Eric Boyd
Senior Director, Strategic Projects, Internet2

Internet2: Looking Forward towards Network Virtualization
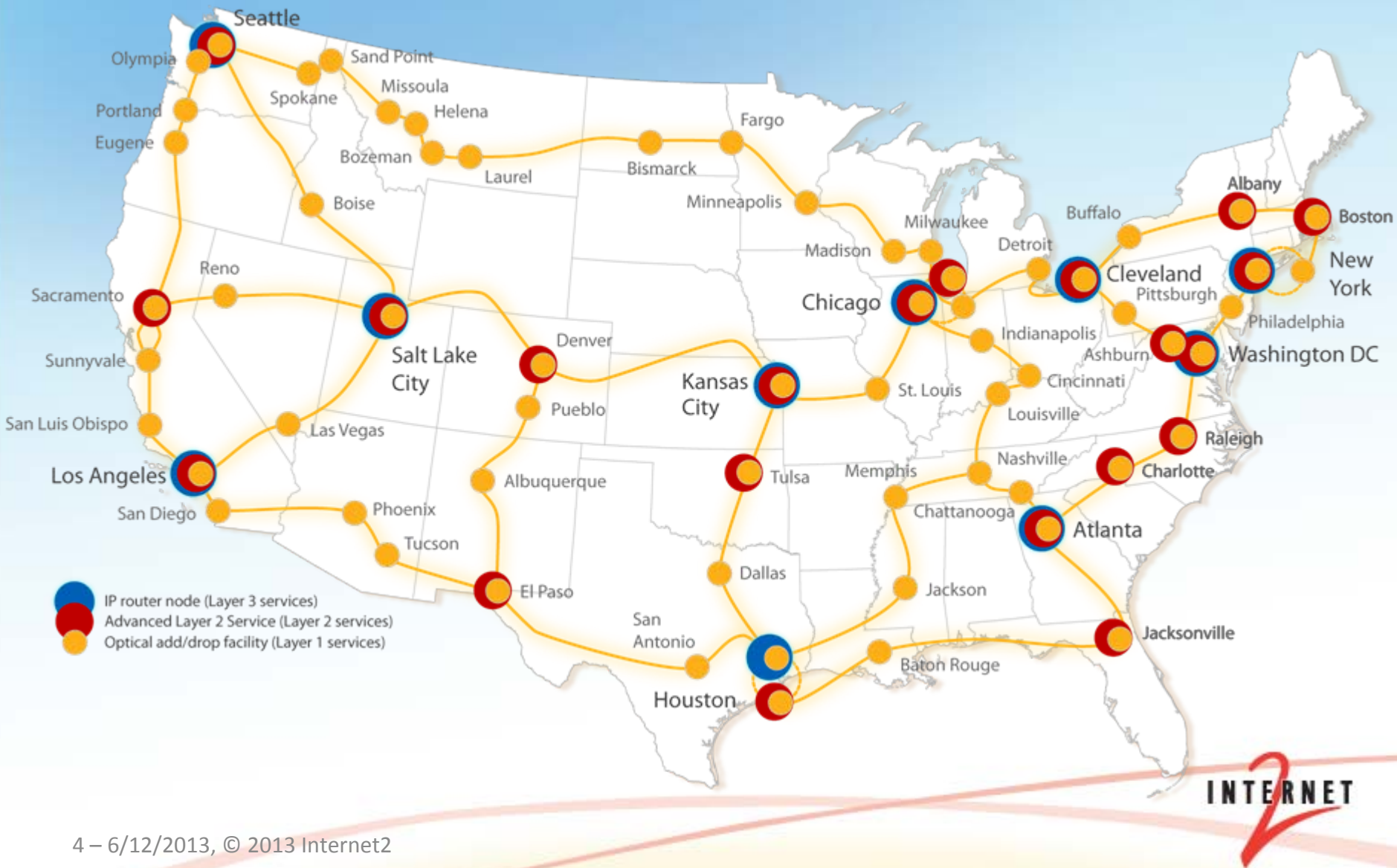
Innovation Platform:
Internet2 Goals for 2013

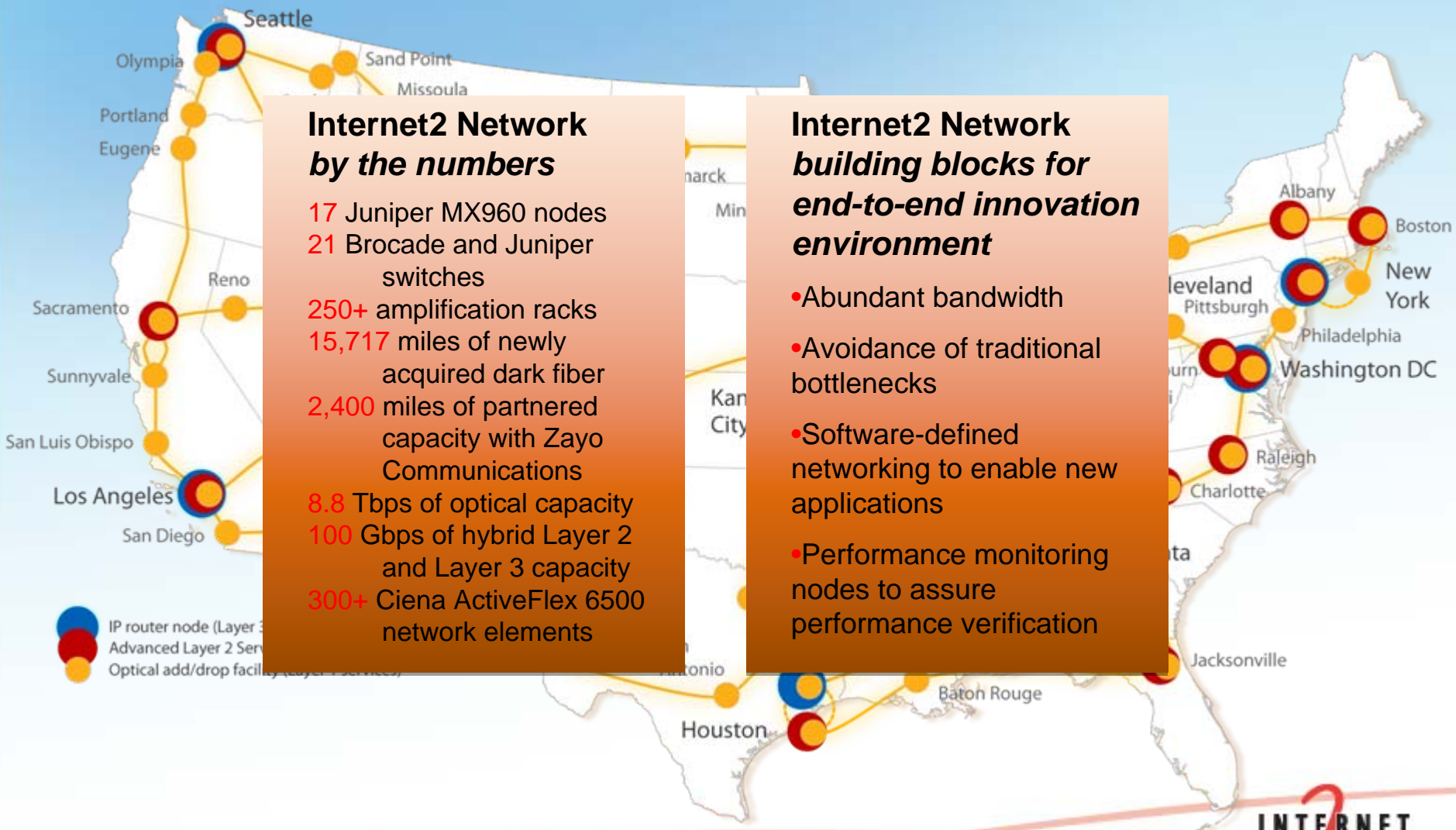*In 2013 …*

- Create an Environment for Innovation

- Support Big Science and Network Research

- Connect Campuses, Regionals, Domain and Network Research Projects

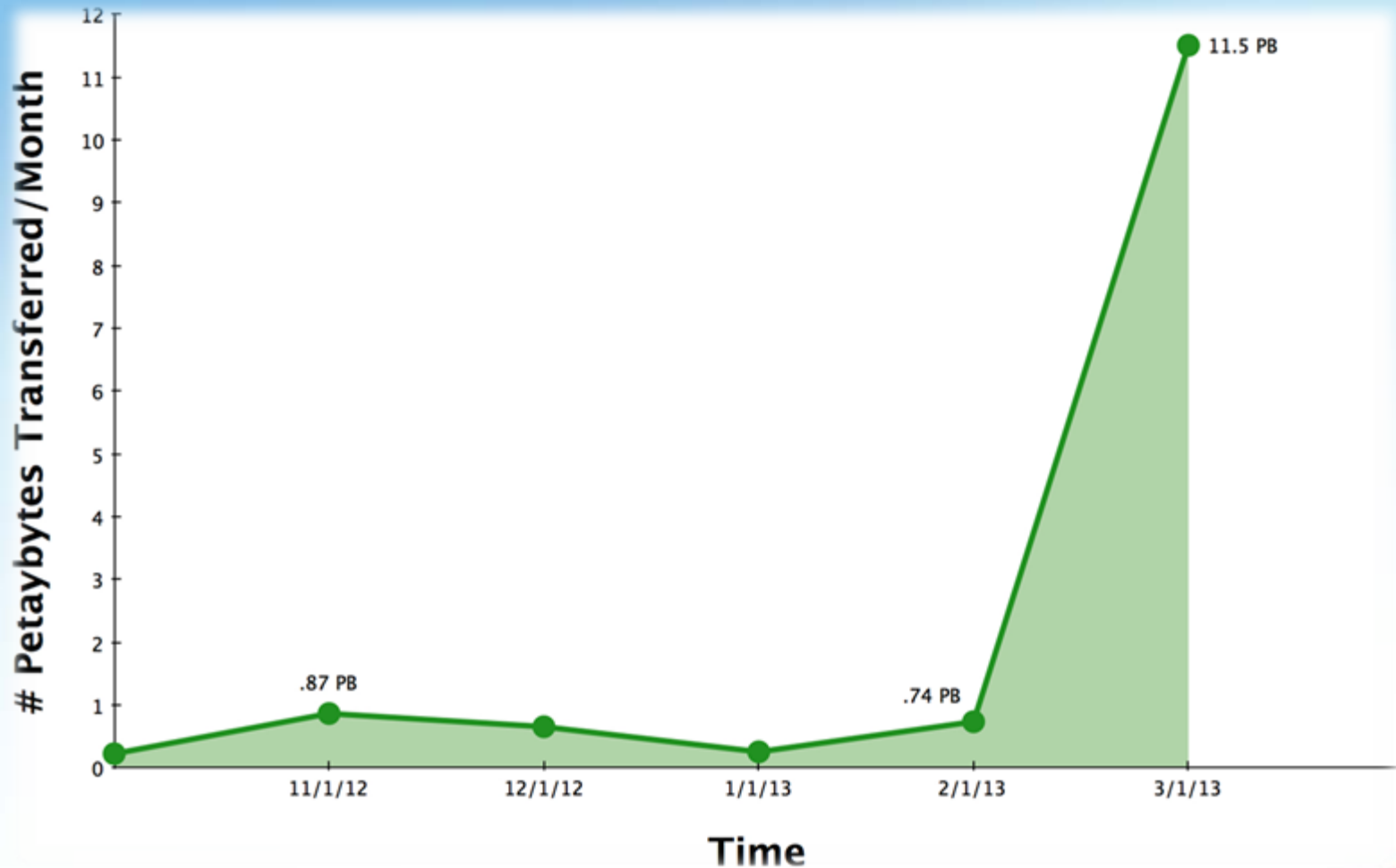- Education through Workshops, Conferences, and Training

INTERNET2

Optical Build Status

Internet2 Network

Internet2 Network Infrastructure Topology

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

IP router node (Layer 3
Advanced Layer 2 Ser
Optical add/drop facility (Layer 1 Services)

INTERNET 2

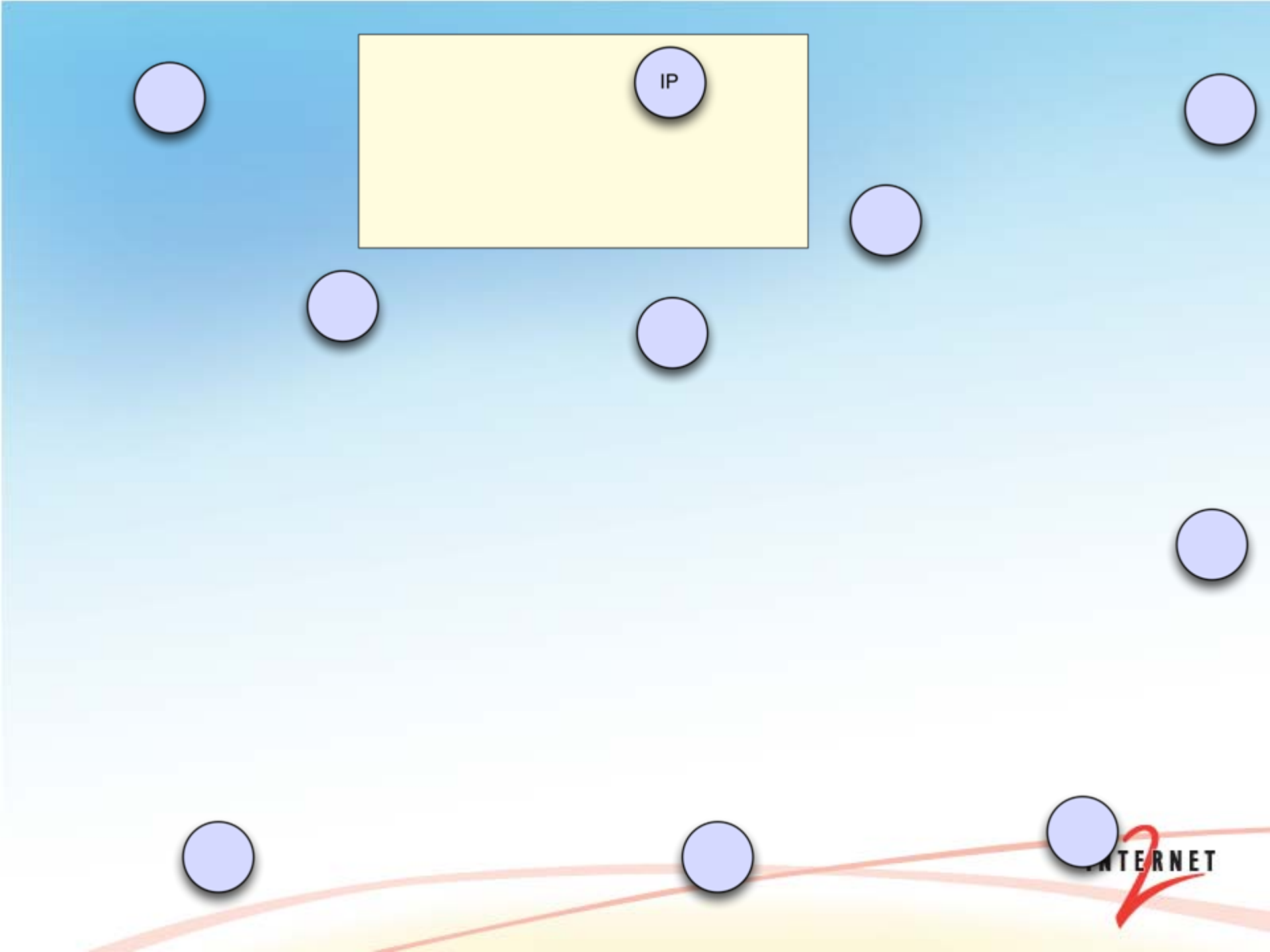# Advanced Layer2 Operational Stability

- 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%
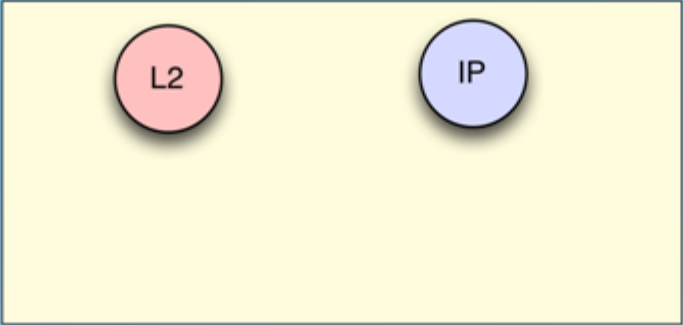   - Almost all route downtime related to underlying optical system outages or AL2S node software upgrades
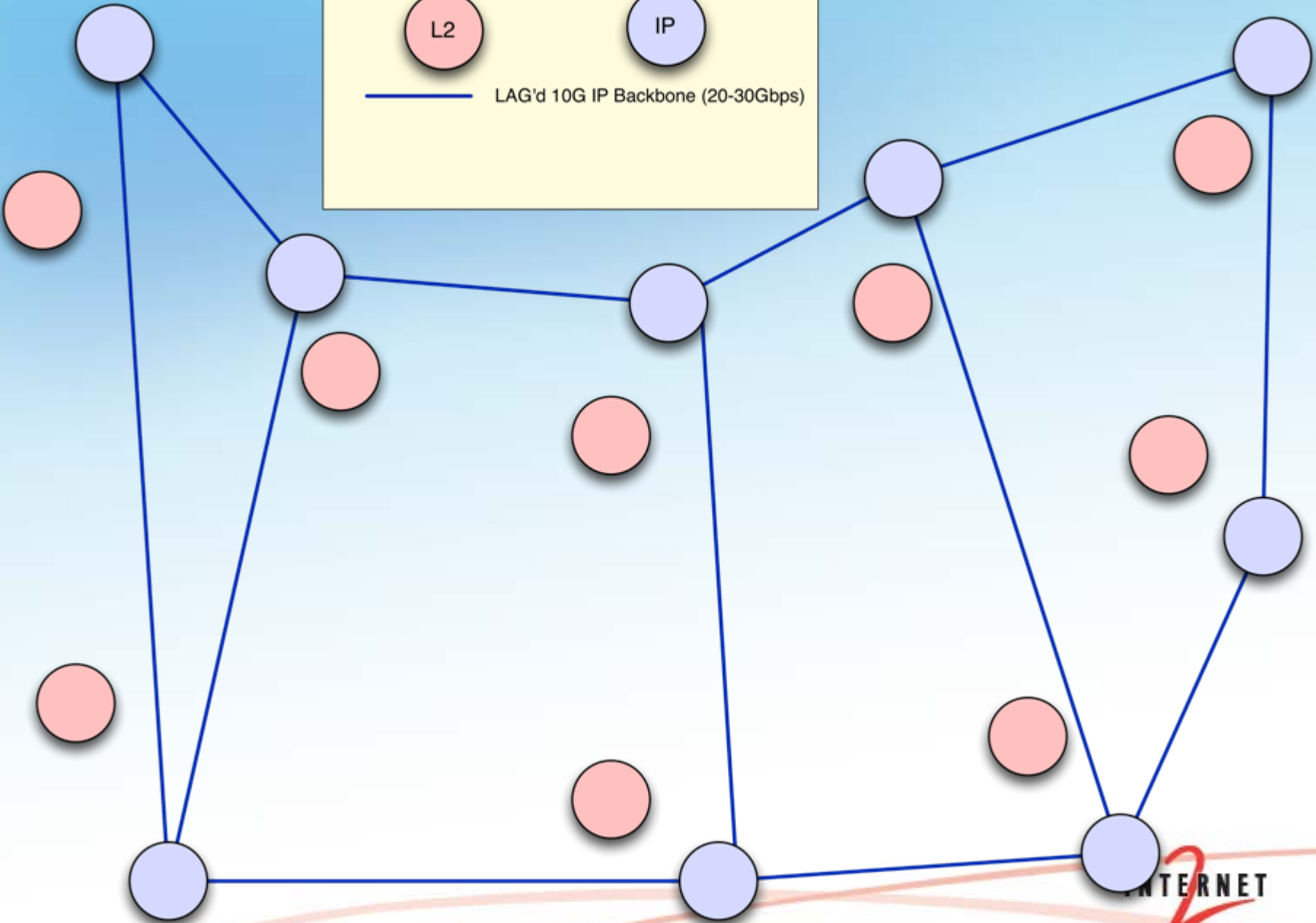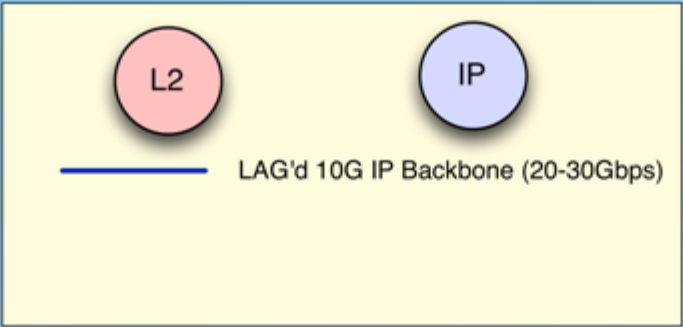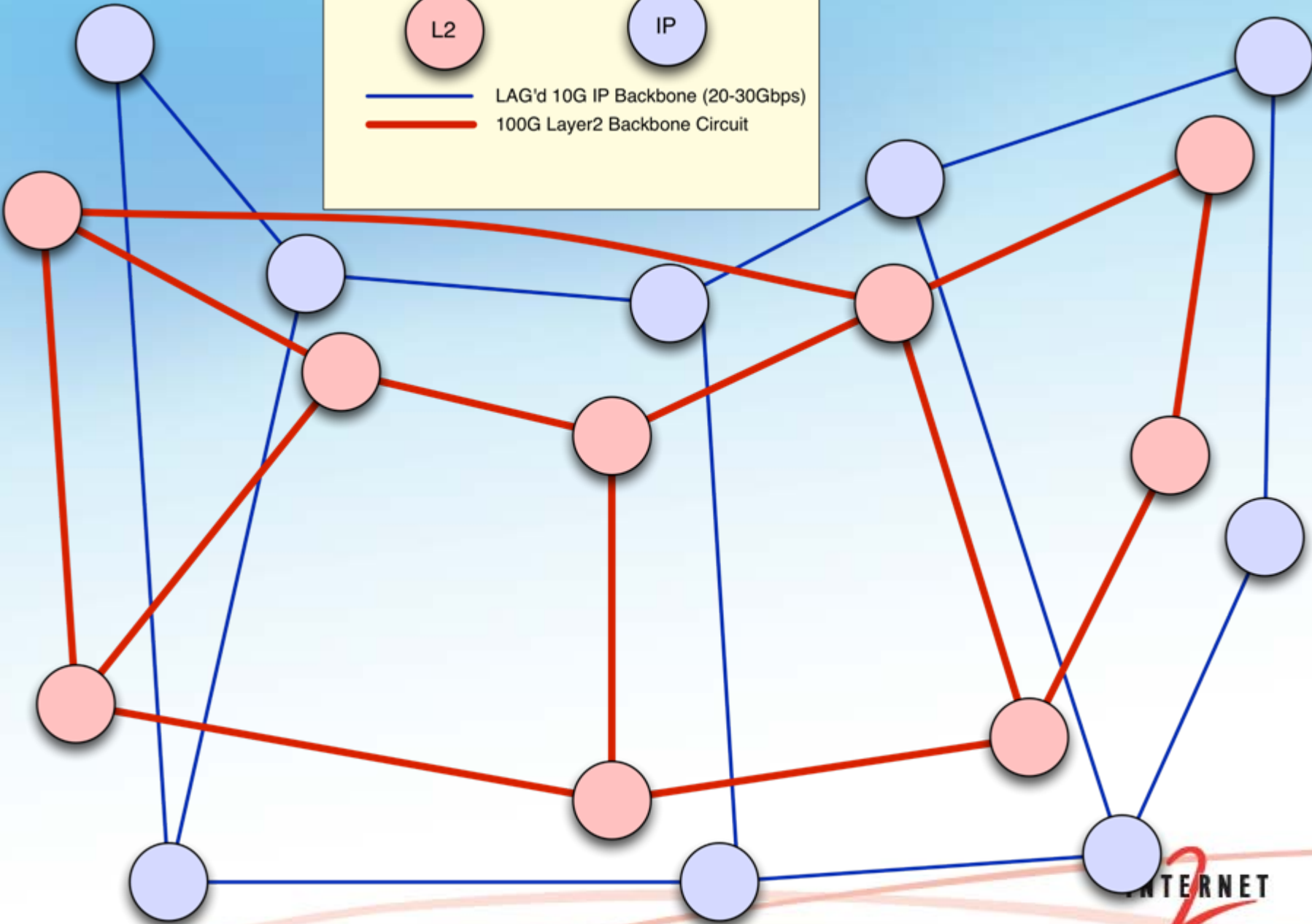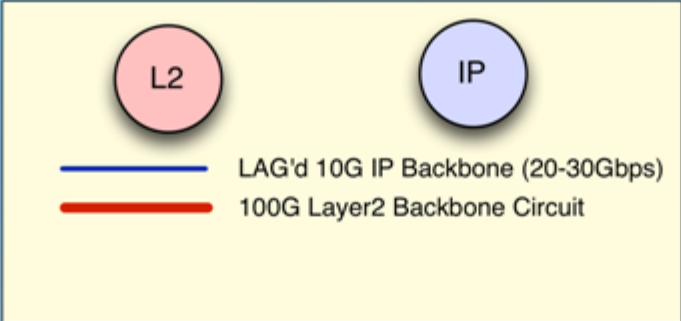
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Advanced Layer2 Service Traffic Growth

Advanced Layer2 Service Deployment

IP

L2   IP

Legend:
- L2
- IP
- LAG'd 10G IP Backbone (20-30Gbps)

L2　　　IP

LAG'd 10G IP Backbone (20-30Gbps)
100G Layer2 Backbone Circuit

L2

IP

LAG'd 10G IP Backbone (20-30Gbps)

100G Layer2 Backbone Circuit

2x100G IP-Layer2 Interconnect

L2

IP

LAG'd 10G IP Backbone (20-30Gbps)

100G Layer2 Backbone Circuit

2x100G IP-Layer2 Interconnect

IGP adjacency across VLAN

statically
configured
VLAN

INTERNET
2

L2

IP

LAG'd 10G IP Backbone (20-30Gbps)

100G Layer2 Backbone Circuit

2x100G IP-Layer2 Interconnect

IGP adjacency across VLAN

statically
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VLAN

SDN
Signalled
VLAN

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2

L2

IP

LAG'd 10G IP Backbone (20-30Gbps)

100G Layer2 Backbone Circuit

2x100G IP-Layer2 Interconnect

IGP adjacency across VLAN

statically configured VLAN

SDN Signalled VLAN

Native IP Backbone
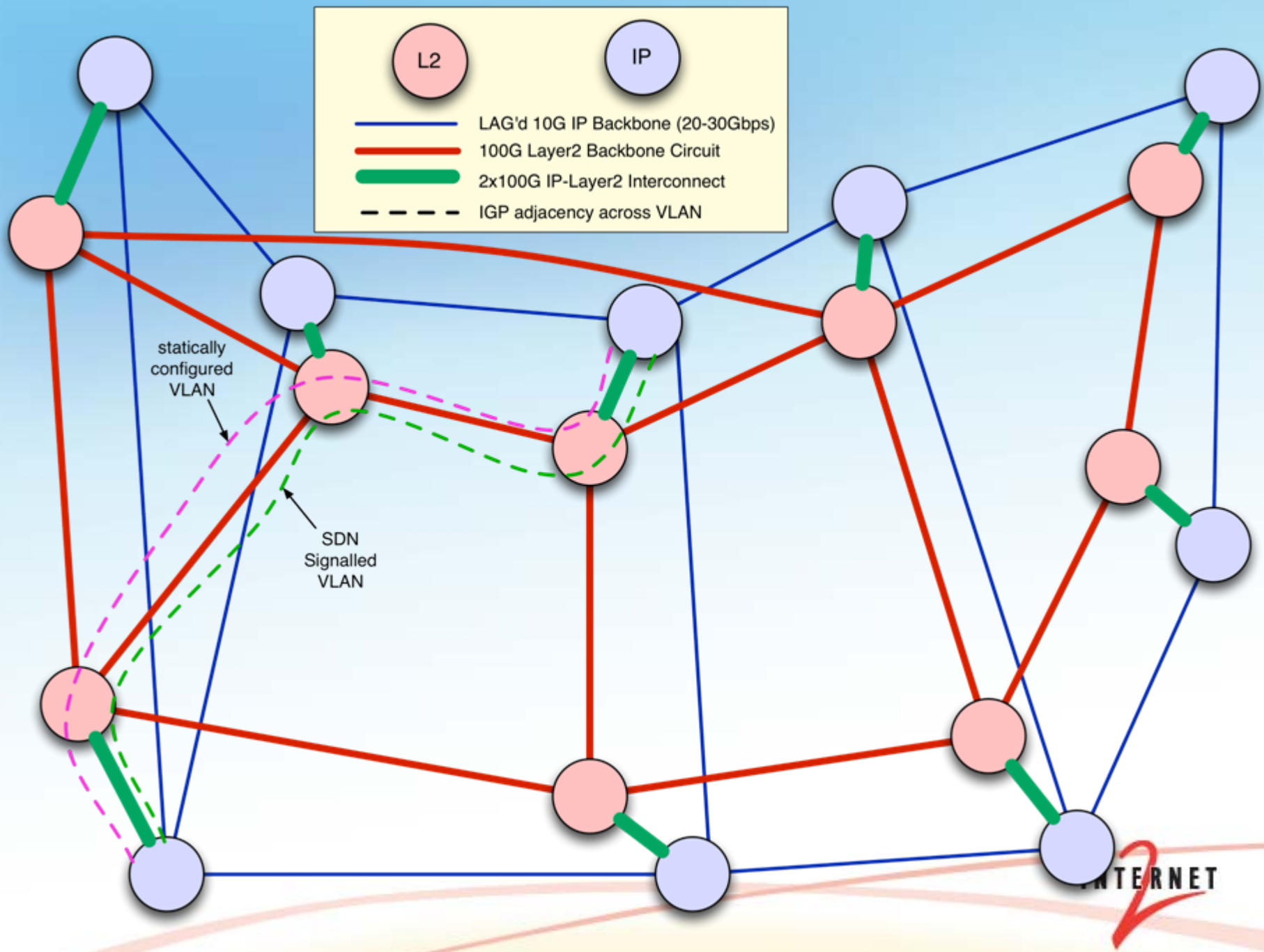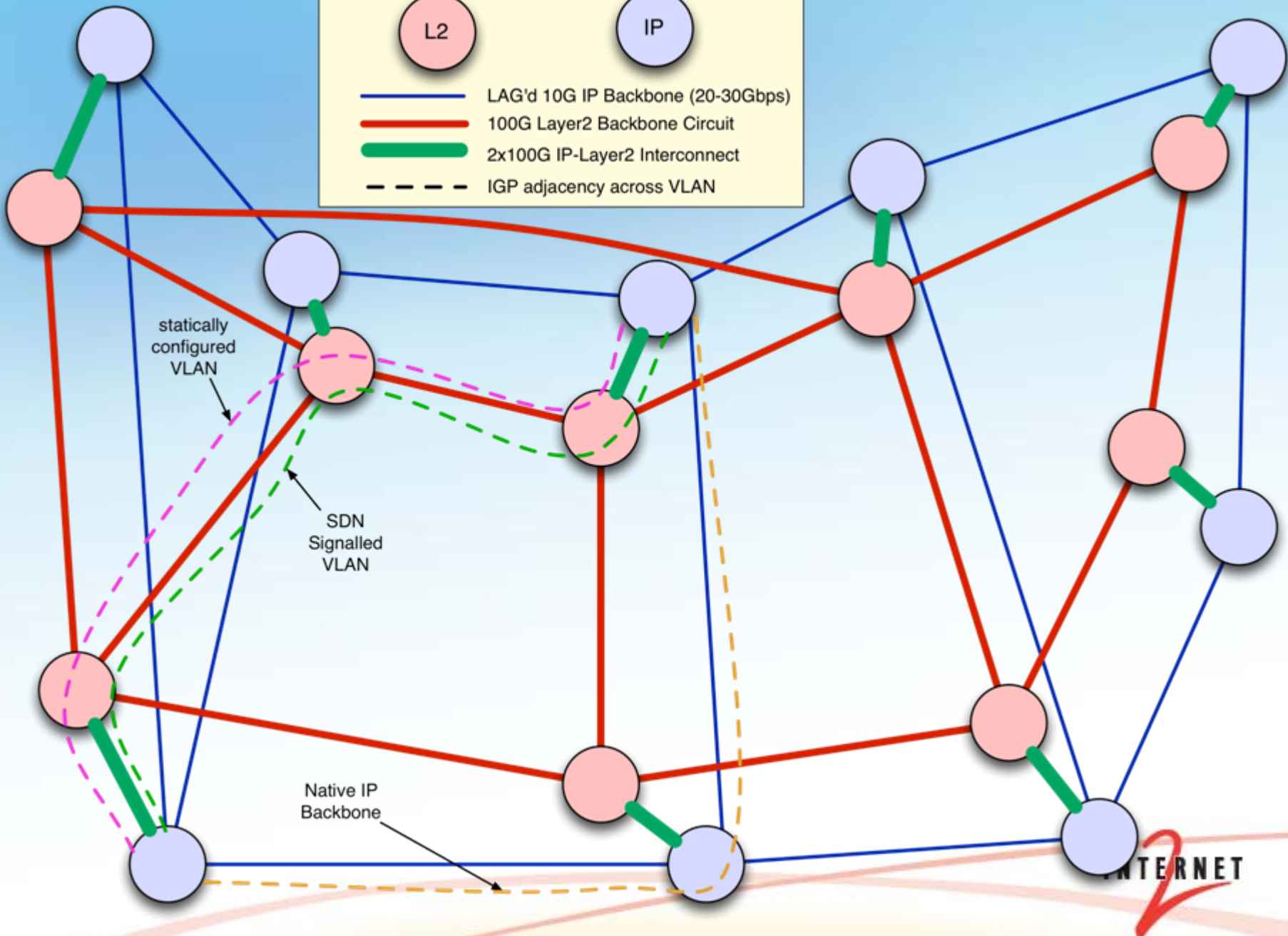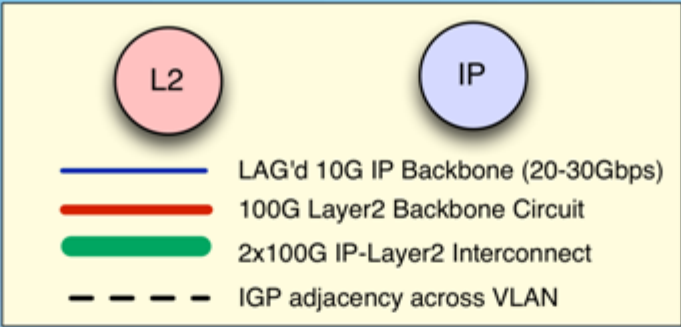
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Strawman Summary

- 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

INTERNET
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INTERNET 2 ®

- **100G Nationwide Backbone**
- **Native OpenFlow w/ virtual slices**
- **Multivendor Environment**
- **Available at Public Peering Points**
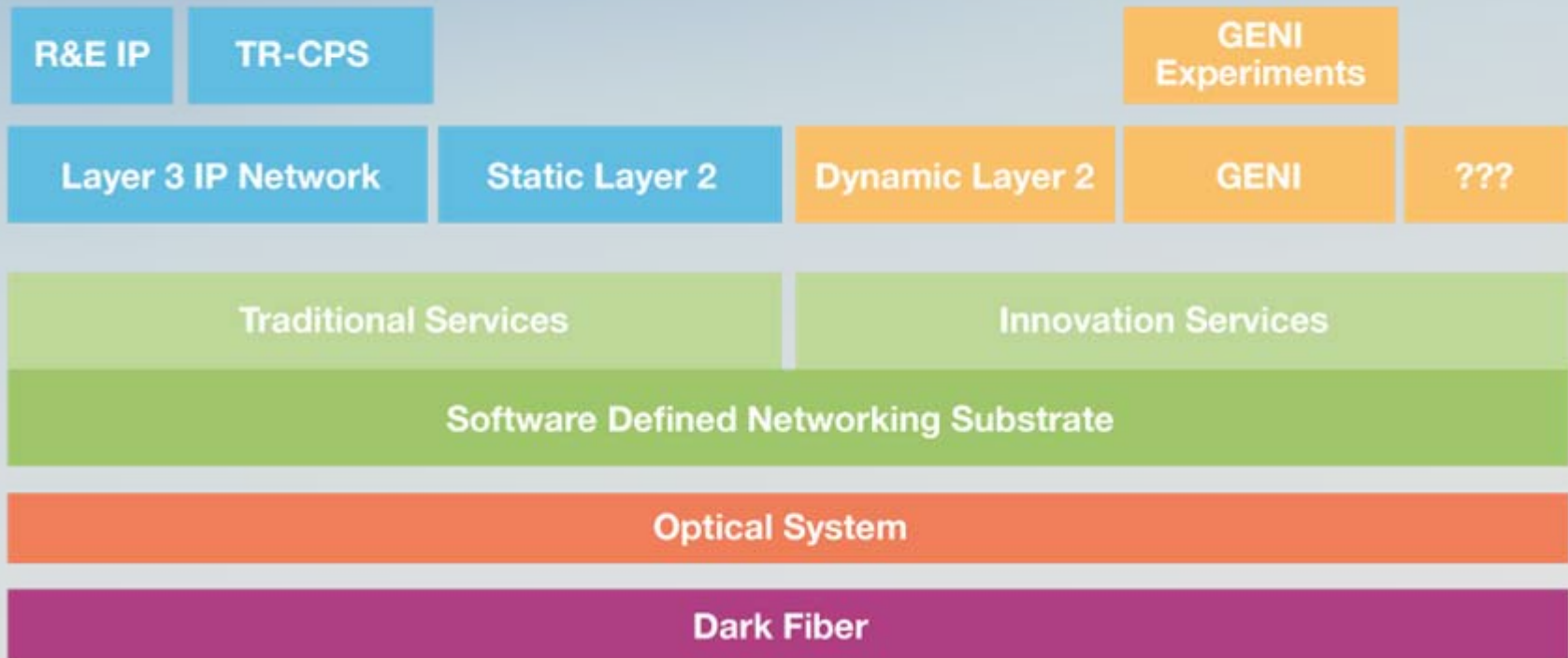- **½ Year of solid production experience**

- **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
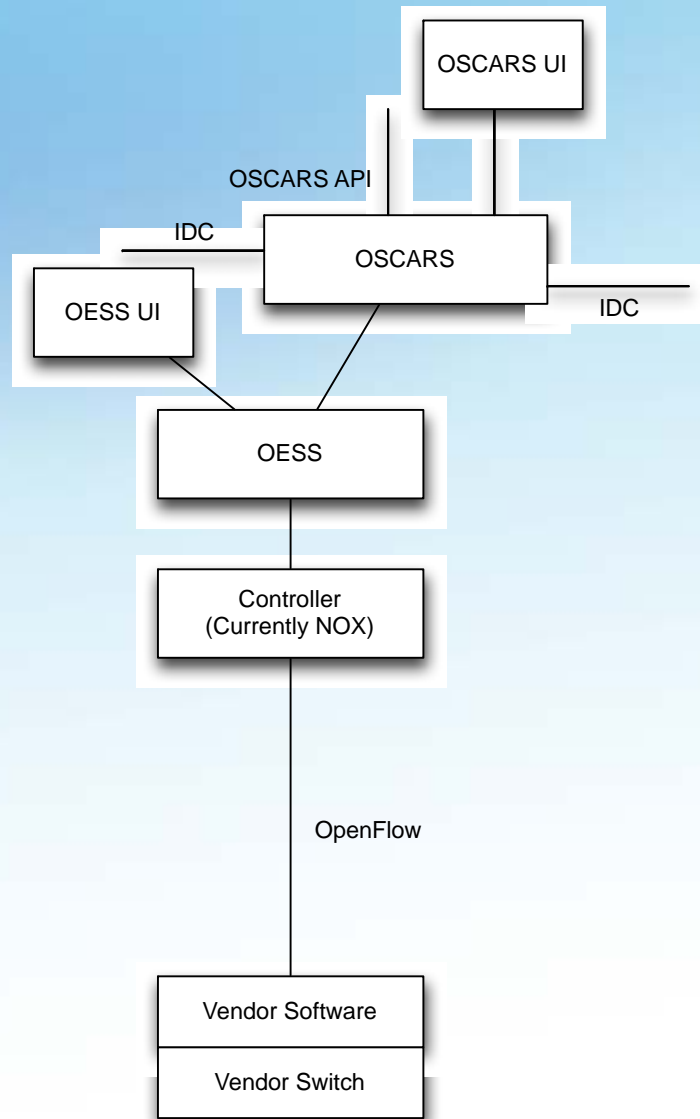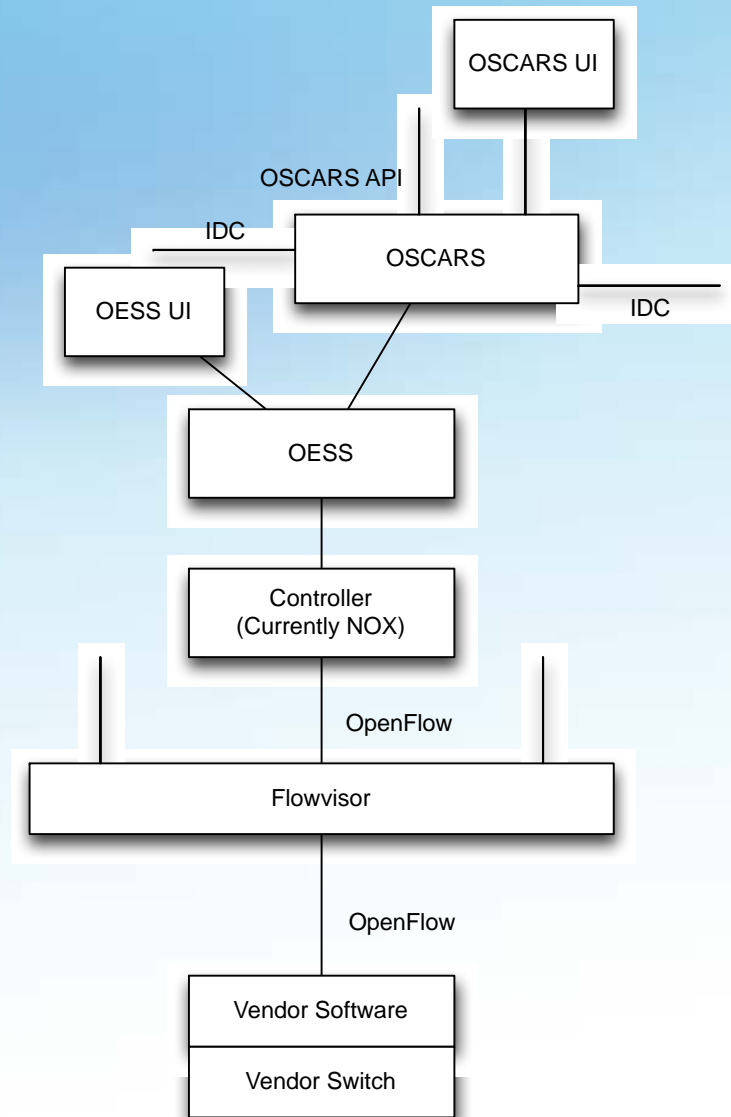
Long-term Architectural Aspiration

Internet2 Goals for Network Virtualization

- Common physical infrastructure

- Reliable production services

- Virtual network Definition

  – Slice of the physical network

  – Full functionality within constrained resources
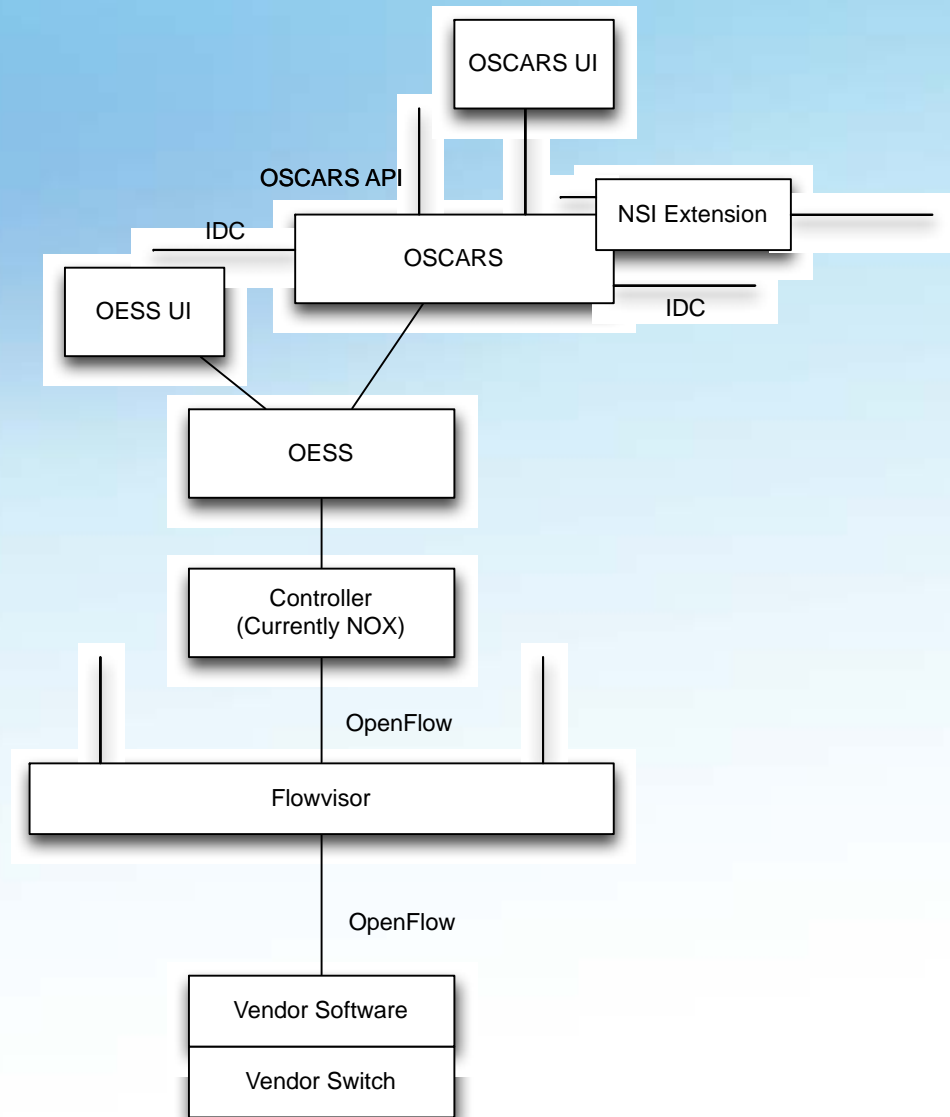
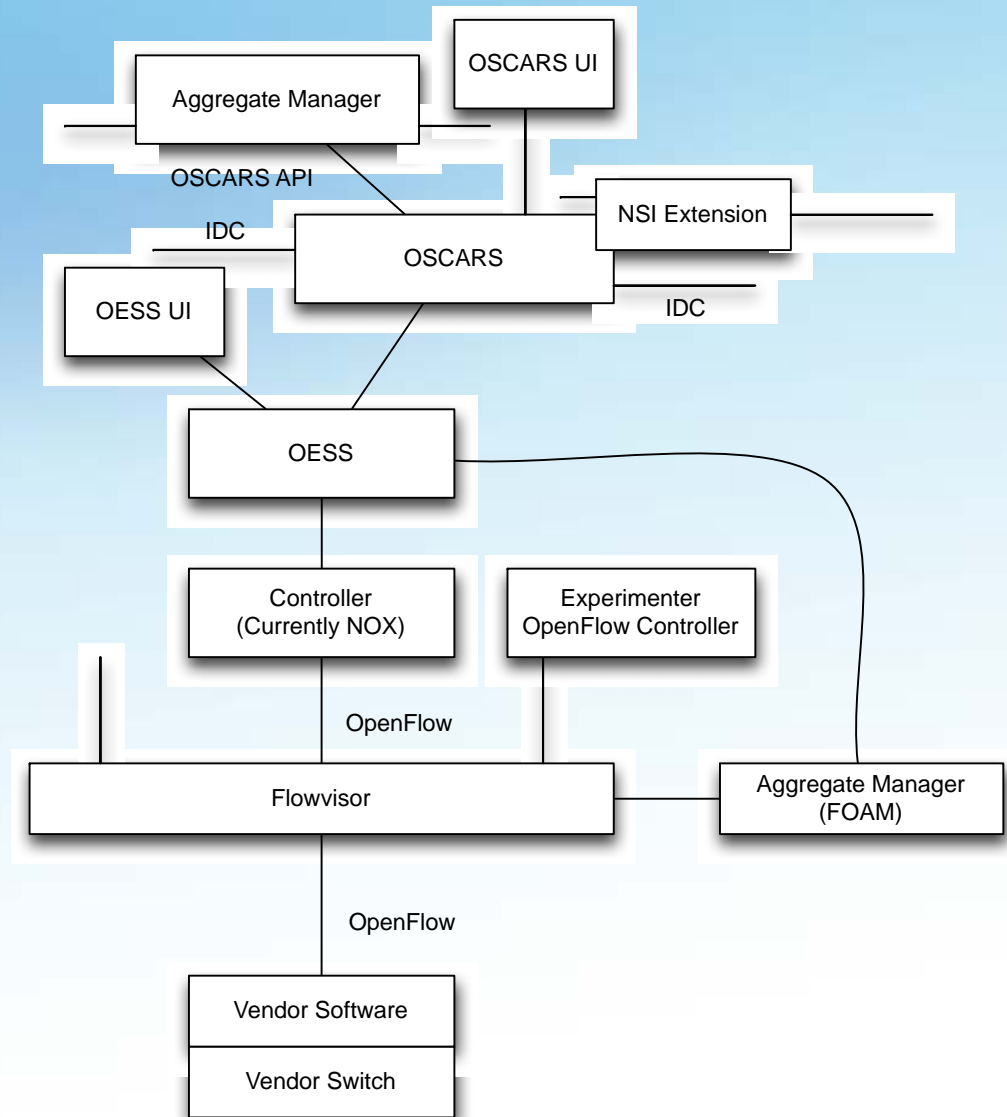 – Ability to try out "bad code"

INTERNET

Software Stack — Q3 2012

OSCARS UI

OSCARS API

IDC

OSCARS

OESS UI

IDC

OESS

Controller
(Currently NOX)

OpenFlow

Vendor Software

Vendor Switch

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Software Stack — Q1 2013

OSCARS UI

OSCARS API

IDC

OSCARS

OESS UI

IDC

OESS

Controller
(Currently NOX)

OpenFlow

Flowvisor

OpenFlow

Vendor Software

Vendor Switch

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Software Stack — Now

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Software Stack — Q2 2013

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INTERNET2: BUILDING THE NEXT U.S. INNOVATION PLATFORM

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