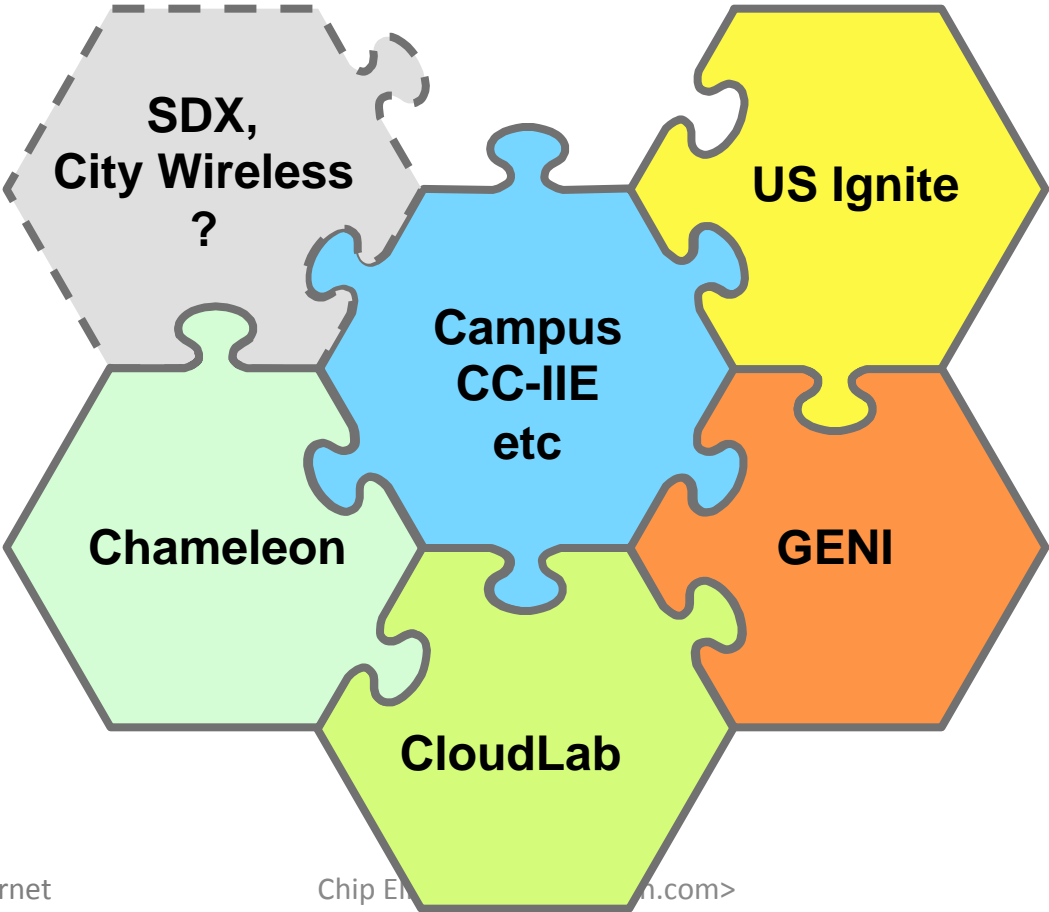
Interoperable systems supporting end-to-end slices

c. 2015



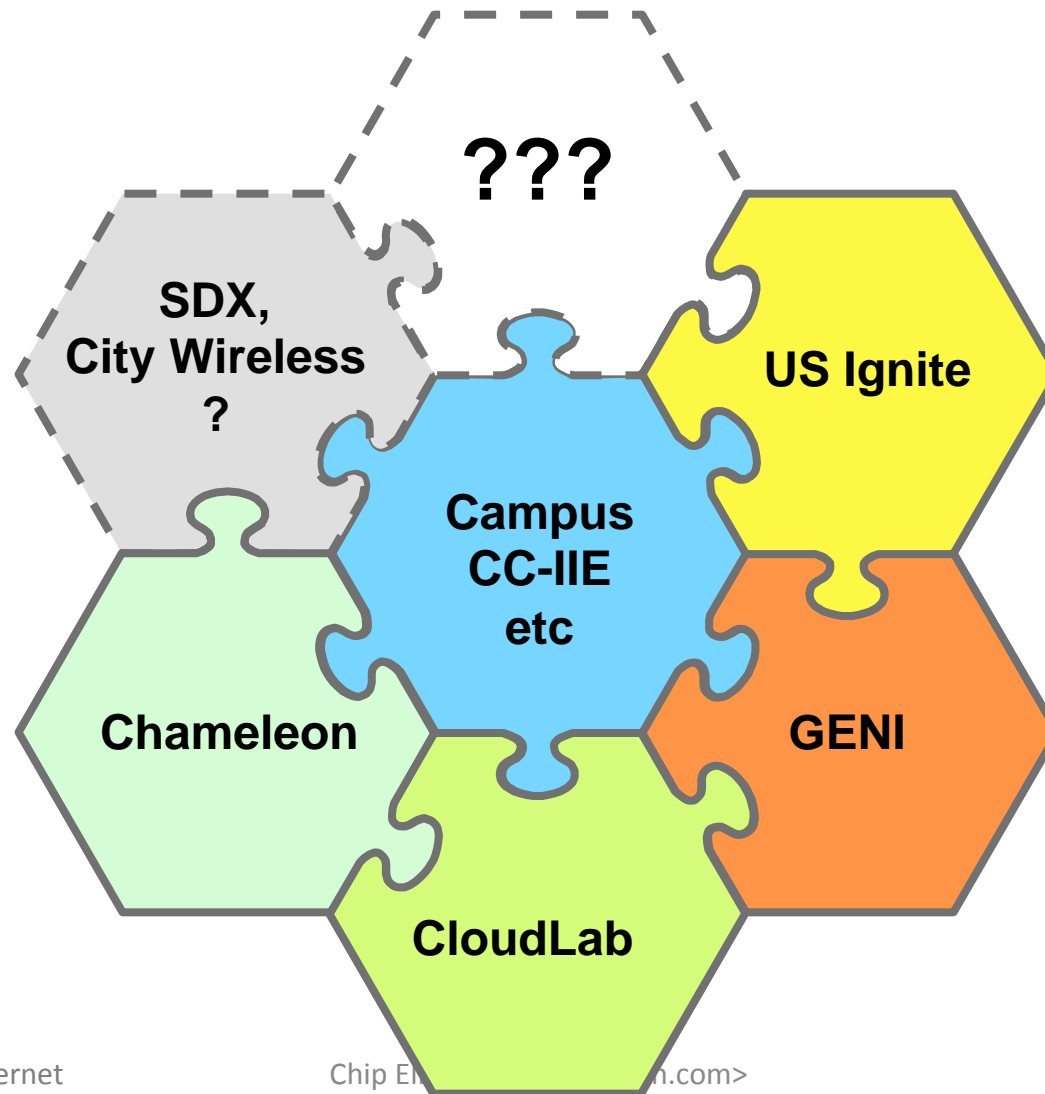
Interoperable systems supporting end-to-end slices

c. 2018 ?



Interoperable systems supporting end-to-end slices

c. 2018 - other good ideas ?



NSF Planning Group for Mid-Scale Infrastructure

Planning Group Members

- Suman Banerjee
- Terry Benzel
- Jim Bottum
- Prasad Calyam (*)
- Jeff Chase
- Tracy Futhey
- Kate Keahey
- Ray Raychaudhuri (*)
- Jenn Rexford
- Rob Ricci (*)
- Glenn Ricart
- Peter Steenkiste

(*) Workshop chair

Workshops

- SDI / SDX (Ricci)
- Wireless Cities (Raychaudhuri)
- Future Apps (Calyam)

Organizers

- Chip Elliott
- Dave Farber
- Larry Landweber

Interested ?

- Please participate !
- Stay tuned for workshop announcements
- These are very fun & interesting times for computer science systems research !



thanks to

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