A NATIONAL/GLOBAL SDN INNOVATION PLATFORM: NDDI / OS3E

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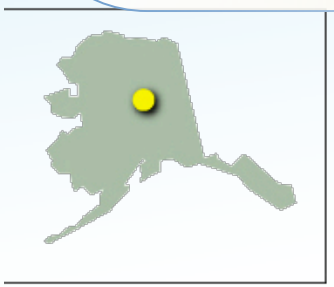
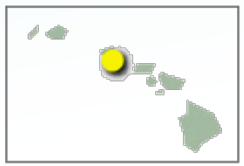
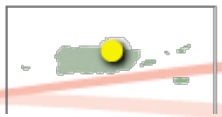
Open Network Summit - October 19, 2011

Internet2 the Community:

- Internet2 was formed by 34 universities in 1996
- 200+ Higher Ed members are core of Internet2
- Over 40 corporate members collaborate on advanced network and applications
- 11 corporate members counted at this summit







Internet2 Network 100G Infrastructure

By the numbers…

50+ colocation facilities
250+ amplification racks
17,500 miles community dark fiber
8.8 Tbps of optical capacity
40+ planned SDN nodes-5 complete
100+ Gbps of IP capacity
10 Juniper T1600 routers (R&E)
7 Juniper MX960's (peering)
.7->1 Petabytes a day of traffic
300+ Ciena 6500 optical elements
8 International peering points
100 Global network collaborators

Partners: ESnet, NOAA, NSF/GENI
35+ state and regional networks

What is the research and education "community"?

- Thousands of the leading thinkers collaborating in an open environment to advance the Internet and advanced applications.
- As a community, we *create* markets.
- We *create* markets by incubating great ideas from prototypes to *early adoption at scale* in the time before they are commercially viable.

Opportunity for innovation begins with understanding history.

- The research and education community has played *a seminal role* in the creation of the modern Internet and the applications that have made it *the* transformative technology of the 20th and 21st century

- The story is on-going-- not simply historical. What we do today sets the groundwork for next stages of Internet development

The ROI on the investments in R&E networking have been staggering

Total 30 year Federal investment of $225M to enable the precursors of the internet are small, but…

- NSFNet/connections program ~$75M
- ARPAnet ~$150M

That investment has catalyzed Internet businesses including:

- Internet Services Providers $40B /yr
- Network hardware vendors $100B /yr
- Internet software & services $100B /yr

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Vignette: The Commercial Internet

- First commercial Internet companies were spun out of R&E networks
  - Merit Network co-created ANS
  - The Center for Seismic Studies in Northern Virginia created UUNET
  - Nysernet created PSINet
- WWW and web browsers and early commercial sites created avalanche of demand for commercial Internet presence
  - The first web browsers were created by CERN and NCSA at the University of Illinois Urbana-Champaign
  - First US web server came online at Stanford's SLAC.
- Reality: The Internet became the de facto standard because that's where the action was...
- A new *open* platform that some argued would never work because it couldn't scale, wasn't robust enough, lacked management, etc…
- Now the ISP Market is $40B+ annually and Internet Software and Services Market is $100B+ annually

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Leading companies have their roots in research networks and campuses

- Workstations (Sun Micro from Stanford, BSD from Berkley)
- Routers (CISCO from Stanford)
- Network caching (Akamai from MIT)
- Security/IDS (Arbor Networks from Univ. of Michigan)
- Content: Facebook (Harvard) Google (Stanford)
- The entire Internet world evolved from the bandwidth rich environment in labs and on campuses that started with the ARPAnet and NSFnet

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Whole new markets driving the global economy have emerged from R&E innovation

- Many companies have been created or re-invented through innovations in the R&E community
- Even those who have been reluctant to lead change have become major beneficiaries of that innovation
- The research and education community has been the source of the “disruptive technologies” that enabled whole new industries and changed existing ones
- We led and continue to lead thinking from bandwidth scarcity to bandwidth availability
- We moved and continue to move the world from proprietary to open
- We still need this incubation capability

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Going forward: We can't predict the future, but we can stimulate innovation

- Demand follows application availability (which needs large scale operating environments to enable adoption)
  - Commercial approaches tend to limit use to find ROI
  - Innovation platforms need to encourage utilization
- Real applications tend to evolve from ubiquitous deployment in real communities, which R&E has traditionally enabled.
  - small demo pilots don't provide adequate scale and real-world conditions for applications to take off
- We need to create a platform for future innovation that enables new thinking and capabilities at increased scale

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