OpenADN: Mobile Apps on Global Clouds Using Software Defined Networking



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These slides and audio/video recordings are available at:
http://www.cse.wustl.edu/~jain/talks/adn_ant.htm

Top Networking Trends of 2012

1. Cloud Computing and Mobile Apps
2. Software Defined Networking
3. Centralization of Control Pane
4. Virtualization

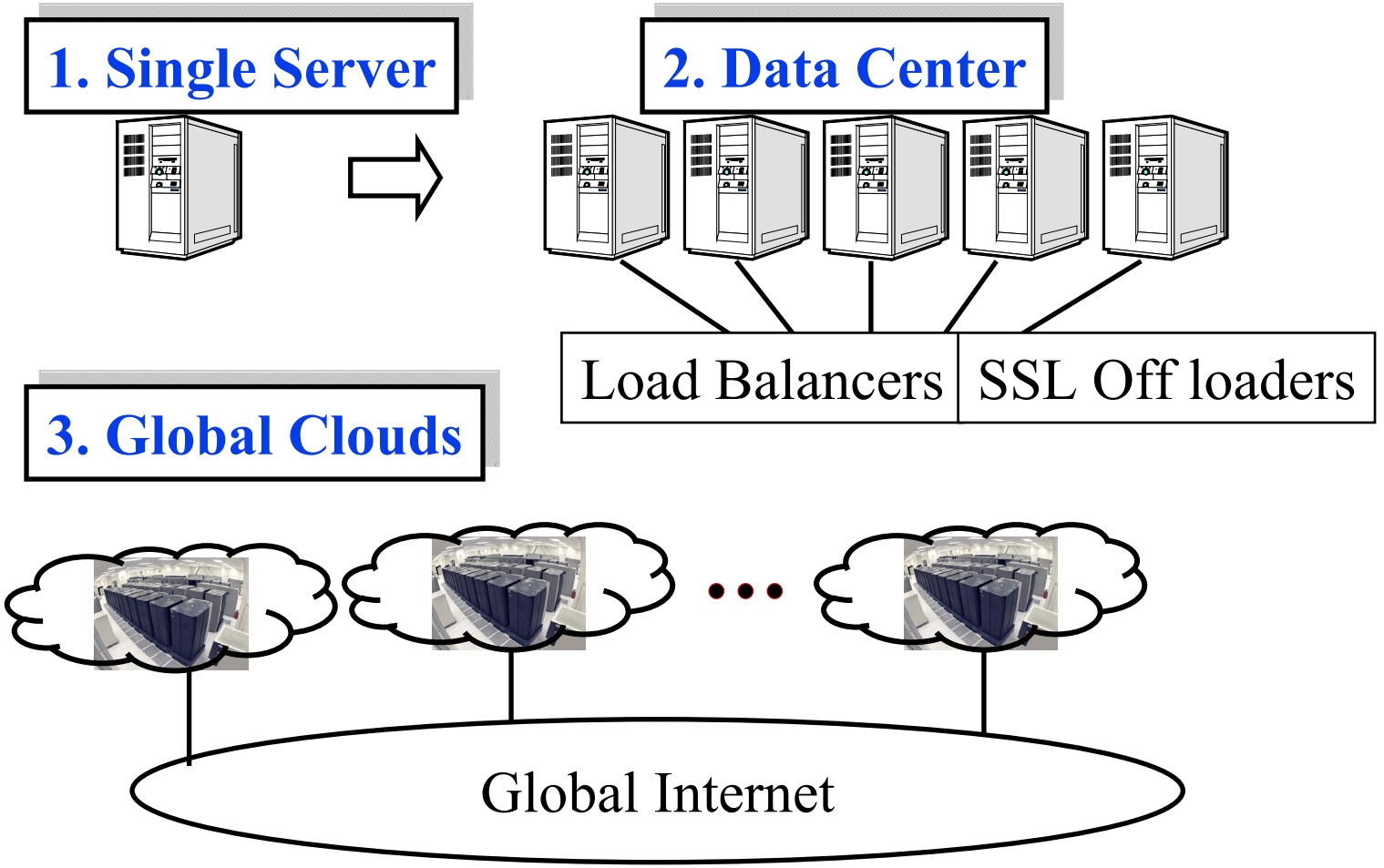
Clouds and Mobile Apps

- August 25, 2006: Amazon announced EC2
  ⇒ Birth of Cloud Computing in reality
  (Prior theoretical concepts of computing as a utility)
- *Web Services To Drive Future Growth For Amazon* ($2B in 2012, $7B in 2019)
  - Forbes, Aug 12, 2012

- June 29, 2007: Apple announced iPhone
  ⇒ Birth of Mobile Internet, Mobile Apps
  - Almost all services are now mobile apps: Google, Facebook, Bank of America, …
  - Almost all services need to be global (World is flat)
  - Almost all services use cloud computing

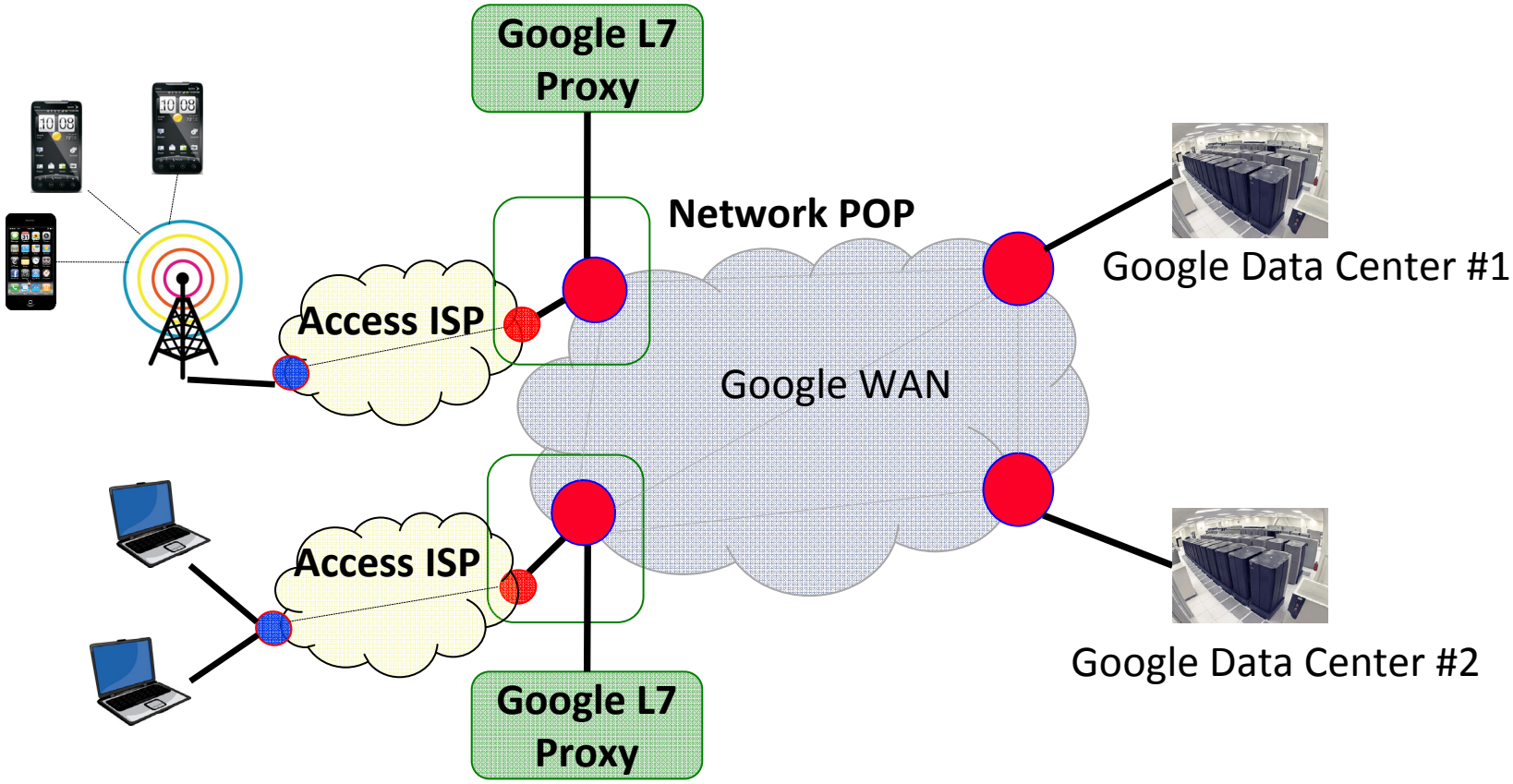
Networks need to support efficient service setup and delivery

Service Center Evolution



Need to make the global Internet look like a data center

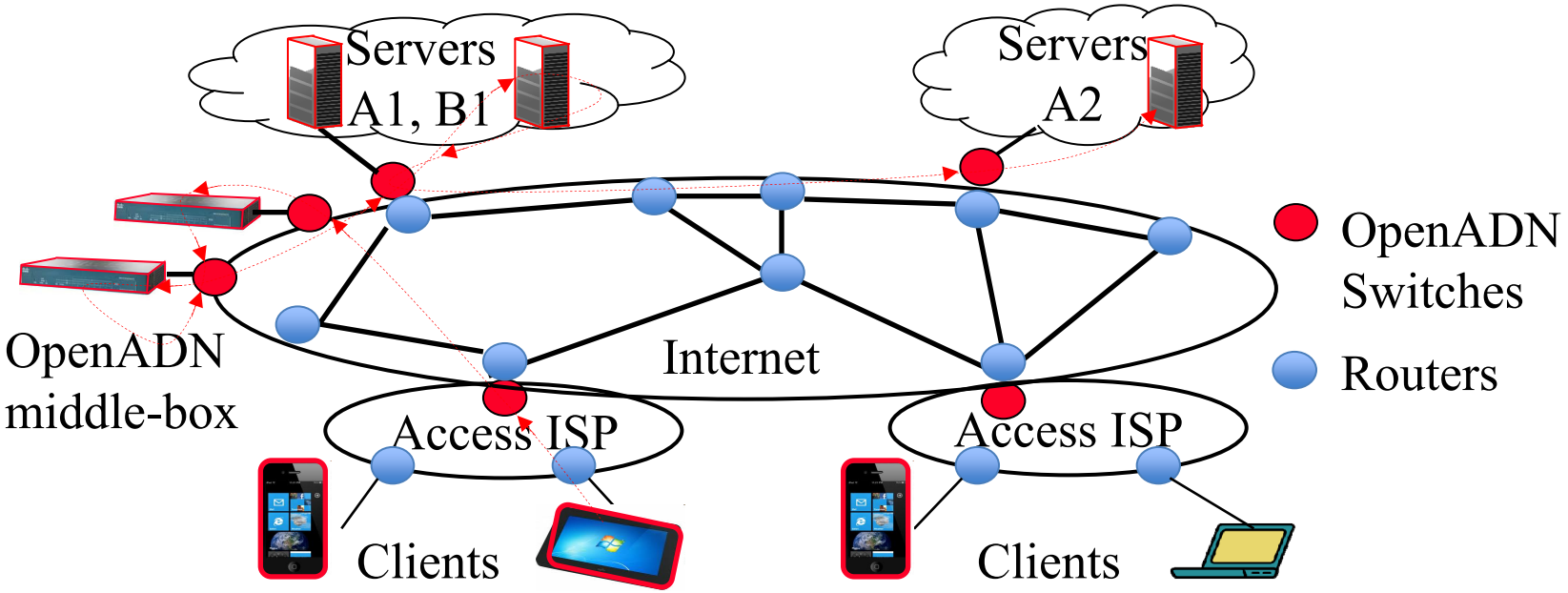
Google WAN



- Google appliances in Tier 3 ISPs
- Details of Google WAN are not public
- ISPs can not use it: L7 proxies require app msg reassembly

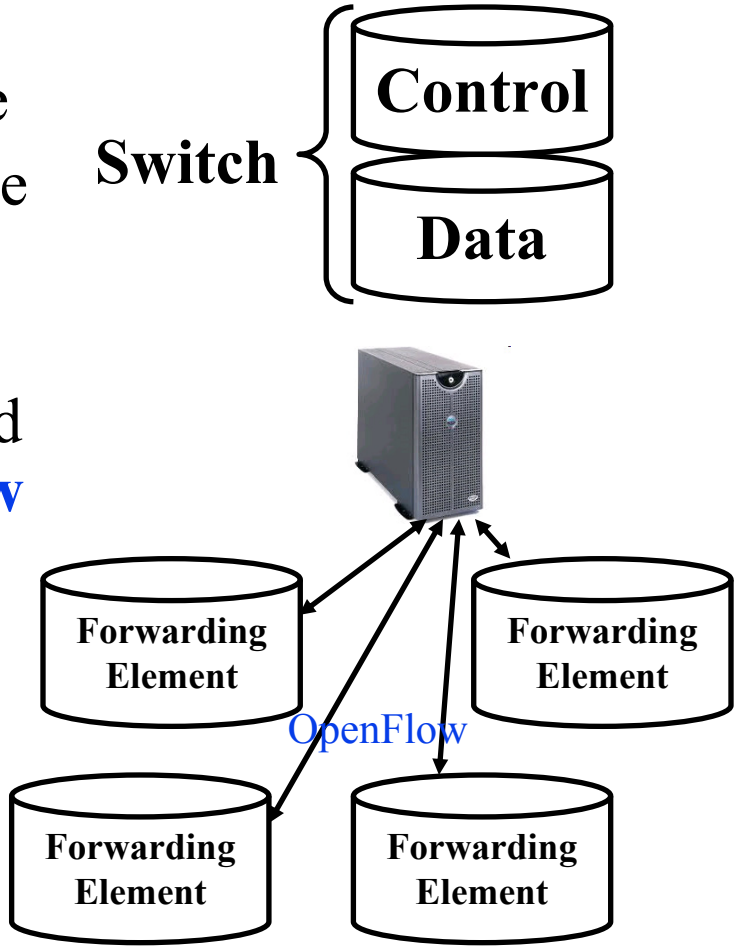
Our Solution: OpenADN

- Open Application Delivery Networking Platform
  Platform = OpenADN aware clients, servers, switches, and middle-boxes
- Allows Application Service Providers (ASPs) to quickly setup services on Internet using cloud computing⇒ Global datacenter



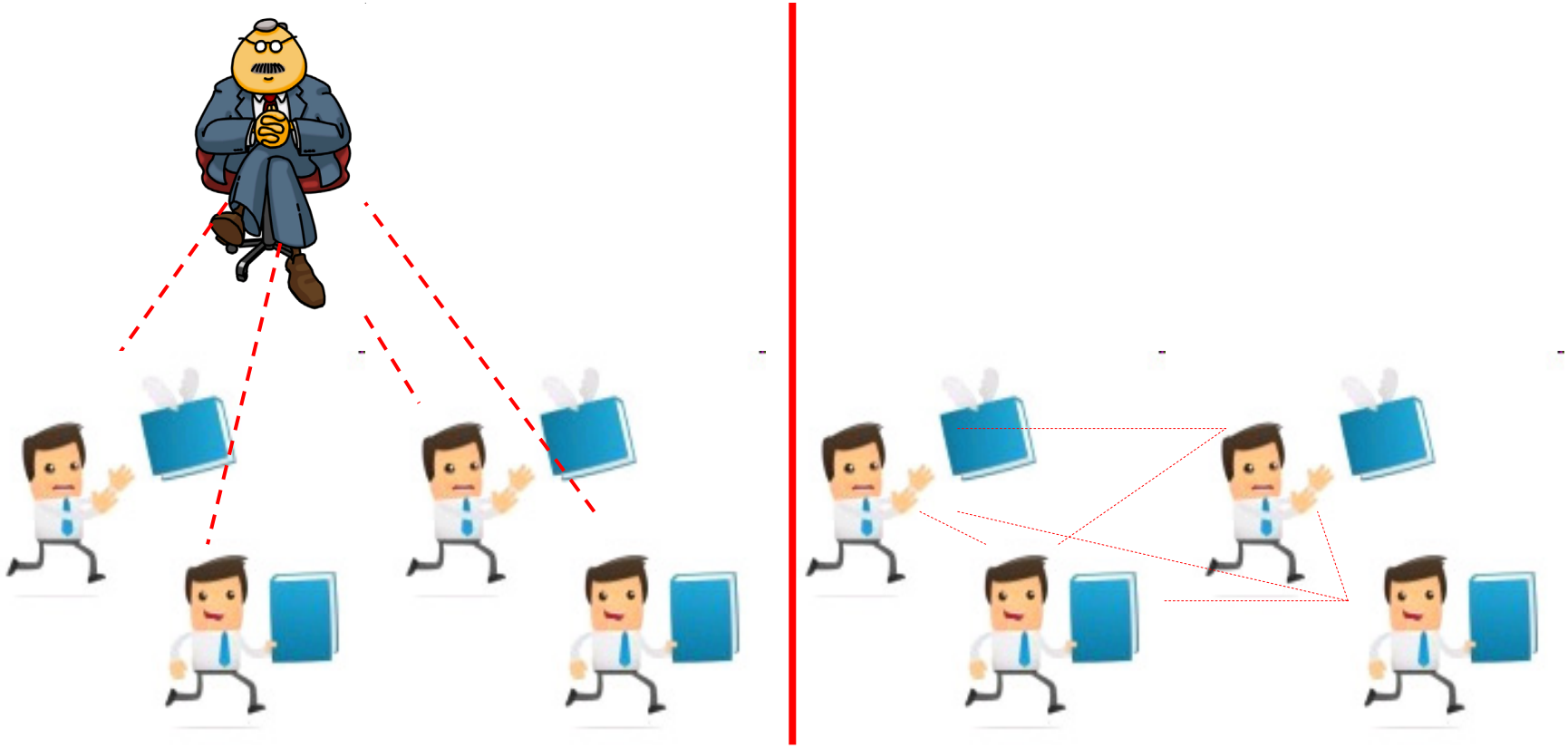
Step 1: Centralization of Control Plane

- Control = Prepare forwarding table
- Data Plane: Forward using the table
- Forwarding table is prepared by a central controller
- Protocol between the controller and the forwarding element: **OpenFlow**
- Centralized control of policies
- Switches are simple.
  Controller can be complex
  Can use powerful CPUs
- Lots of cheap switches
  = Good for large datacenters



Ref: [MCK08] ``OpenFlow: Enabling Innovation in Campus Networks," OpenFlow Whitepaper, March 2008
http://www.openflow.org/documents/openflow-wp-latest.pdf

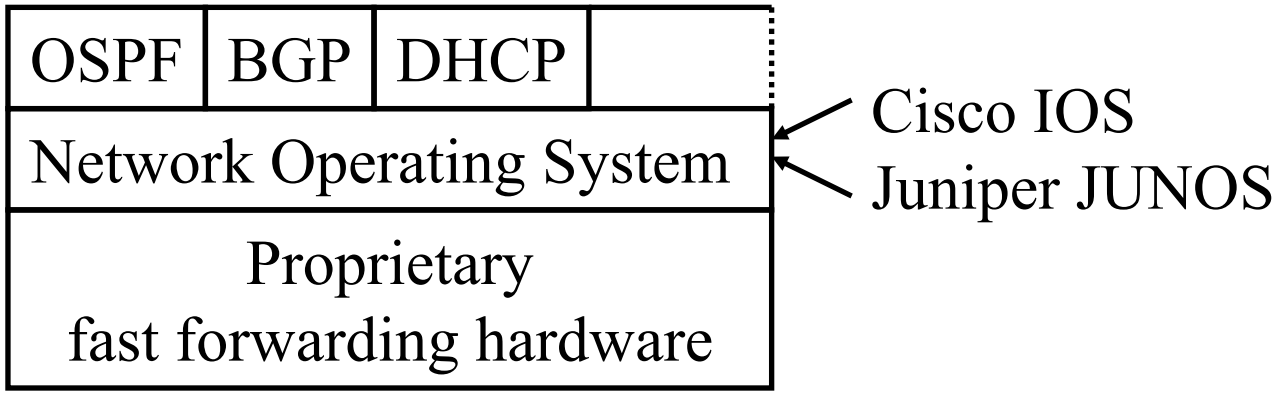
Centralized vs. Distributed



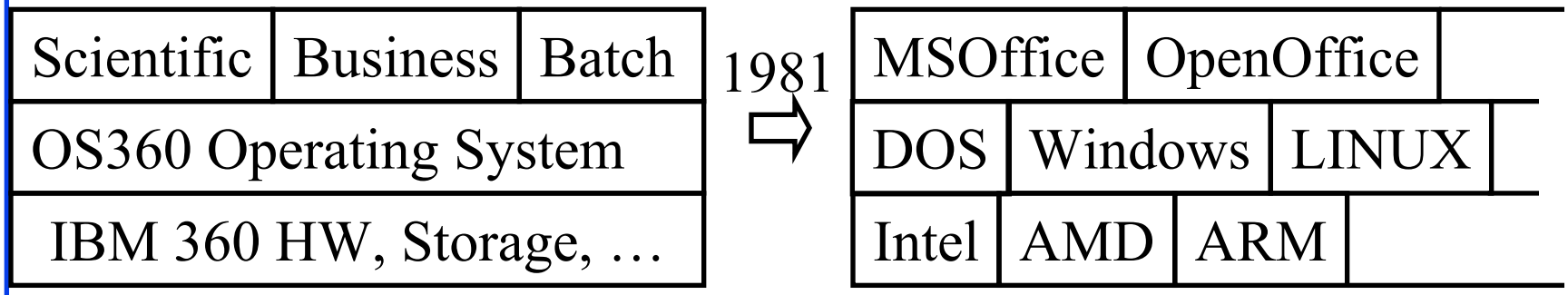
- Fully centralized is not scalable.
  Fully distributed is not manageable.
  ⇒ Hierarchy

Step 2: Standardized Abstractions

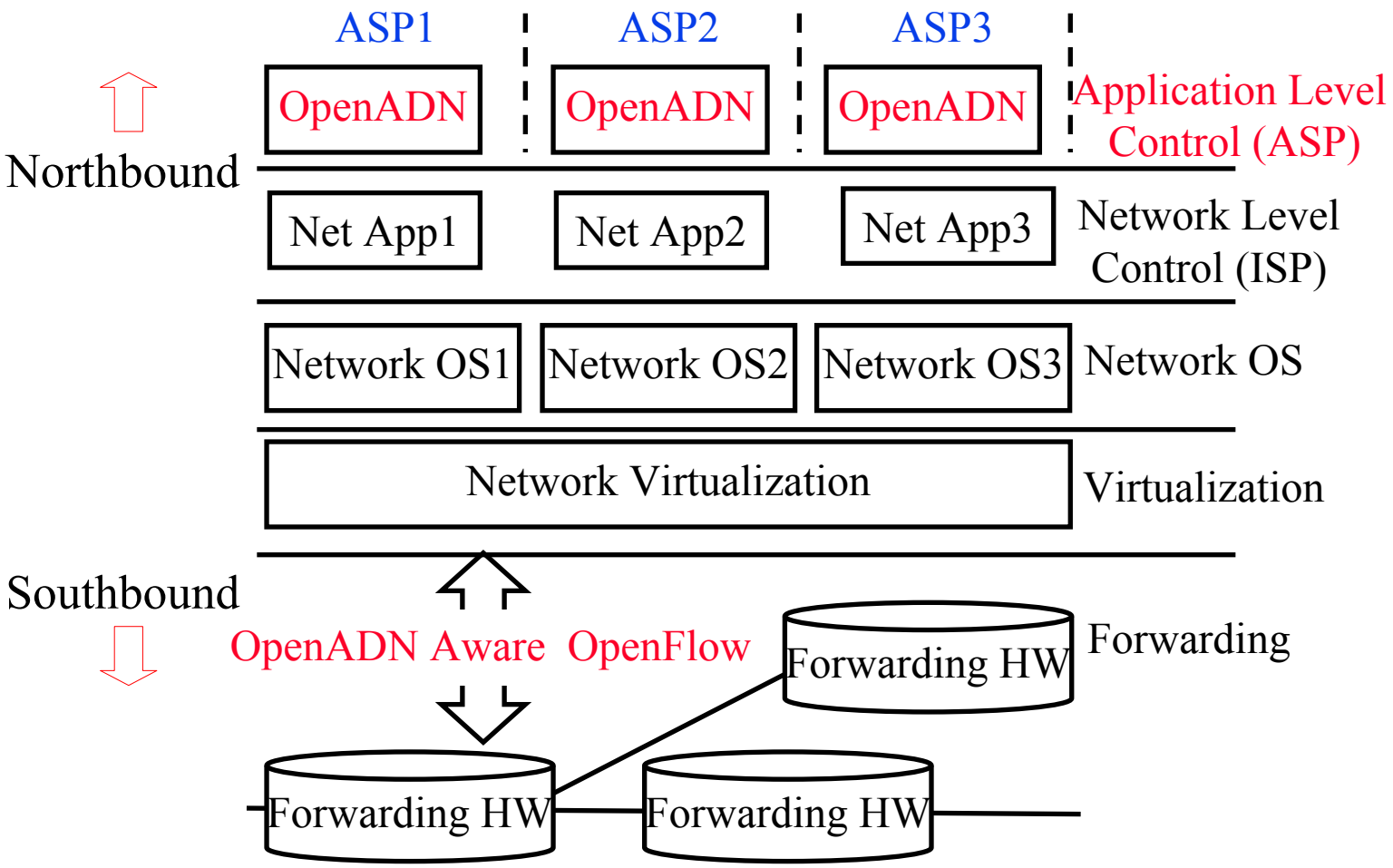
- The routers are expensive because there is no standard implementation.



- Similar to Mainframe era computers.



SDN's Layered Abstraction



Ref: http://www.itc23.com/.../K1_McKeown-ITC_Keynote_Sept_2011.pdf

SDN Impact

- Why so much industry interest?
  - Commodity hardware
    $\Rightarrow$ Lots of cheap forwarding engines $\Rightarrow$ Low cost
  - Programmability $\Rightarrow$ Customization
  - Those who buy routers, e.g., Google, Amazon, Docomo, DT will benefit significantly
- Tsunami of software defined devices:
  - Software defined wireless base stations
  - Software defined optical switches
  - Software defined routers

Industry Growth: Formula for Success

Innovators
⇒ Startups
⇒ Technology Differentiation

Big Companies
Manufacturing
⇒ Price differentiation

Number of Companies

New Entrants

Consoli-dation

Stable Growth

Time

- Paradigm Shifts ⇒ Leadership Shift
- Old market leaders stick to old paradigm and loose
- Mini Computers→PC, Phone→Smart Phone, PC→Smart Phone

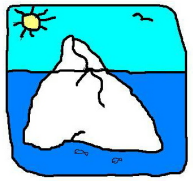
Key Features of OpenADN

1. Edge devices only.
   Core network can be current TCP/IP based, OpenFlow or future SDN based
2. Coexistence (Backward compatibility):
   Old on New. New on Old
3. Incremental Deployment
4. Economic Incentive for first adopters
5. Resource owners (ISPs) keep complete control over their resources

Most versions of Ethernet followed these principles.
Many versions of IP did not.

Network Virtualization

- OpenADN is per-application virtual global Internet
- Virtualization is the key enabler of cloud computing.
- Compute virtualization, storage virtualization, networking virtualization
- **Networking**: Plumbing
  - Past: Virtual Channels, Virtual LANs, VPN
  - Networks consist of: Hosts - L2 Links - L2 Bridges - L2 Networks - L3 Links - L3 Routers - L3 Networks – L4 Transports – L5 Applications
  - Each of these can be/need to be virtualized
  - Quick review of re[illegible]hnologies for network virtualization



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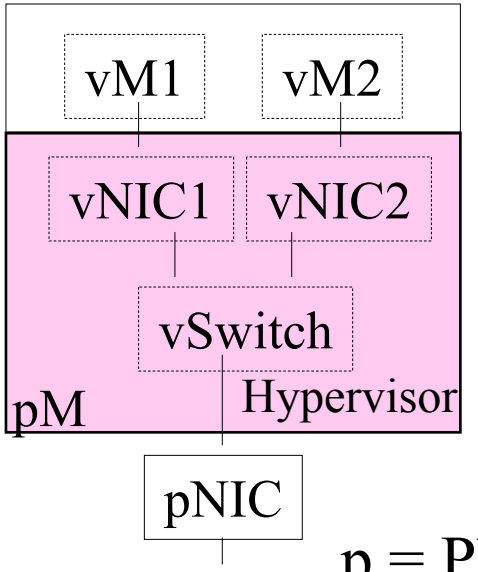
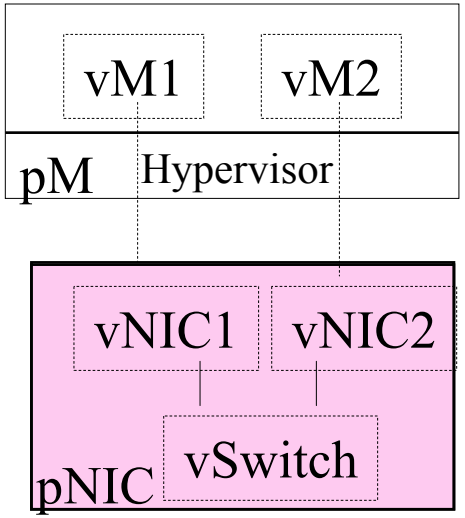
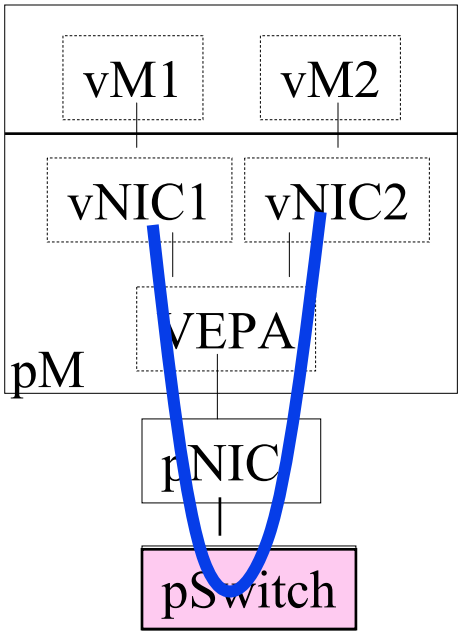
vNICs





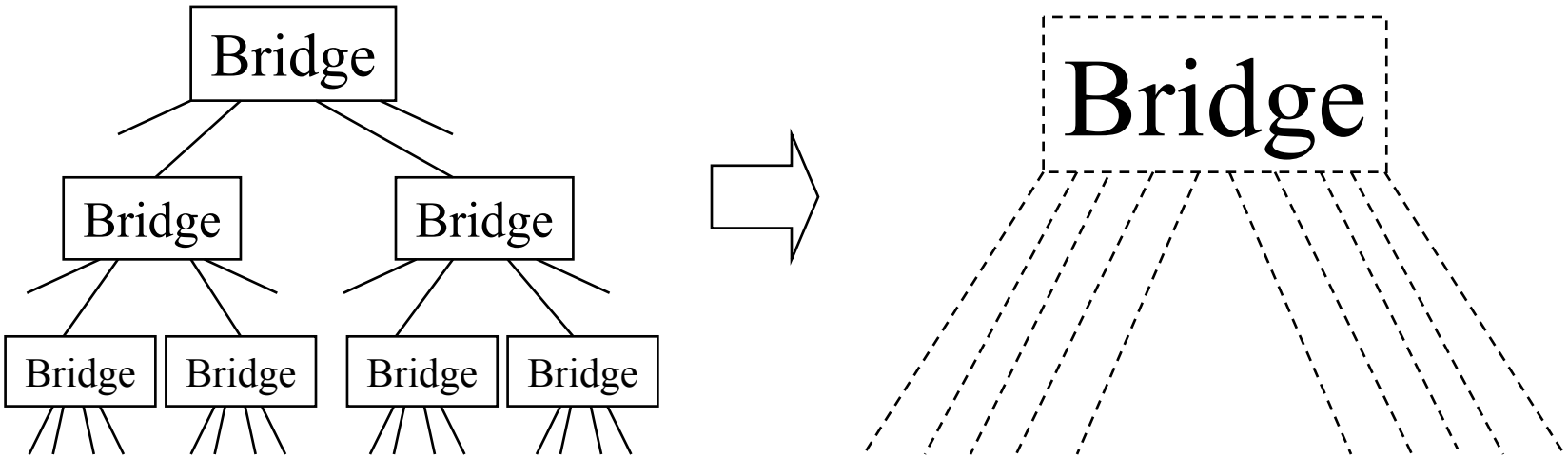


p = Physical, v = Virtual

1. Hypervisor vendors: S/W NICs in w Virtual Ethernet Bridge (**VEB**)(overhead, not ext manageable, not all features)
2. NIC Vendors: NIC provides virtual ports using Single-Route I/O virtualization (**SR-IOV**) on PCI bus
3. Switch Vendors: Switch provides virtual channels for inter-VM Communications using virtual Ethernet port aggregator (**VEPA**): **802.1Qbg** (s/w upgrade), **802.1Qbh** (new switches)

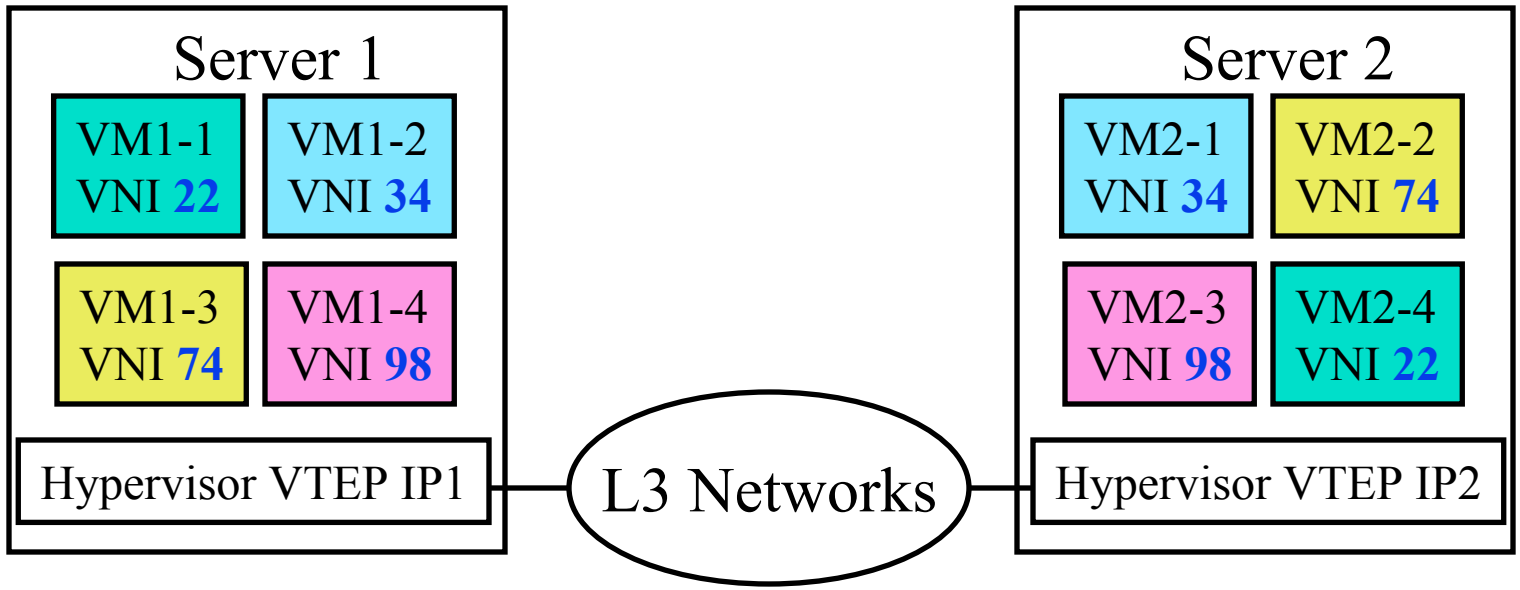
Bridge Port Extension

- Multiple physical bridges to make a single virtual bridge with a large number of ports
  ⇒ Easy to manage and configure
- **IEEE 802.1BR**



Multi-Tenants

- Each tenant needs its own networking domain with its VLAN IDs

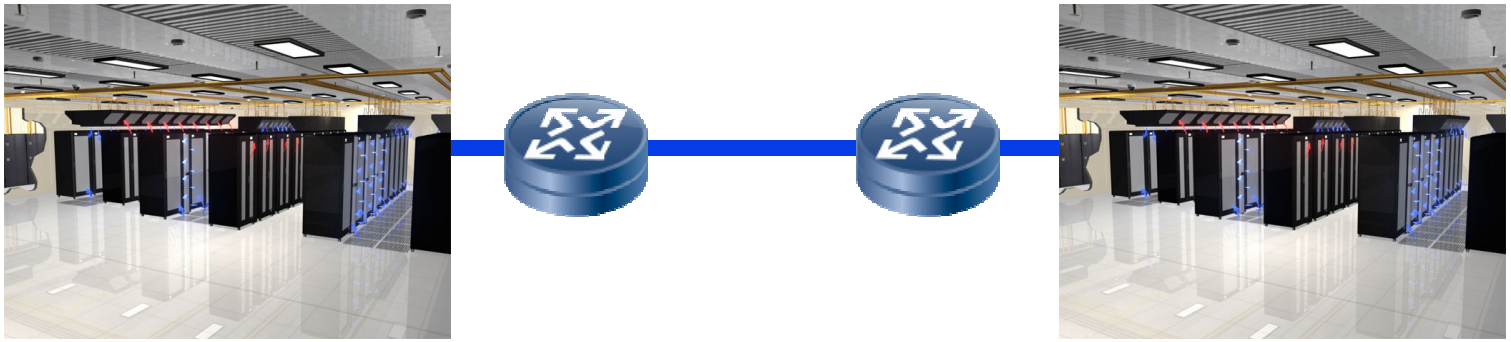


1. Virtual Extensible Local Area Networks (**VXLAN**)
2. Network Virtualization using Generic Routing Encapsulation (**NVGRE**)
3. Stateless Transport Tunneling Protocol (**STT**)

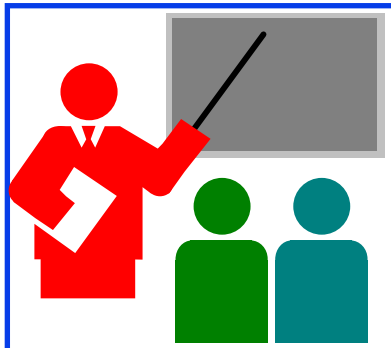
⇒ Network Virtualization over L3 (**NVO3**) group in IETF

Multi-Site

- Better to keep VM mobility in a LAN (IP address changes if subnet changes)



- Solution: IP encapsulation
- Transparent Interconnection of Lots of Links (**TRILL**)



Summary

1. Cloud computing ⇒ Virtualization of computing, storage, and networking
   ⇒ Numerous recent standards related to networking virtualization both in IEEE and IETF
2. Recent Networking Architecture Trends:
   1. Centralization of Control plane
   2. Standardization of networking abstractions
      ⇒ Software Defined Networking (SDN)
   3. Most networking devices will be software defined
3. OpenADN enables delivery of applications using North-bound SDN API