Internet2: Looking Forward towards Network Virtualization

Eric Boyd
Senior Director, Strategic Projects, Internet2
Innovation Platform:

Internet2 Goals for 2013

In 2013 ...

• Create an Environment for Innovation
• Support Big Science and Network Research
• Connect Campuses, Regionals, Domain and Network Research Projects
• Education through Workshops, Conferences, and Training
Internet2 Network by the numbers

- 17 Juniper MX960 nodes
- 21 Brocade and Juniper switches
- 250+ amplification racks
- 15,717 miles of newly acquired dark fiber
- 2,400 miles of partnered capacity with Zayo Communications
- 8.8 Tbps of optical capacity
- 100 Gbps of hybrid Layer 2 and Layer 3 capacity
- 300+ Ciena ActiveFlex 6500 network elements

Internet2 Network building blocks for end-to-end innovation environment

- Abundant bandwidth
- Avoidance of traditional bottlenecks
- Software-defined networking to enable new applications
- Performance monitoring nodes to assure performance verification
Advanced Layer2 Operational Stability

- Available public tools
  - OE-SS software
  - Traffic Map
  - Traffic graphs
  - “Router Proxy”
  - Weekly availability reports

- Availability summary (October 1st, 2012 through April 7th, 2013)
  - NOTE: all numbers include planned maintenance downtime
  - Aggregate node availability: 99.979%
    - Worst: 99.969%
    - Best: 99.980%
  - Aggregate route availability: 99.857%
    - Worst: 99.361%
    - Best: 99.98%
    - Almost all route downtime related to underlying optical system outages or AL2S node software upgrades
Advanced Layer2 Service Traffic Growth

The chart shows the growth of traffic in petabytes transferred per month from 11/1/12 to 3/1/13. The traffic remained relatively stable until 2/1/13, after which there was a significant increase to 11.5 PB by 3/1/13.

The data points are as follows:
- 11/1/12: 0.87 PB
- 12/1/12: 1.6 PB
- 1/1/13: 0.87 PB
- 2/1/13: 0.74 PB
- 3/1/13: 11.5 PB

# Petabytes Transferred/Month

Time
LAG'd 10G IP Backbone (20-30Gbps)
LAG’d 10G IP Backbone (20-30Gbps)
100G Layer2 Backbone Circuit
2x100G IP-Layer2 Interconnect
Strawman Summary

- IP Backbone Connectivity
  - Dual 100GigE interconnects between Layer2 and IP boxes at 10 IP cities
  - Three IGP adjacencies between IP routers
    - Via “natively configured” VLANs on Layer2 network
    - Via “SDN configured” VLANs on Layer2 network
    - Via existing LAG’d 10G Layer1 circuits
    - Order of preference to be discussed further
  - Desire to depend on SDN-signalled circuits as soon as possible
    - E.g. Collect three months worth of uptime data and re-evaluate
  - Full VLAN mesh between all routers (e.g. Kansas City will be directly “adjacent” to Los Angeles)
    - Need to convey path somehow (DNS?)
    - Need to think about restoration (use OE-SS or IGP convergence)
  - Bandwidth between networks to augment, when needed
• 100G Nationwide Backbone
• Native OpenFlow w/ virtual slices
• Multivendor Environment
• Available at Public Peering Points
• ½ Year of solid production experience
• Open for controlled experimentation

Provides production & innovation platform to:
• Dozens of high performance compute clusters
• Hundreds of campus data centers
• Thousands of native OpenFlow ports
• Hundreds of wireless access networks
• Millions of potential collaborators
Long-term Architectural Aspiration

Software Defined Networking

- R&E IP
- TR-CPS
- Layer 3 IP Network
- Static Layer 2
- Dynamic Layer 2
- GENI
- GENI Experiments
- ???

- Traditional Services
- Innovation Services
- Software Defined Networking Substrate
- Optical System
- Dark Fiber
Internet2 Goals for Network Virtualization

- Common physical infrastructure
- Reliable production services
- Virtual network Definition
  - Slice of the physical network
  - Full functionality within constrained resources
  - Ability to try out “bad code”
Software Stack — Q3 2012
Software Stack — Q1 2013

- OSCARS UI
- OSCARS API
- IDC
- OESS UI
- OESS
- Controller (Currently NOX)
- OpenFlow
- Flowvisor
- OpenFlow
- Vendor Software
- Vendor Switch
Software Stack —
Now
Software Stack — Q2 2013
INTERNET2: BUILDING THE NEXT U.S. INNOVATION PLATFORM

Eric Boyd
Senior Director, Strategic Projects, Internet2

Thank you. For more information,
visit http://www.internet2.edu
or e-mail innovation@internet2.edu