SDN Applications for IXPs and Service Providers

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What if you could …

| Build Networks Without Having to Manage an Endless List of Resource Limits | Virtualize Your Network to Increase Asset Utilization | Create and Deliver Customized Services and New Offerings | Unlock the Intelligence From Your Network for Real-Time Orchestration and Analytics |

Why can't you do these things today?

Types of Software Defined Networking

Two Main Approaches

Transform the Physical Network

SDN Controller

OpenFlow

Physical Network
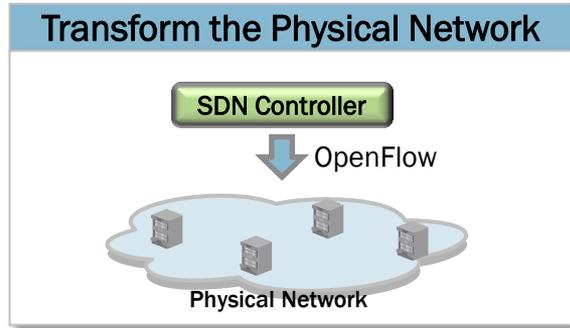
- Move Control Plane out of routers/switches
  - Modify how routers/switches work
  - Control routers with a programmatic interface (OpenFlow)

- Applications
  - Traffic engineering, Service Insertion, Network Analytics, DC Network Virtualization, etc.

- Applicability
  - WAN, Data Center

Build Overlay Logical Networks

SDN Controller

Logical Network
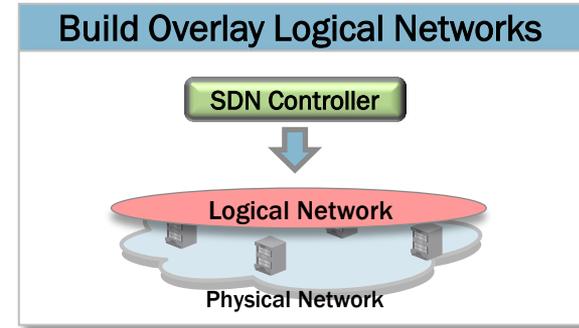
Physical Network

- Give up on modifying routers/switches
  - Use existing routers/switches (no change)
  - Build overlay logical network using Tunnels

- Applications
 - DC Network Virtualization

- Applicability
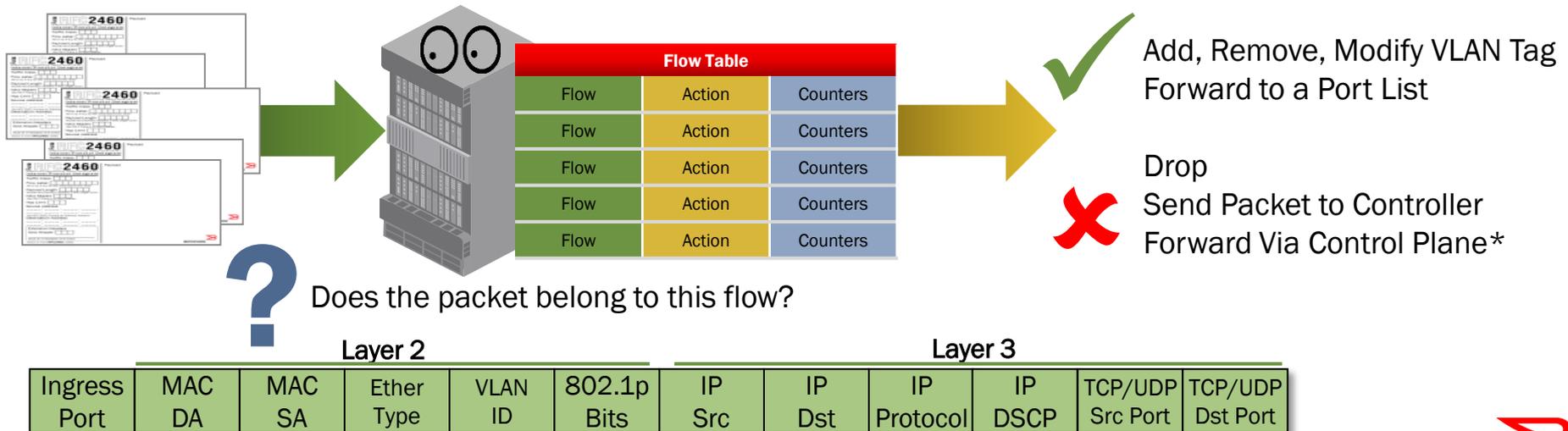 - Data Center

OpenFlow Basics

OpenFlow Overview

- Protocol that enables communication between an OpenFlow controller and an OpenFlow router
  - Control plane routing decisions are made by the controller, which typically runs on a server
  - Data plane forwarding is still done by the router

- Router and controller communicate via the OpenFlow protocol, which defines messages

- Router maintains flow tables, which are maintained by the controller using APIs
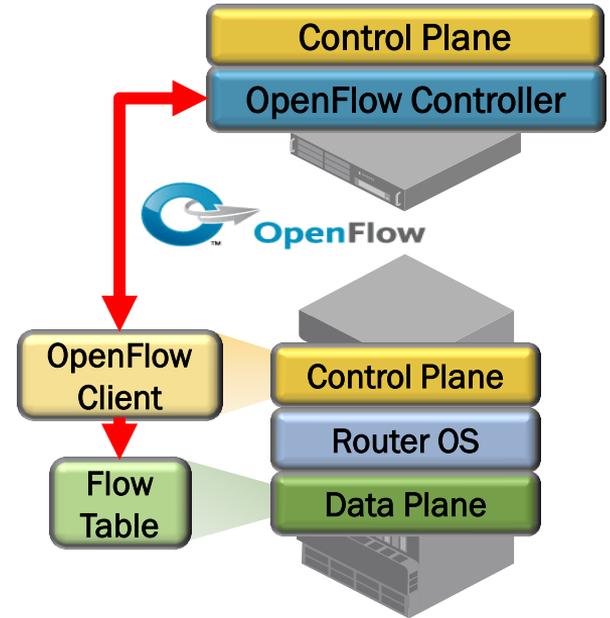
OpenFlow Router Operation

- Flow table contains entries that define a flow based on the packet header

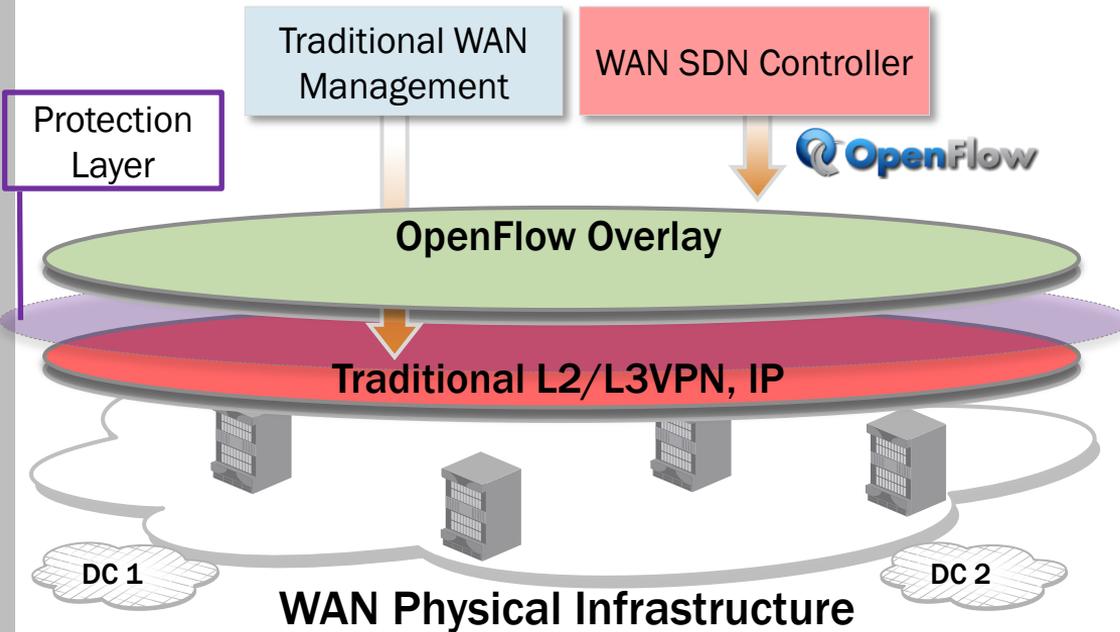- Flows are sorted by priority as defined by the controller, highest priority flows match first

Flow Table		
Flow	Action	Counters
Flow	Action	Counters
Flow	Action	Counters
Flow	Action	Counters
Flow	Action	Counters

✔ Add, Remove, Modify VLAN Tag
Forward to a Port List

✘ Drop
Send Packet to Controller
Forward Via Control Plane*

? Does the packet belong to this flow?

	Layer 2					Layer 3					
Ingress Port	MAC DA	MAC SA	Ether Type	VLAN ID	802.1p Bits	IP Src	IP Dst	IP Protocol	IP DSCP	TCP/UDP Src Port	TCP/UDP Dst Port

SDN USE CASE
WAN Traffic Engineering with OpenFlow
Example SDN Use Case

Internet2

BROCADE OPENFLOW ENABLED 100G NATIONWIDE BACKBONE

Internet 2

- **49 Custom Location Facilities**
- **15,500 miles of dark Fiber**
- **8.8 Tbps of Optical Capacity**
- **Hybrid Mode with protected OpenFlow traffic**

WAN Network Virtualization

Traditional L2/L3VPN-IP Network with OpenFlow Overlay

- OpenFlow as an overlay to existing network
  - Allows for new revenue-generating features on top of existing production network

- Enabled by Brocade's "Hybrid port mode"
  - OpenFlow and traditional features enabled concurrently on same router ports

- Protected Hybrid Port Mode
  - OpenFlow does not affect Traditional traffic
  - Protection in hardware
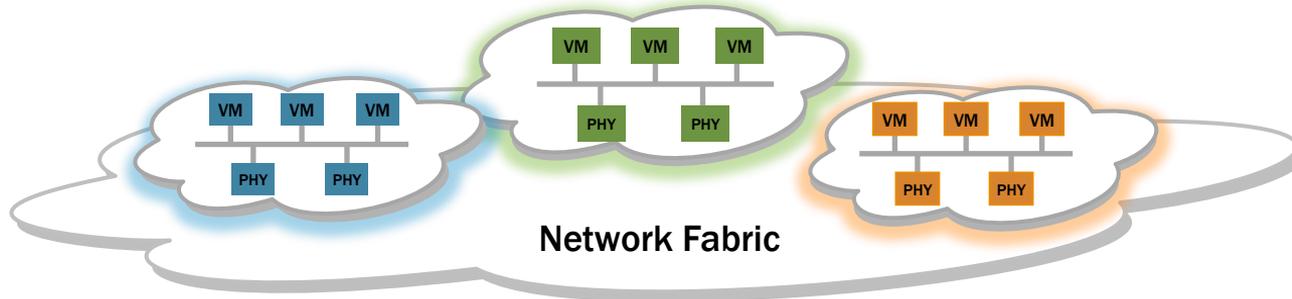 - Allows for initial OpenFlow overlay service development without risk

SDN USE CASE
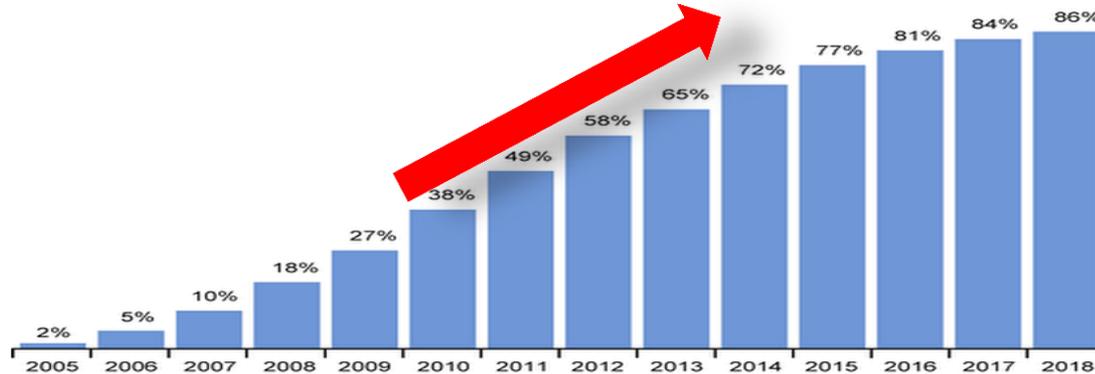# Large-Scale Data Center and Network Virtualization

Large-Scale Data Center

A Use Case For Overlay Type SDN
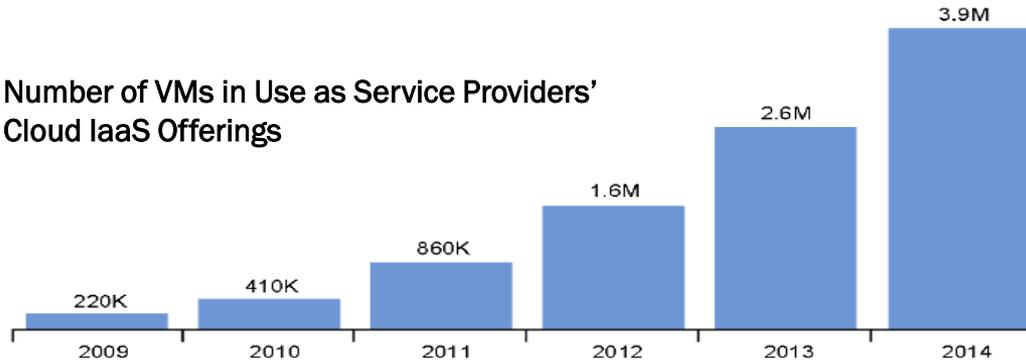

Network Fabric

- Web 2.0 and SP Cloud companies manage multiple large data centers
  - 1000s of racks per DC, 40 servers per rack, each server with 20 VM's
  - Many Millions of VMs (MAC addresses)

- Need a scalable way to provision thousands of virtual layer-2 networks within the private clouds.

Cloud Providers Will Face Same Challenges

Increasing virtualization in cloud providers' environments

2% 2005
5% 2006
10% 2007
18% 2008
27% 2009
38% 2010
49% 2011
58% 2012
65% 2013
72% 2014
77% 2015
81% 2016
84% 2017
86% 2018

Number of VMs in Use as Service Providers'
Cloud IaaS Offerings

Source: Gartner, March 2011

220K 2009
410K 2010
860K 2011
1.6M 2012
2.6M 2013
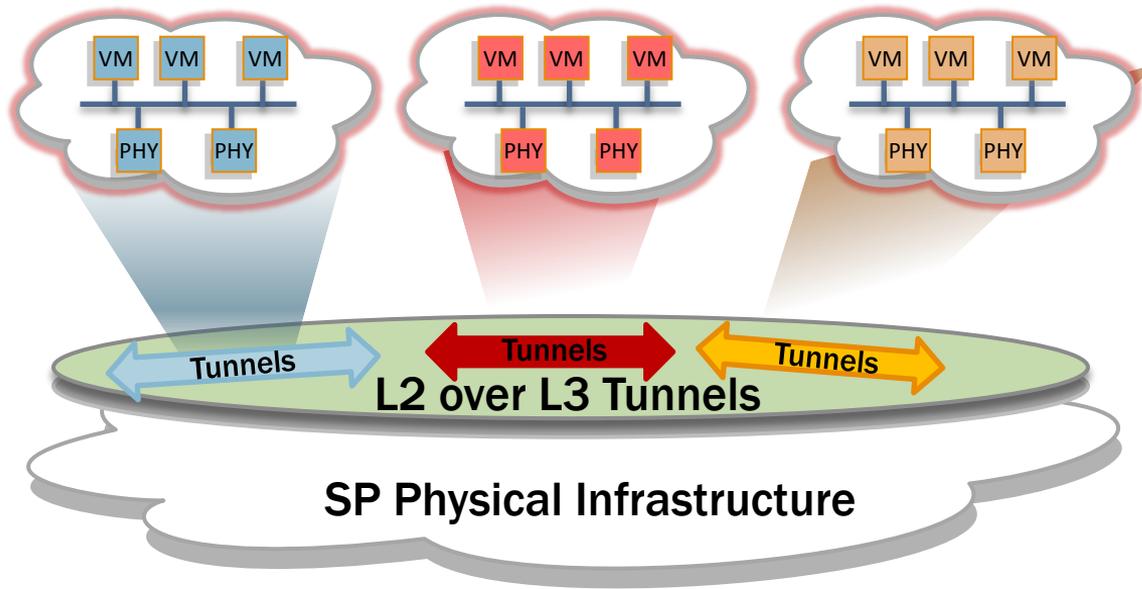3.9M 2014

Network Virtualization Using L2 over L3 Tunnels
## An Industry Trend for Hyper-Scale Data Centers

- Network Virtualization created using L2 over L3 tunnels

- Programmatic interface may use OpenFlow

- Requires additional management protocols beyond OpenFlow to provision tunnels

Network Virtualization Using L2 over L3 Tunnels

TUNNEL TECHNOLOGY: RECENT INDUSTRY PROPOSALS

- VxLAN (IETF draft, August 2011)

  - Author: VMware

- NVGRE (IETF draft, September 2011)

  - Author: Microsoft
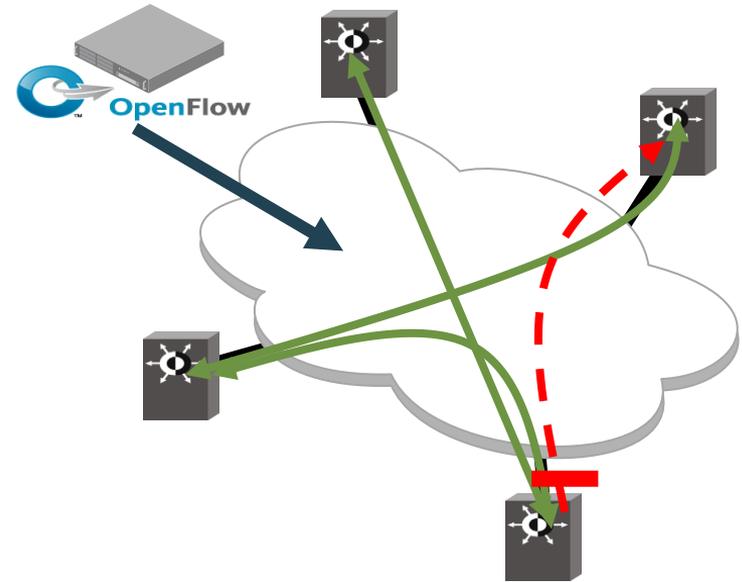
- STT (IETF draft, March 2012

  - Author: Nicira

L2 over L3 tunnel

L2 → L2 L3 → L2

Payload   Tunnel header
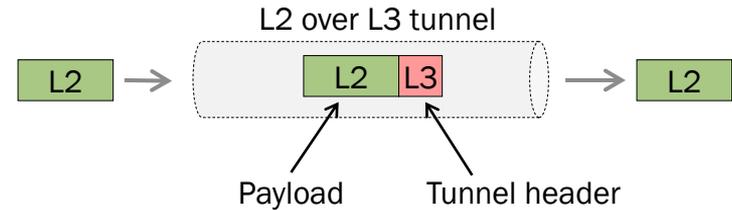
BROCADE SOLUTIONS WILL BE TUNNEL AGNOSTIC

Policy Based IXP

Policy-Based IXP with SDN

- IXP peering flows could be programmed entirely with OpenFlow
  - MAC addresses already have to be registered

- Offers much greater port security and traffic control
  - Solves problem of receiving unwanted traffic/default routing
  - Intercept all ARP/ND and punt to server for validation

- Could offer member-provisioned public peering or VLAN PNIs through portal

Thank You