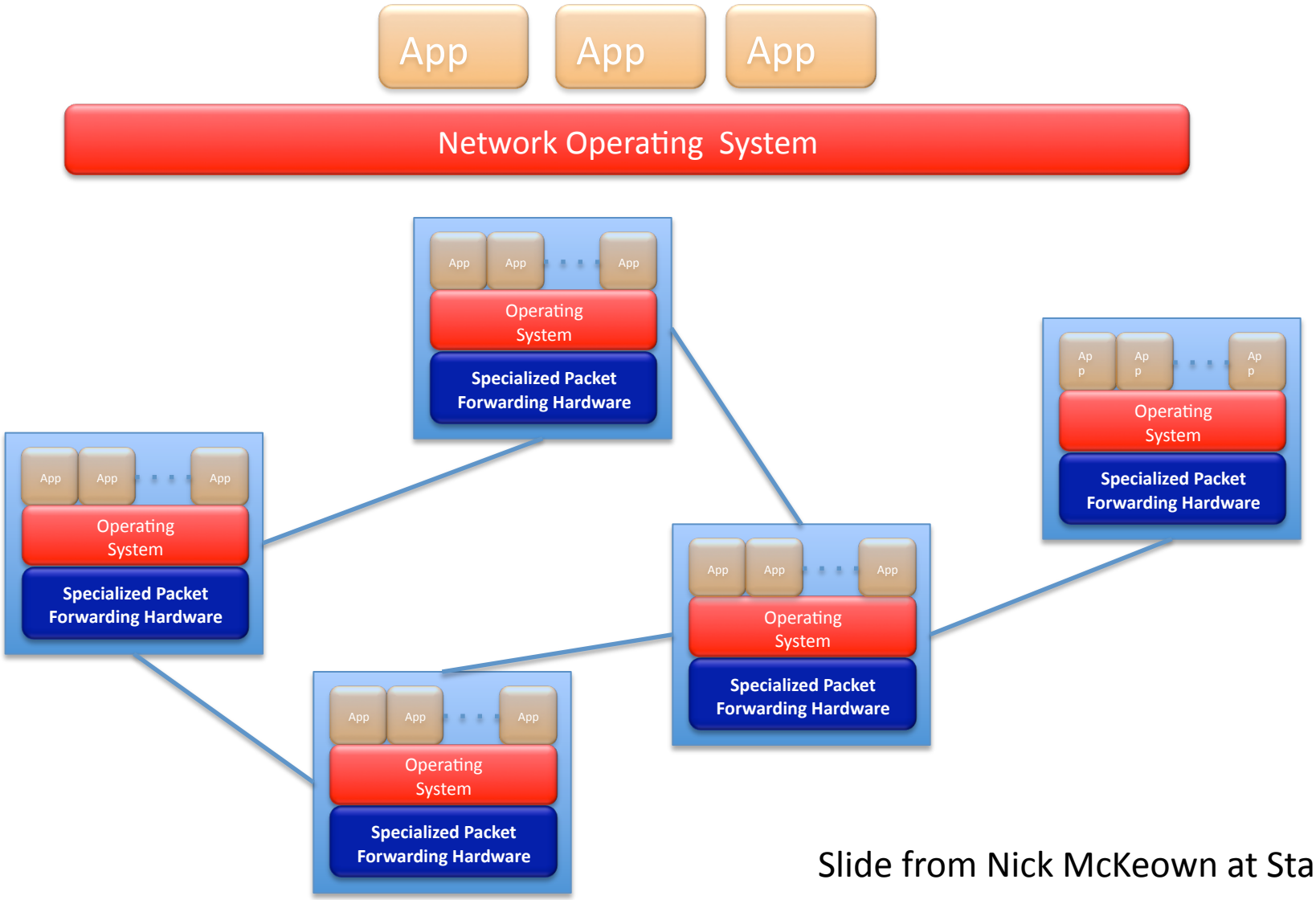
OpenFlow: operational experiences

Christopher Small, Indiana University

APAN Future Internet Workshop

August 11th, 2010



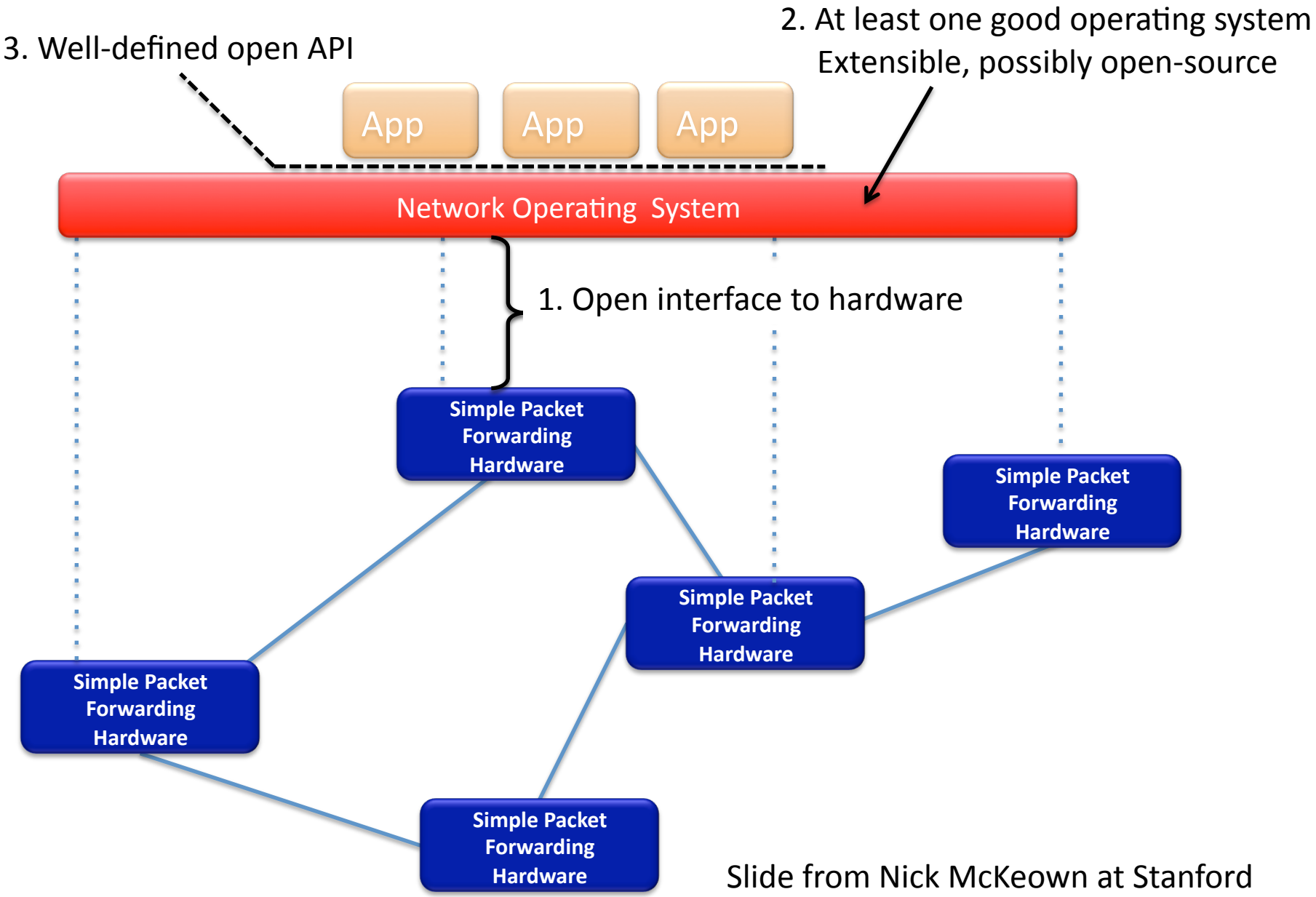
Slide from Nick McKeown at Stanford

Keys to OpenFlow/Software-Defined Networking

- Separation of Control Plane & Data Plane with Open API Between the Two
- Logically Centralized Control-Plane with Open API to Applications
- Network Slicing/Virtualization

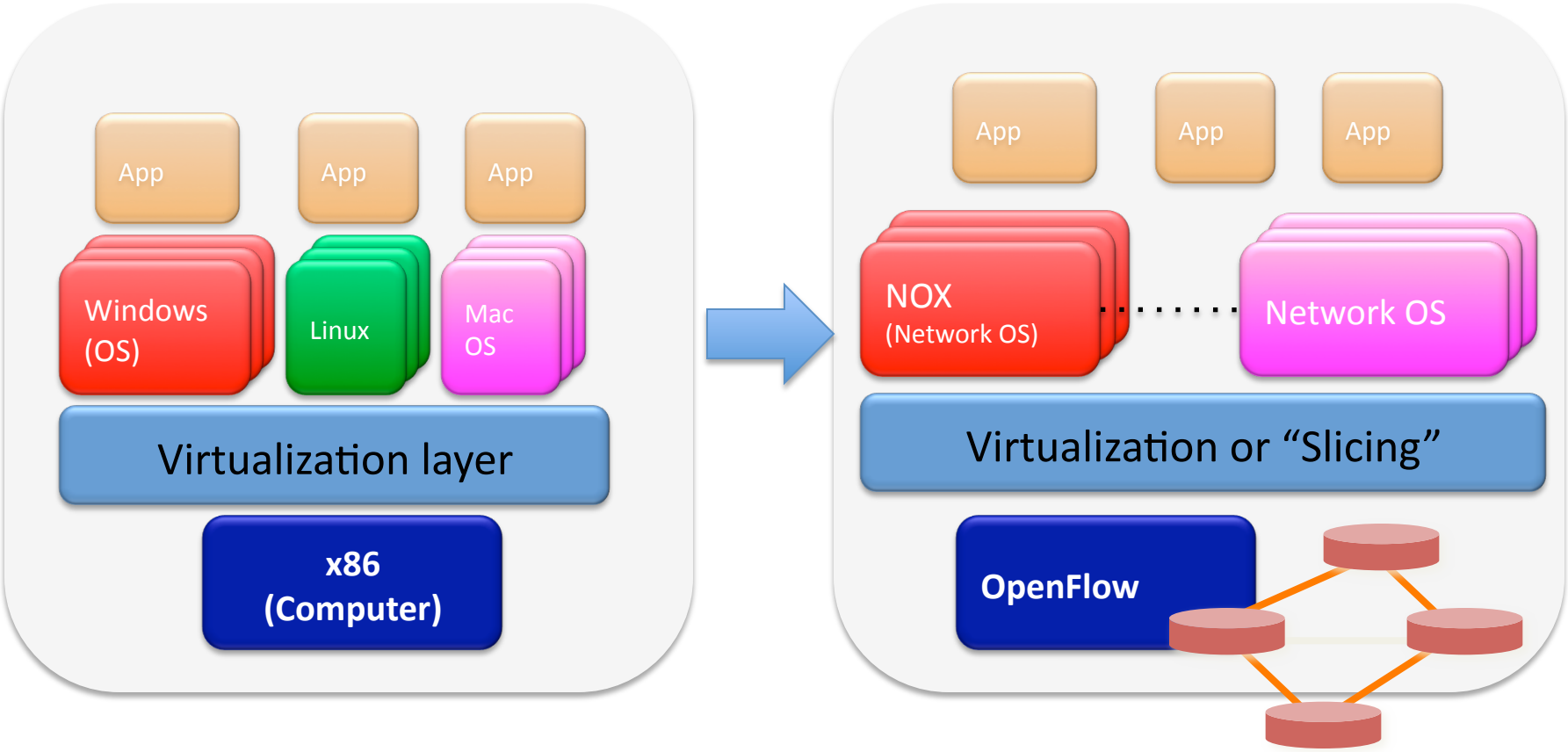
- Creates Open Interfaces between Hardware, OS and Applications Similar to Computer Industry
- Increases Competition, Enables Innovation

The "Software-defined Network"



Slide from Nick McKeown at Stanford

Trend



Computer Industry

Network Industry

Slide from Nick McKeown at Stanford

Logically Centralized Control-Plane

- “Logically” because multiple controllers for scalability and resiliency; even geographic diversity
- Analogy to Chassis-based Architecture
  - Mgmt Module (PC-class hw) Running OS
  - Mgmt Module Updates Linecard ASICs that forward packets
  - With Openflow, OS runs on central server and can update ASICs in many switch enclosures
- Turns your network into one big switch

What Could You Do with Openflow ?

- 1k-3k TCAM Entries in Typical Edge Switch
  - Difficult to take advantage of
    - Individual configuration in every switch
    - Pushing ACLs via RADIUS has limited benefit
      - Can only push once at time of authentication
      - Specific to individual switch port
      - Only Support Allow/Deny
  - But what if you could flexibly program these centrally using a standard API ?

Possible Uses of OpenFlow (Quick Wins)

- Security Applications
  - Network Access Control
  - Intrusion Detection System
  - Remote Packet Capture & Injection
- VM Mobility
  - Redirect specific application traffic to remote site
  - Flow-based forwarding – no need to extend entire broadcast domain – no STP issues

Possible Uses of OpenFlow (Quick Wins)

- Dynamic Circuit Provisioning
  - Don't need to extend layer-2 end-to-end
  - Simply direct specific flows down a engineered path with guaranteed priority
  - Don't have to rely on scripted SSH sessions, SNMP or other sub-optimal ways to programmatically configure switches/routers.

Possible Uses of Openflow (Grand Challenges)

- Distributed Control-Plane Architecture Requires a Lot of State to be Synchronized Across Many Devices
- Many Protocols Needed for Synchronization Internally to Networks (OSPF, RSVP, STP, etc)
- Can these “internal” protocols eventually be removed entirely with only BGP for inter-domain route advertisements ?

Virtualization/Slicing

- Enable Multiple Research Instances on Same Switch
  - Each research slice would have separate controller
- Once Production is OpenFlow Controlled…
  - Slicing Enables Separate Controllers for Production & Research (or regular forwarding)
  - Multiple Controllers for Different Parts of Production Network (Think MPLS VPN Replacement)
- Ease of transition from Research to Production

GENI & OpenFlow

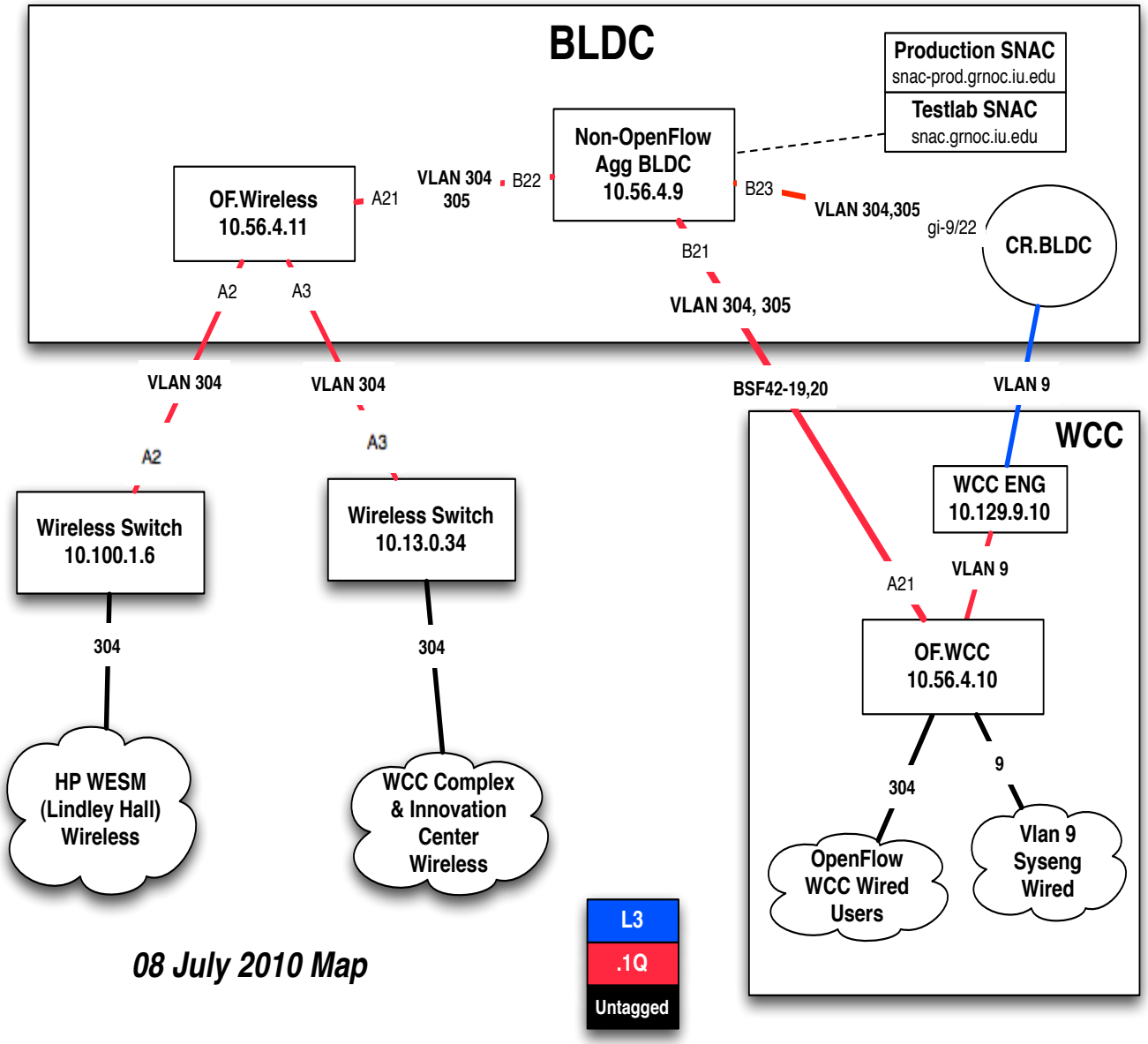
- Global Environment for Network Innovation
  - NSF Funded research infrastructure to conduct research
  - Virtualized environment
- OpenFlow Campus Trials at 7 U.S. Campuses
- National Deployments in U.S. (Internet2/ National Lambda Rail)
- International connections ?? (IRNC, OFELIA)

OpenFlow deployments

- Need Basic Components for Deployment
  - Openflow: 1.0 available, 1.1 in development
  - Hardware (HP, NEC, Pronto)
  - Open-Source Controller (NOX)
  - Apps that provide base functionality
    - SNAC
      - Basic Layer-2 Switching
      - Policy Enforcement (ACL & Captive Portal)
      - Enables “Edge” Deployment
  - Operational Tools

Current Status @ IU

- 2 Campuses w/national connectivity (via NLR/I2)
  - 4 OpenFlow-enabled switches in lab
  - 3 OpenFlow switches in production
    - Opt-in users only
- OpenFlow SSID in 6 Buildings
- 20-30 Regular Users
- Focused on “Edge” Deployment
  - Most compelling short-term use case
  - Limitations # of table entries, flows/sec
- Adapting NMS and processes to OpenFlow



08 July 2010 Map

How do I get started ?

- www.openflowswitch.org
- Can run everything in VMs (Mininet, OpenVSwitch, OpenFlowVMS)
- Start with SNAC + Switch
- Install Reference Implementation for Wireshark Plugin and dpctl
- Deploy on existing hw switches if you have ones that support OpenFlow