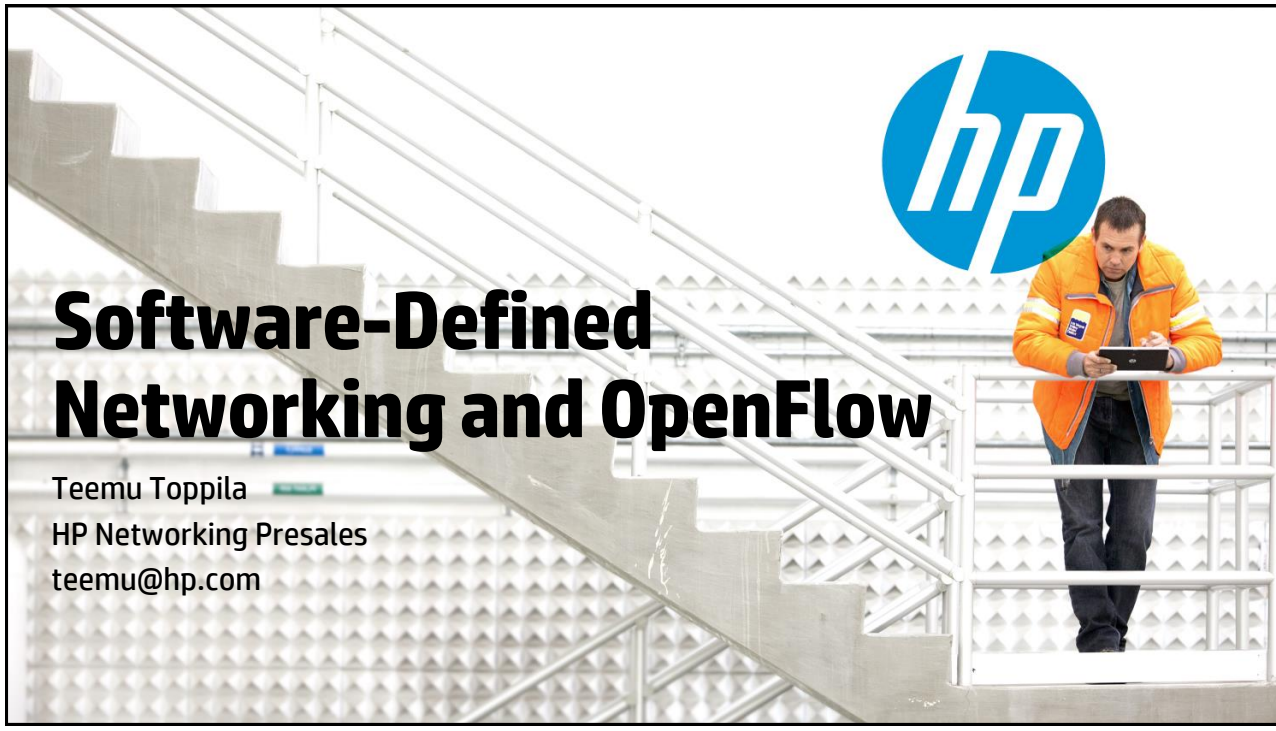


Software-Defined Networking and OpenFlow

Teemu Toppila
HP Networking Presales
teemu@hp.com

Legacy data center networks are at a breaking point

Complex	Constrained	Manual
Over **30 years**	More than **80%** of all traffic	Human middleware **box-by-box**
Of network design principles have kept Virtual Network Infrastructure at bay[1]	In the data center's LAN to be between servers, and up to 80% of end-user traffic will move to the WAN by 2014[2]	CLI configuration is the typical method used by todays admins to provision networks[3]

[1] Forrester Research, Inc., The Forrester Wave™: Data Center Networking Hardware, January, 2013

[2] Plan Now For the Hyper converged Enterprise Network Gartner ID:G00232582 May 2012

[3] HP (ES/TS - CLI based L2/3 switch, router configuration of legacy network deployments)

Legacy network human middleware can't scale for cloud

Time and resource intensive, not suited for cloud scale

10,000 provisions per day

X 20 commands per change

200,000 commands per day

X 1 minute per command

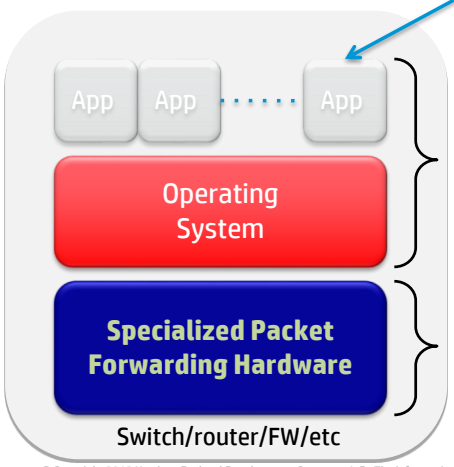
3,333 hours of effort and 420 network admins

50,000 users

Source: HP

We have lost our way…

Routing, management, mobility management, access control, VPNs, …



Million of lines of source code

5400 RFCs

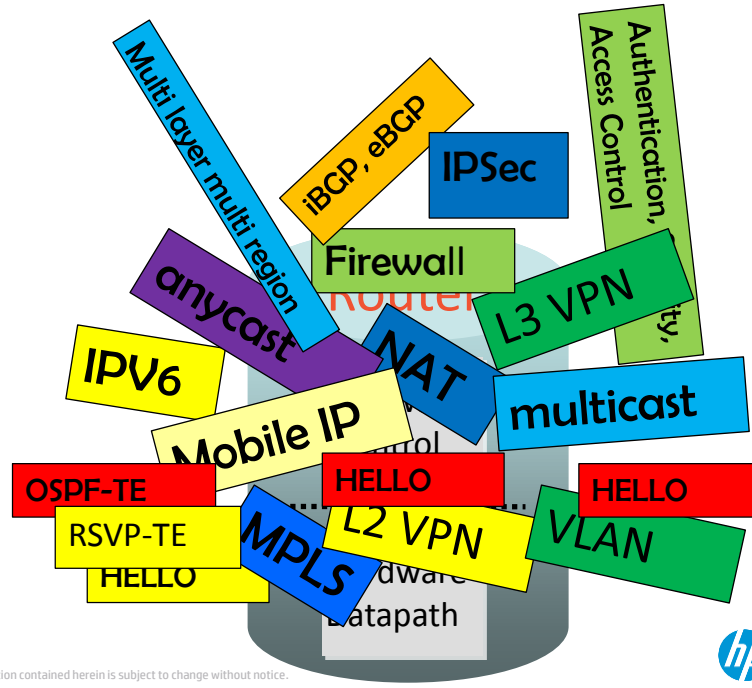
500M gates
10Gbytes RAM

Power Hungry

We are really lost…

Many complex functions baked into the infrastructure

- OSPF, BGP, multicast, differentiated services,
  Traffic Engineering, NAT, firewalls, MPLS, redundant layers, …
- **Independent** devices negotiating hundreds of settings
- Each device configured **individually**



What is software-defined networking?

Definition from the Open Network Foundation

… In the SDN architecture, the control and data planes are **decoupled**, network intelligence and state are logically **centralized** and the underlying network infrastructure is abstracted from the applications …

Source: opennetworking.org

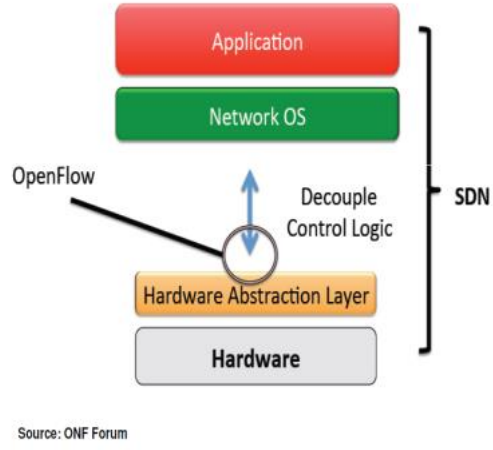
Definitions

Software Defined Networking (SDN)

- New network architecture
- Separates the network control plane from the forwarding hardware.
- Allows the data plane to be defined by a logically centralized controller (or set of controllers).

OpenFlow

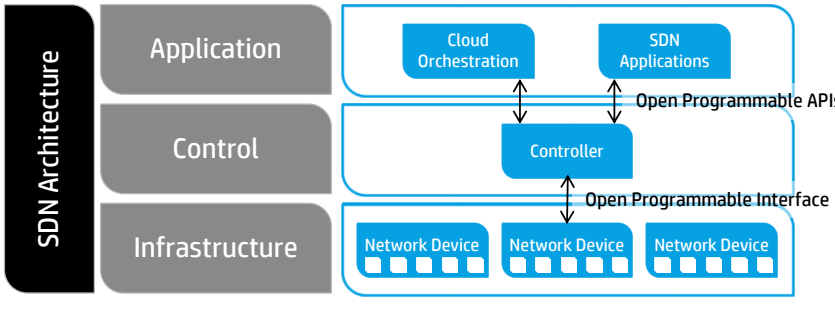
- Standard protocol used between the control and data planes.
- Open and multivendor
- Driven by the Open Networking Foundation (ONF)
  - HP, Cisco, Juniper, Extreme, IBM, Google, Microsoft, Brodace, F5, Huawei, ZTE, Oracle, Riverbed, Intel, …



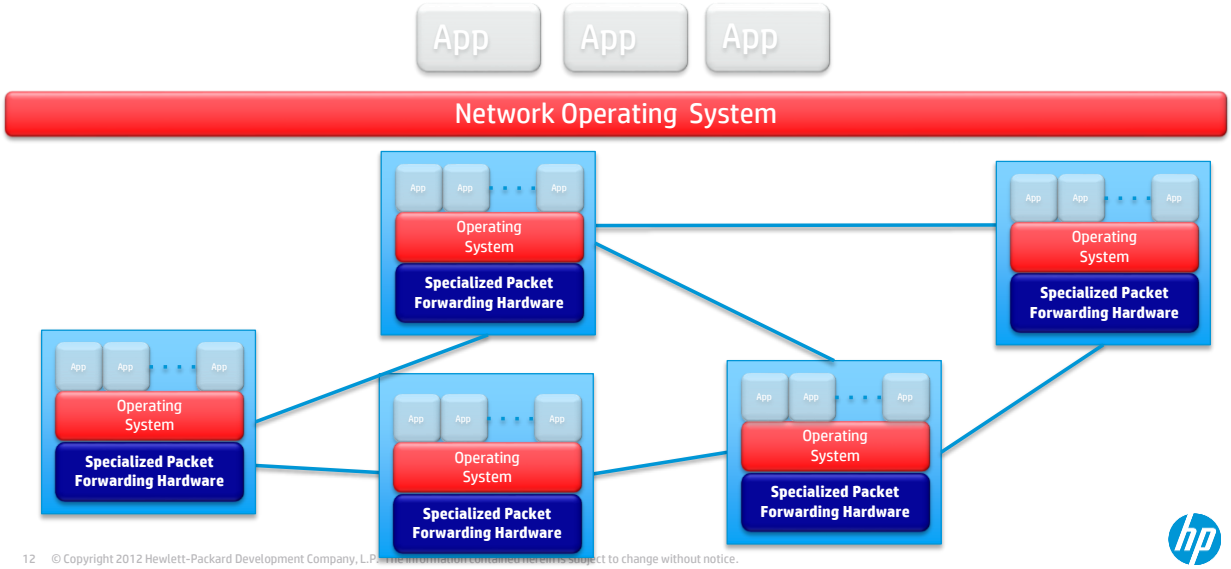
Source: ONF Forum

Software-defined Network components

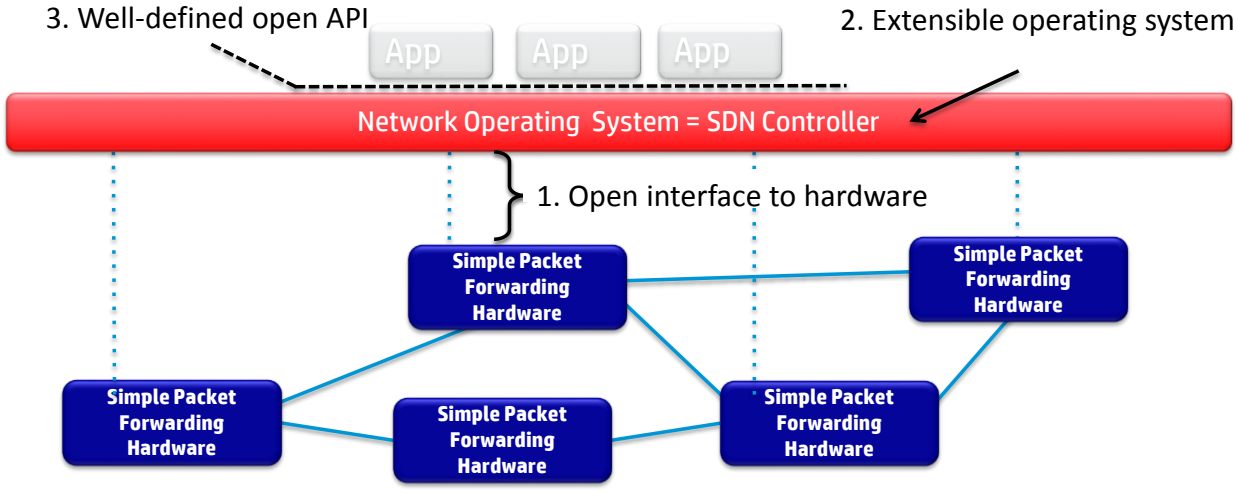
Delivering the functions of an SDN architecture



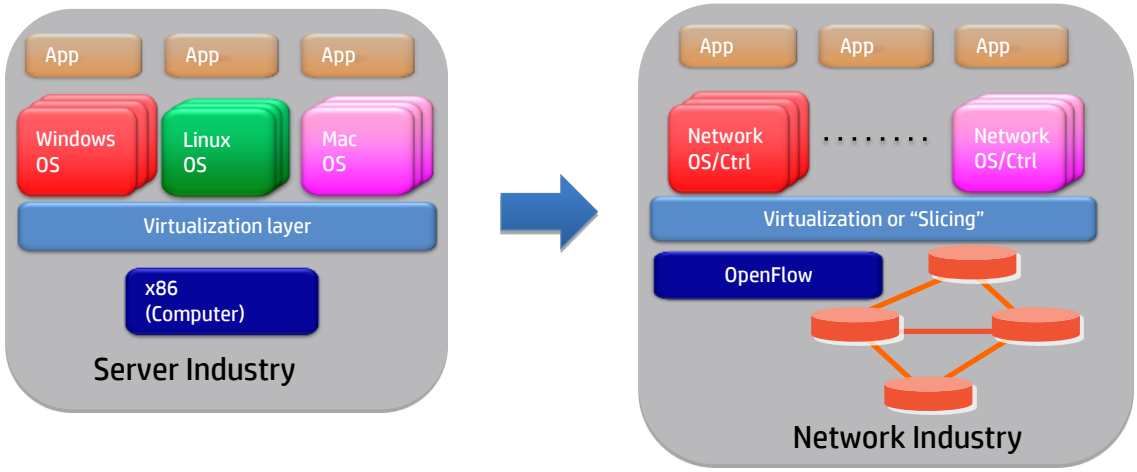
SDN could still save us



The Software-Defined Network with OpenFlow



Trend in the IT industry



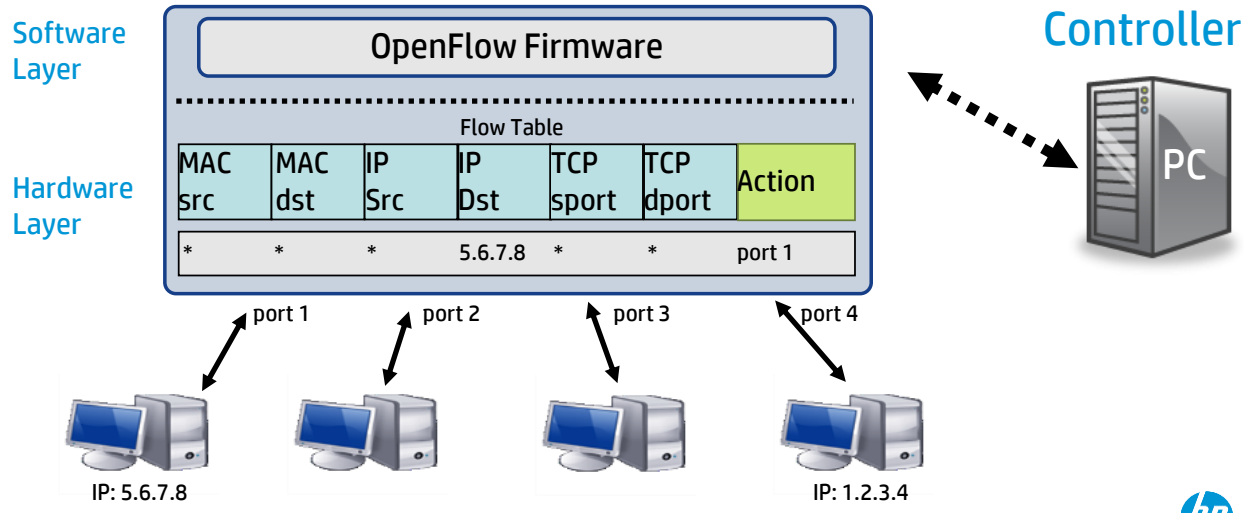
Simple common stable hardware substrate below + programmability + strong isolation model = flexible network fabric with intelligence

Debunking SDN Myths

A Software-defined Network is Not

Only Implementing Network Functions in Software or on Virtual Machine	**Only Programmable Proprietary APIs for Network Device or Management System**	**The End of Hardware Innovation**

OpenFlow Flow Table Abstraction



OpenFlow table entries

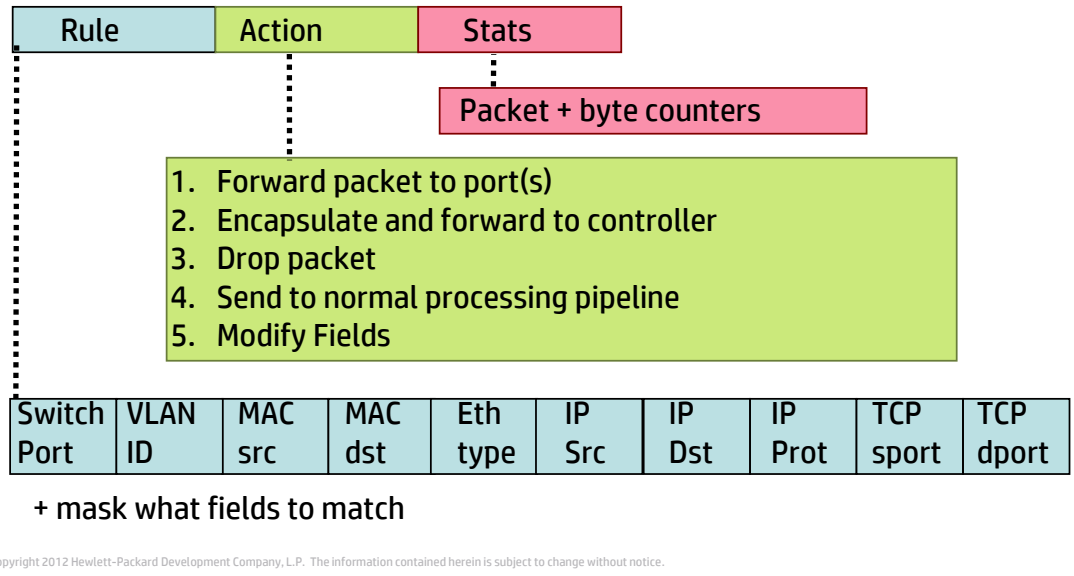


Table entry examples

Switching

Switch Port	MAC src	MAC dst	Eth type	VLAN ID	IP Src	IP Dst	IP Prot	TCP sport	TCP dport	Action
*	*	00:1f:..	*	*	*	*	*	*	*	port6

Flow Switching

Switch Port	MAC src	MAC dst	Eth type	VLAN ID	IP Src	IP Dst	IP Prot	TCP sport	TCP dport	Action
port3	00:20..	00:1f..	0800	vlan1	1.2.3.4	5.6.7.8	4	17264	80	port6

Firewall

Switch Port	MAC src	MAC dst	Eth type	VLAN ID	IP Src	IP Dst	IP Prot	TCP sport	TCP dport	Forward
*	*	*	*	*	*	*	*	*	22	drop

Flow Routing vs. Aggregation

Both models are possible with OpenFlow

Flow-Based

- Every flow is individually set up by controller
- Exact-match flow entries
- Flow table contains one entry per flow
- Good for fine grain control, e.g. campus networks

Aggregated

- One flow entry covers large groups of flows
- Wildcard flow entries
- Flow table contains one entry per category of flows
- Good for large number of flows, e.g. backbone

Reactive vs. Proactive

Both models are possible with OpenFlow

Reactive

- First packet of flow triggers controller to insert flow entries
- Efficient use of flow table
- Every flow incurs small additional flow setup time
- If control connection lost, switch has limited utility

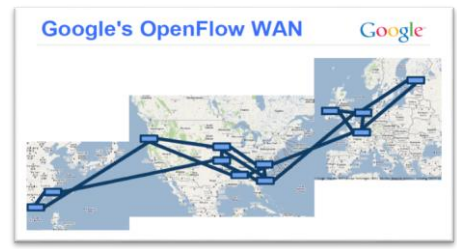
Proactive

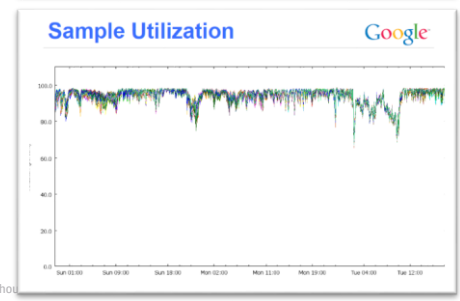
- Controller pre-populates flow table in switch
- Zero additional flow setup time
- Loss of control connection does not disrupt traffic
- Essentially requires aggregated (wildcard) rules

OpenFlow isn't just a hype: Google G-Scale

Internal backbone that carries traffic between Google's data centers worldwide

- Google's OpenFlow WAN activity started 2010. Less than two years later, Google is now running the G-Scale network on OpenFlow-controlled switches. 100% of its production data center to data center traffic is now on this new SDN-powered network.
- The old network has been shut down.
- Google built their own OpenFlow switch because none were commercially available. The switch was built from merchant silicon. It has scaled to hundred of nonblocking 10GE ports.
- A key SDN benefit is the unified view of the network fabric -- higher QoS awareness and predictability.





Source:

http://www.opennetsummit.org/archives/apr12/hoelzle-tue-openflow.pdf

http://www.opennetsummit.org/archives/apr12/vahdat-wed-sdnstack.pdf

Network Function Virtualization NFV

NFV – What is it?

Definition from ETSI NFV Whitepaper

Network Functions Virtualization (NFV)

By leveraging standard IT virtualization technology to consolidate many network equipment types onto industry standard high volume servers, switches and storage, which could be located in Data-Centers, Network Nodes and in the end user premises, NFV provides a model to meet the challenges around reducing CAPEX, improving manageability, increasing the time-to-market and encourages a wider eco-system.

SDN and NFV: What's the difference

- **S**oftware **D**efined **N**etworking: Remove management and control planes from network device
  - Separation of control and forwarding functions
  - Centralization of control
  - Ability to program the behavior of the network using well-defined interfaces
  - Campus, data center / cloud, SP core
  - Open Networking Forum (ONF)

- **N**etwork **F**unction **V**irtualization: Remove need for special hardware
  - Rapid adaptation to new standards and technologies
  - Use of commodity server hardware
  - Service provider network
  - ETSI NFV Working Group

Introducing HP Virtual Services Router (VSR) Series

Industry's first carrier grade Network Function Virtualization (NFV) technology

VSR based on Comware 7

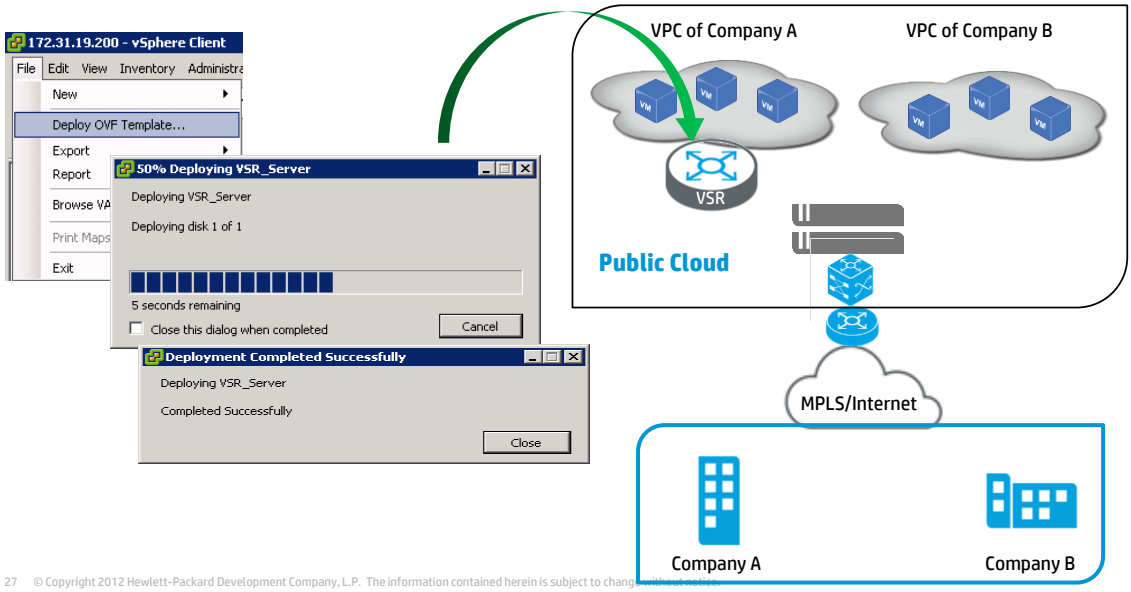
- Deployment flexibility across branch, data center and cloud
- Agile services delivery for faster time to revenue
- Virtualized router for multi-tenant, hosted public clouds
- Extends enterprise routing policies to the cloud

10x faster
time to revenue

80% OPEX
cost reduction

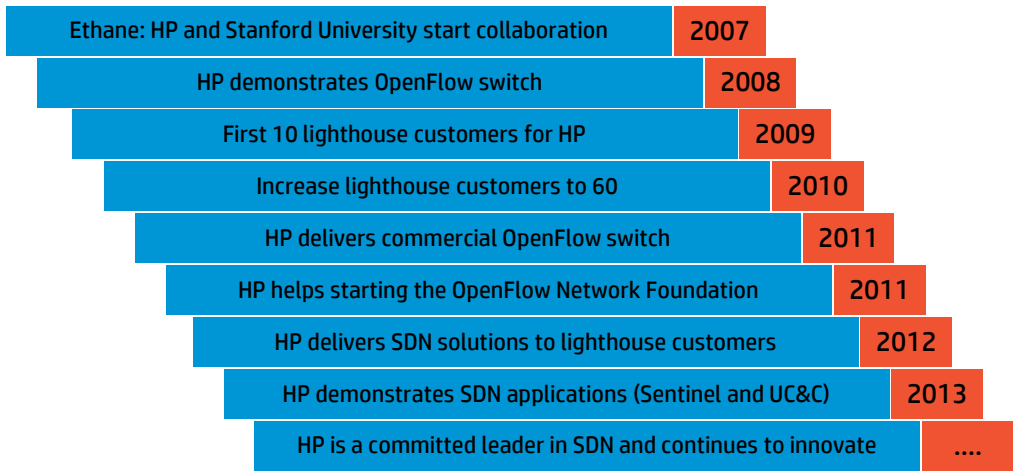
ZERO
dedicated appliances

[1]Compared with Cisco Nexus 1010 Virtual Services Appliance



HP & SDN

HP is leading Software-defined Networking



Software-defined Networking drivers and impact

Human Middleware

Private cloud is not just about cost reduction. Agility will be a key benefit[1]

[1] Gartner G00238288, Five Things That Private Cloud Is Not, 3 August 2012,Thomas J. Bittman

Device Proliferation

By 2020, 50 billion devices will be connected to wireless networks[2]

[2]Ericsson white paper, "More Than 50 Billion Connected Devices," February 2011

Market Growth

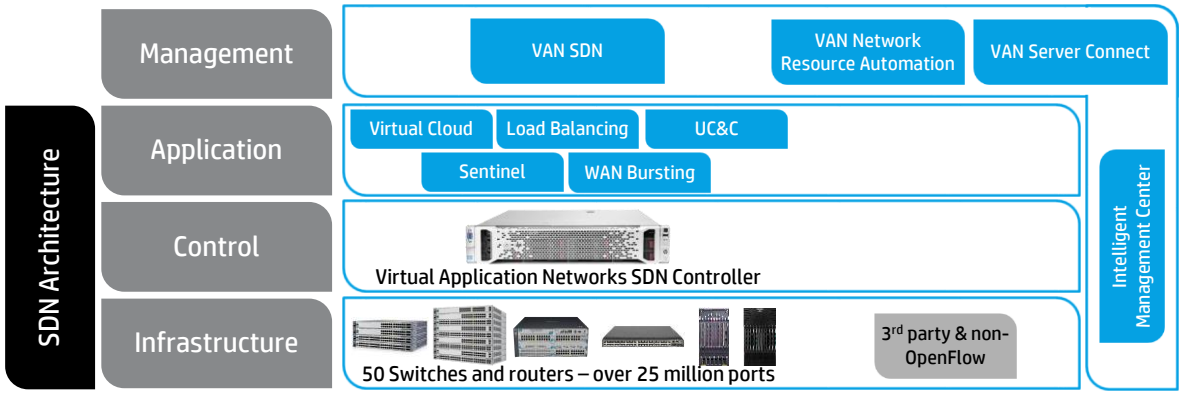
SDN market will grow to $3.7 billion by 2016 ... driven by the growing need for scalability and network programmability[3]

[3] IDC #238044, "IDC Predictions 2013: Competing on the 3rd Platform" November 2012

http://img2.insight.com/graphics/no/info2/insight_art6.pdf

Virtual Application Networks deliver automation, agility

Industry's most complete software-defined networking solution



HP VAN SDN Controller

SDN Controller Platform

Base Control Platform

- Linux / Java / OSGi software stack
- OpenFlow Controller
- Device Discovery, Adoption, Network Topology & Domain Model services
- Device Driver Framework for out-of-band control & management of devices, VMs, etc.

Distributed Platform for High-Availability & Scalability

- Controller Teaming for Load-Balancing and Control Domain Partitioning
- Control State Synchronization for smooth & rapid Fail-Over

Extensible Platform

- Embedded Java Application Deployment
- REST APIs
- GUI

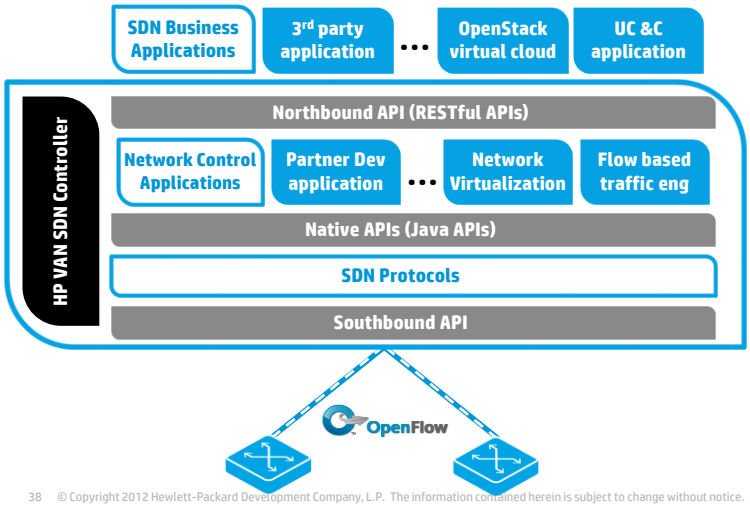
HP VAN SDN Controller

Technical Specifications

Required platform	• Ubuntu 12.04 LTS 64-bit (3.2 kernel) • PostgreSQL 9.1 • OpenJDK 7 JVM • Keystone Identity
Recommended hardware	• 3.0 GHz Intel® Xeon® or Intel® Core™2 Quad processor or equivalent • 8 GB RAM • 64 GB disk space • 1-10 Gbps NIC • KVM, ESXi or physical server
Performance (single controller)	• Maximum new flows per second (Cbench): 1.8 million • Maximum OpenFlow ports: 80,000 • Maximum OpenFlow devices: 2,000 • Typical OpenFlow ports: 1,000-2,000 • Typical OpenFlow devices: 100-200

Southbound API

The interface that the controller uses to interact with the infrastructure

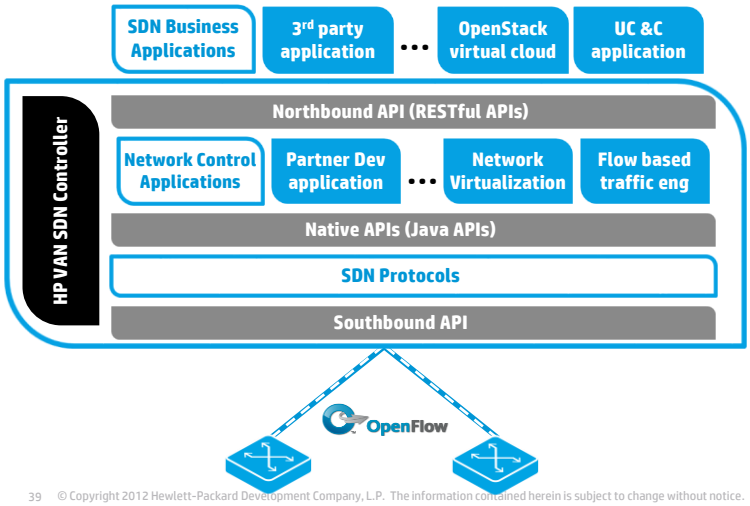


VAN SDN controller supports OpenFlow enabled infrastructure:

- HP 50 OpenFlow enabled switches
- Compliant with OpenFlow 1.0 & 1.3
- Available to work with any OpenFlow enabled switch from other vendors
- Extensible to support future standards

Northbound APIs

The interface that the SDN Business applications use to interact with the network.

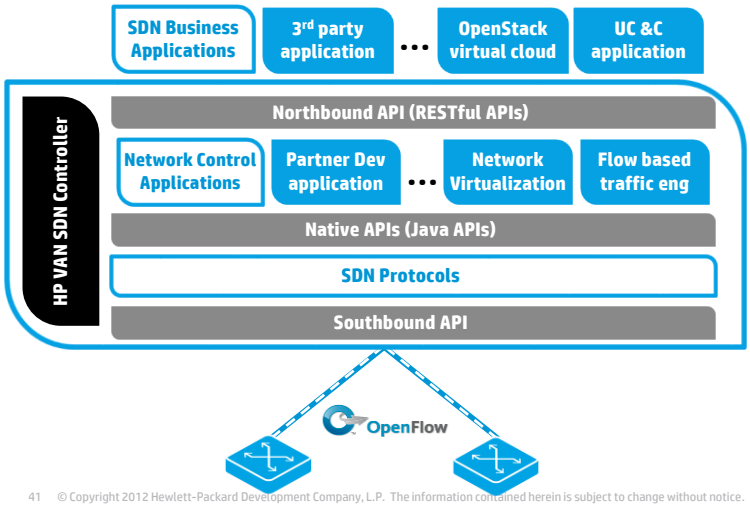


Northbound APIs enable the VAN SDN controller to have support for:

- Third party applications
- Open- source applications
- OpenStack virtual cloud applications
- Unified communications and control application
- Full management platform such as IMC

Native API

The Java interfaces that the Network Control applications use to control the network



Native APIs enable VAN SDN controller to have support for:

- Partner developed applications
- Security service applications
- Wired/wireless security applications
- Flow based traffic engineering

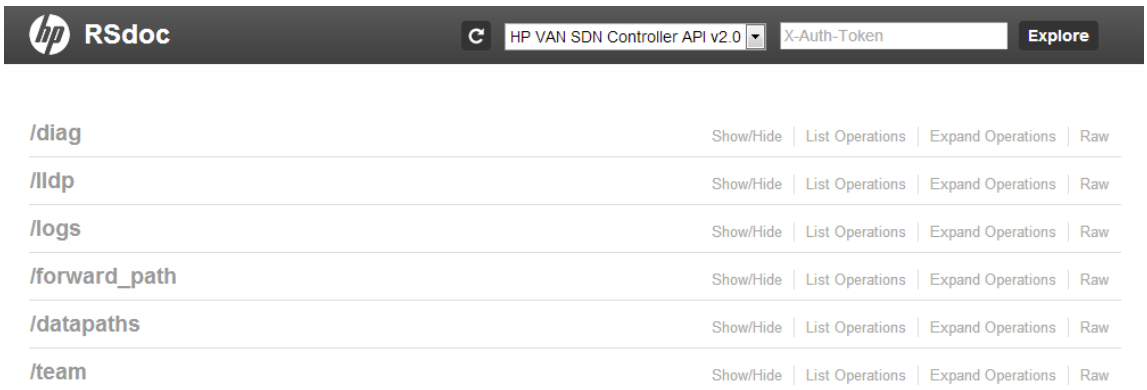
SDN Controller application support

Application programming interfaces (API) enable applications to interact with the network

	SDN Controller Support	Applications
Northbound APIs (RESTful APIs)	• Deployed outside the controller platform • Exposes SDN Controller capabilities • Standard HTTPS interface model • SDK developer support	**SDN Business Applications** • Ideal for applications operating at the business level • Ideal for proactive interactions, such as policy enforcement
Native APIs	• Deployed within the controller platform • Extends SDN Controller capabilities • Built on Java OSGi model • SDK developer support	**Network Control Applications** • Ideal for applications operating at the network level • Ideal for fine-grained, frequent, or low-latency interactions such as handling packet-in events

RSDoc – REST API Documentation

https://<controller-ip>:8443/api

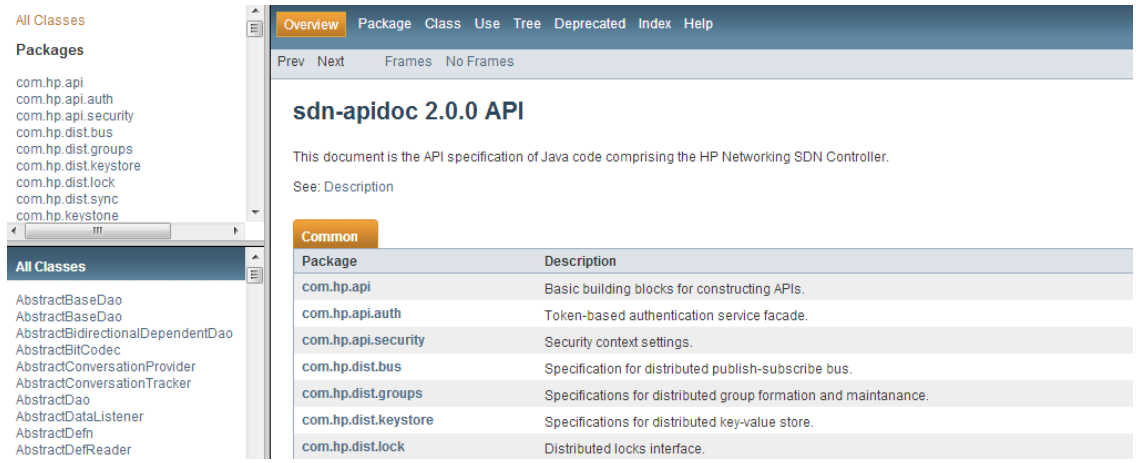


JSON Schema

https://<controller-ip>:8443/

JavaDocs

hp-sdn-apidoc-2.0.0 – http://<path>/index.html

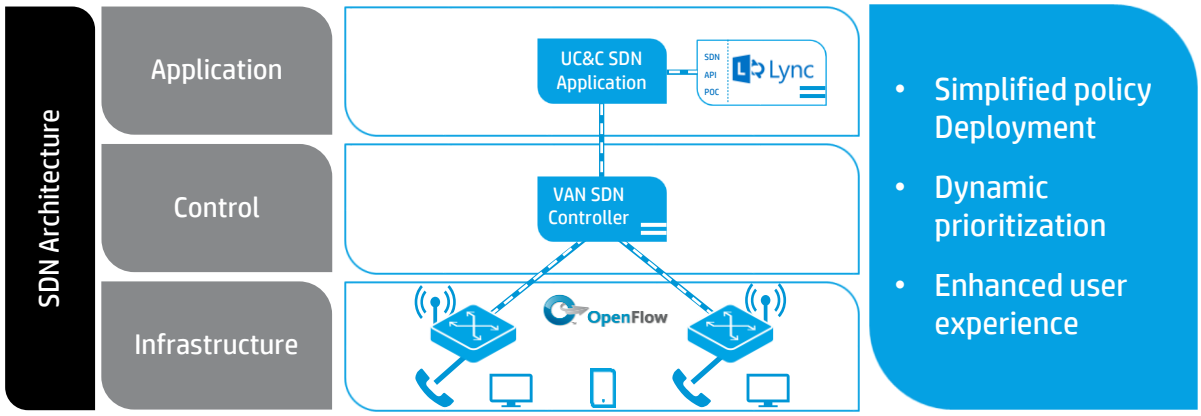


SDN applications

UC&C SDN application for Lync

Microsoft

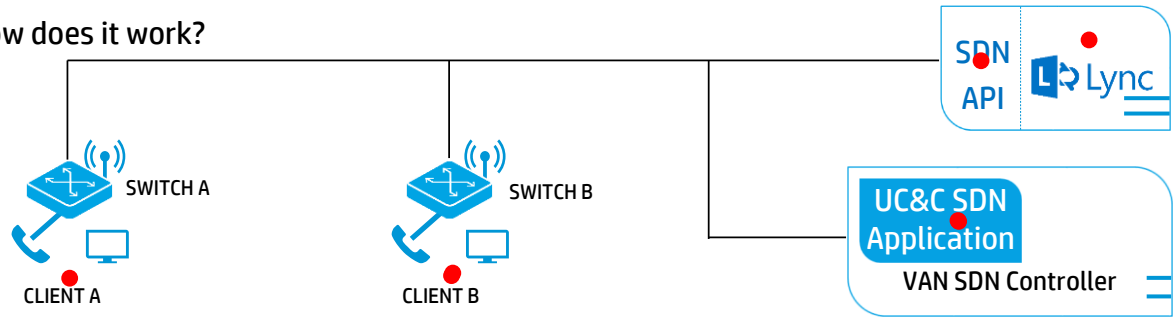
Automating policy for campus enterprise business applications



UC&C SDN Application for Lync

Microsoft

How does it work?

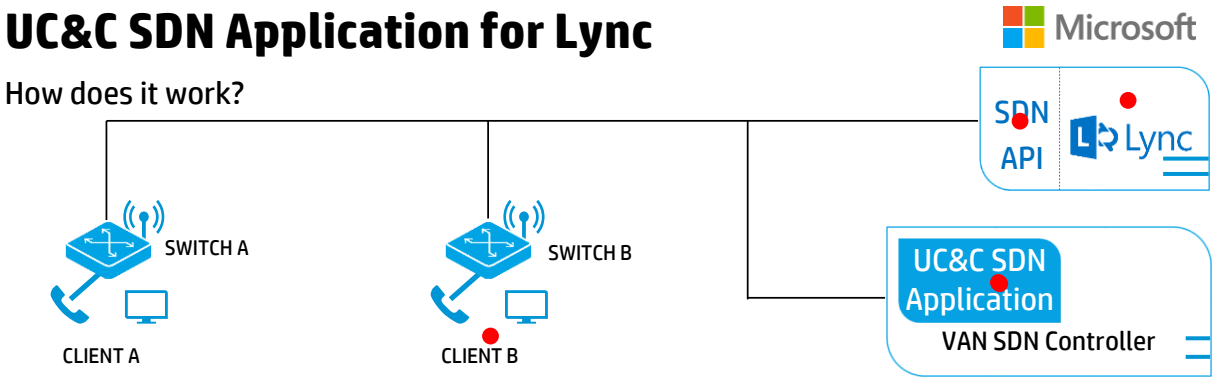


Communication setup:

- Client A establishes connection with Client B
- Lync Front End server registers session and QoE
- SDN API sends session info to UC&C application
- UC&C Application applies QoS flows to the switches
- Improved user experience

UC&C SDN Application for Lync

How does it work?



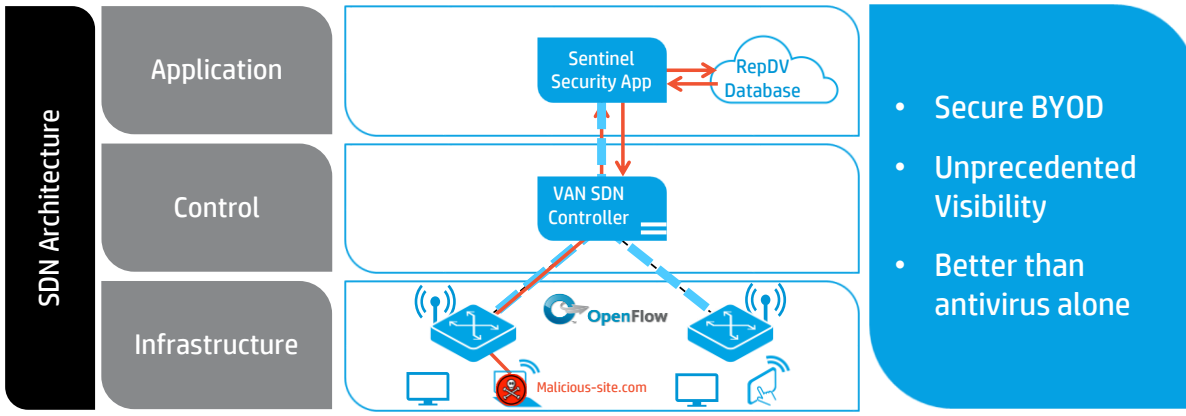
Communication teardown:

- Client A disconnects from Client B
- Lync Front End server deregisters session
- SDN API sends notification to UC&C application
- UC&C Application removes QoS flows

Sentinel security application

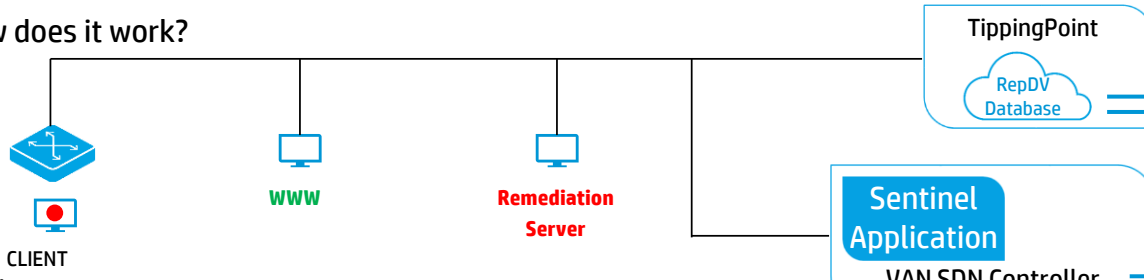
TippingPoint ArcSight An HP Company BALLARAT GRAMMAR

Enabling real-time threat detection across enterprise campus networks



Sentinel security application

How does it work?

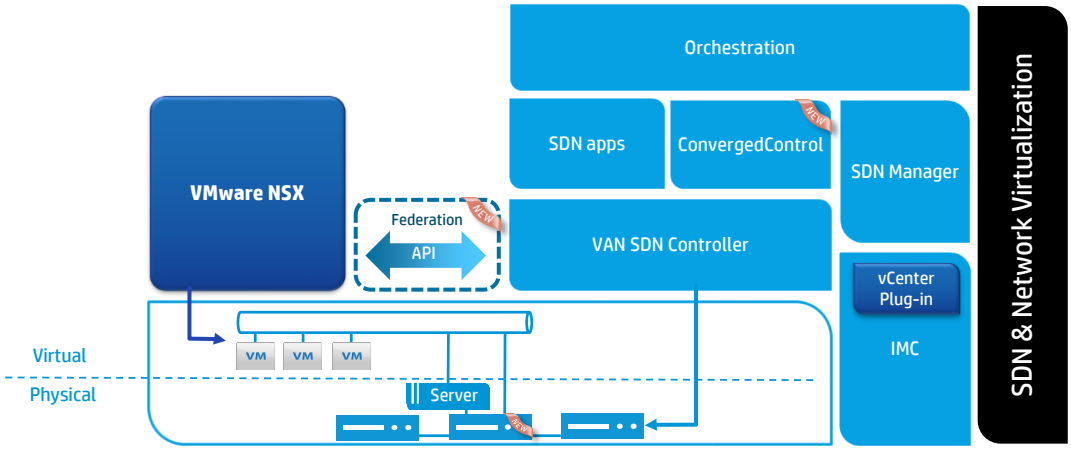


Process:

- Client A sends a DNS request
- Switch intercepts DNS request and redirects to the VAN SDN Controller
- VAN SDN Controller forwards request to the TippingPoint RepDV Engine
- RepDV Engine verifies whether DNS request is allowed
- RepDV Engine sends response back to VAN SDN Controller
- If DNS request is allowed, VAN SDN Controller sends flow to switch to allow DNS request
- If DNS request is not allowed, VAN SDN Controller sends flow to switch, redirecting DNS request

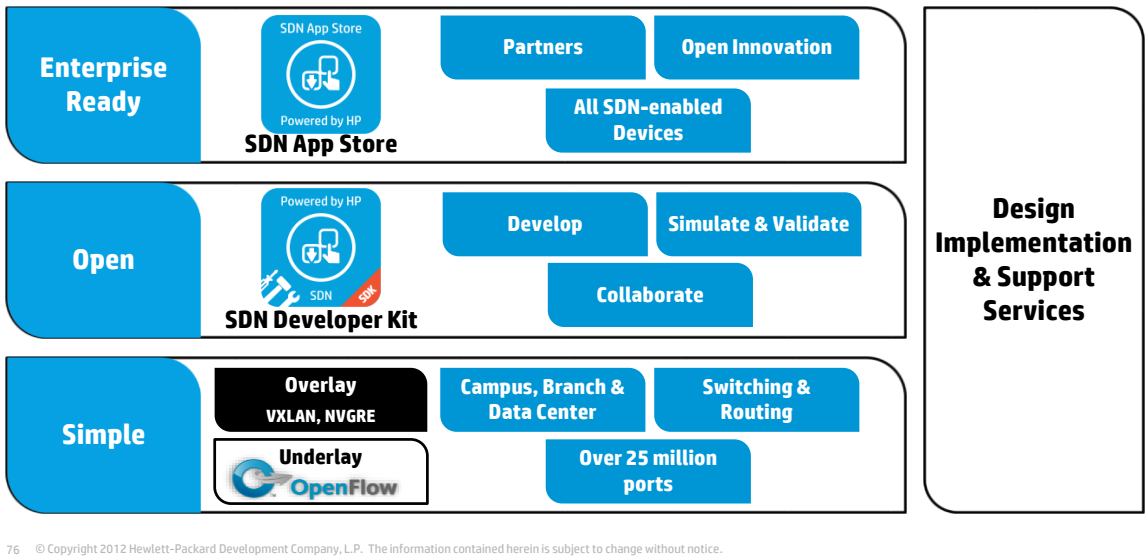
HP-VMware Network Solution

Open, interoperable solution unifying physical and virtual



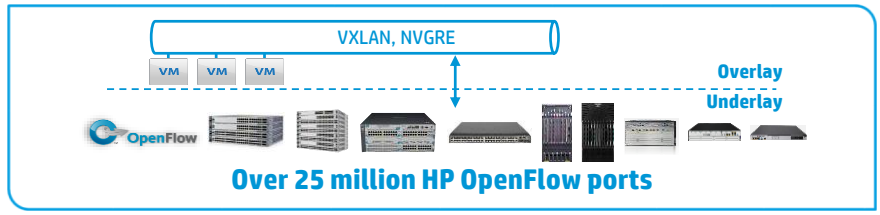
HP SDN Ecosystem

HP creates an open SDN Ecosystem



Simple and programmable – OpenFlow and Overlays

50 switches and 10 new routers



HP Switches	HP Routers (NEW)	3rd Party
• Overlay enabled • OpenFlow enabled	• Delivering NFV • OpenFlow enabled	• Overlay enabled • OpenFlow enabled

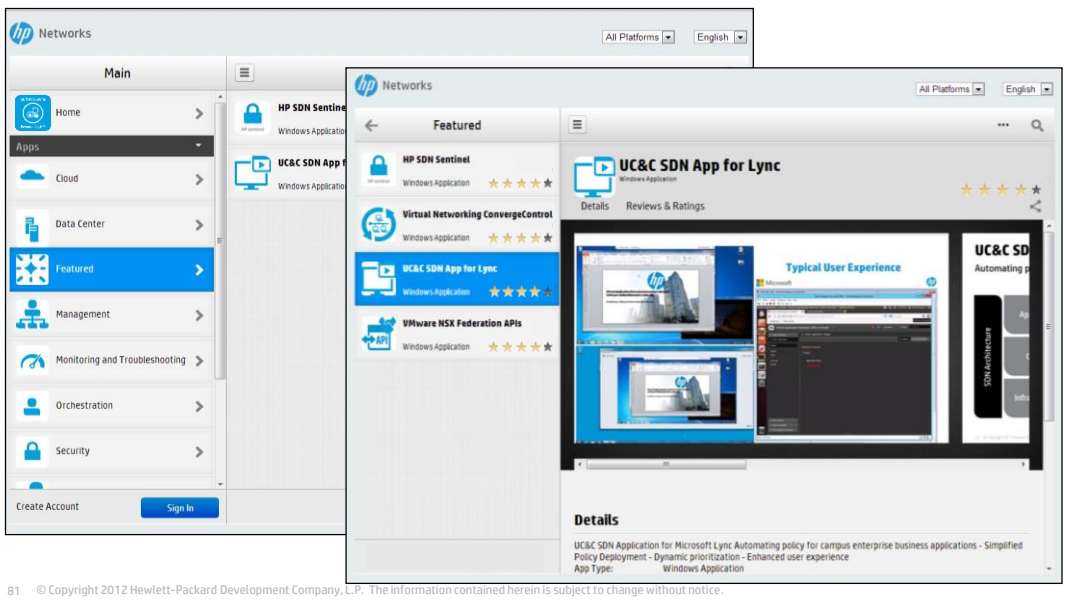
HP SDN Software Development Kit (SDK)

Develop	Simulate & Validate	Collaborate
• RESTful APIs • Developer guide • Sample code	• SDN simulator • SDN virtual lab • Validation test	• Community portal • Knowledge base • Training, services

Enterprise-ready SDN App Store

Accessible	Open	Supported
• Browse & search • Install directly into the SDN controller	• Partner developed • Community apps • Private portal	• HP developed • Joint developed • Partner certified

HP SDN App Store



HP SDK and SDN App Store create an open ecosystem

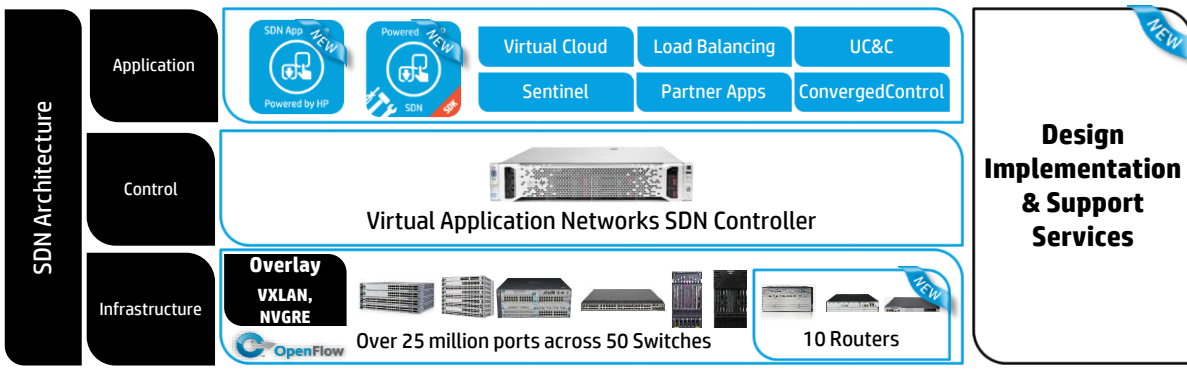
New SDN Learning Journey & Certification

Helping IT professionals & developers understand the best ways to adopt & implement SDN

Prepare	Engage	Deliver
• Understand your network & SDN • Start now with OpenFlow, SDN SDK	• Take SDN architecture & deployment certification • Take SDN application development certification	• Deploy SDN applications • On-going SDN learning

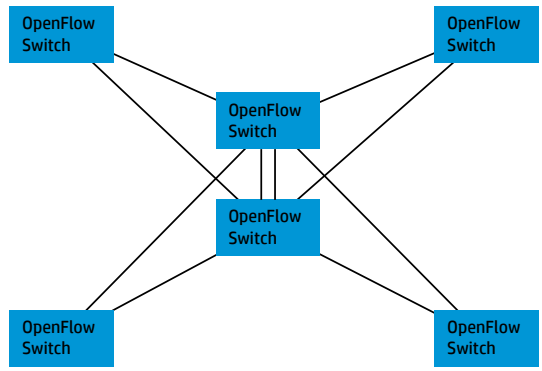
Open SDN portfolio, SDK, App Store enable Ecosystem

Programmable network aligned to business application delivers agility

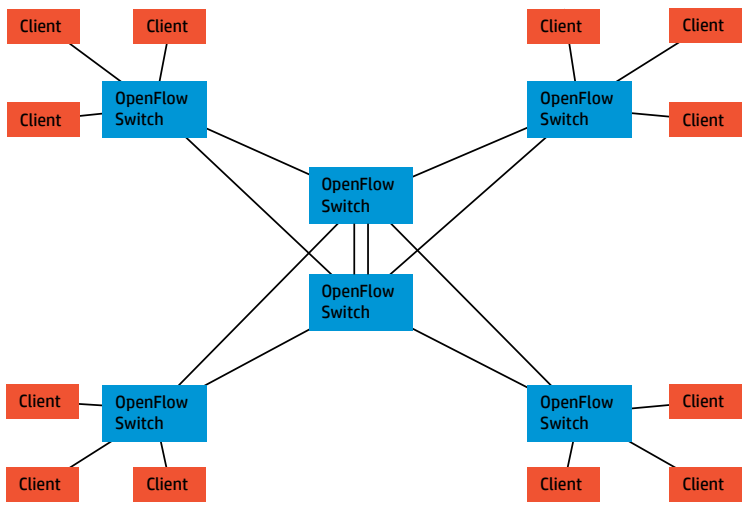


Demo

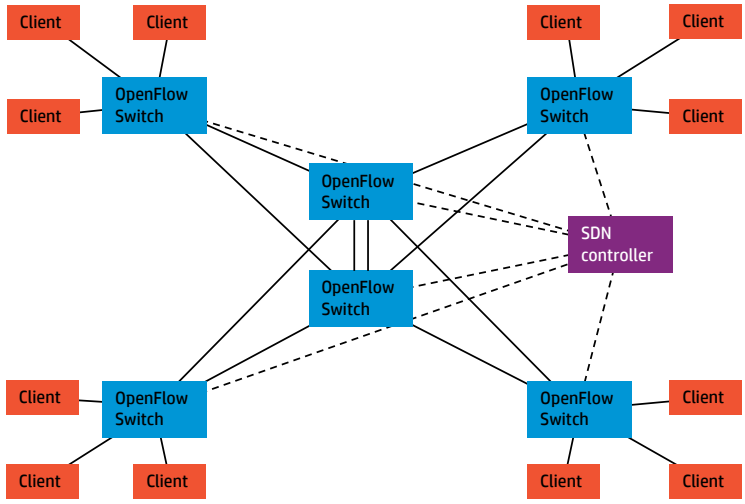
Demo setup



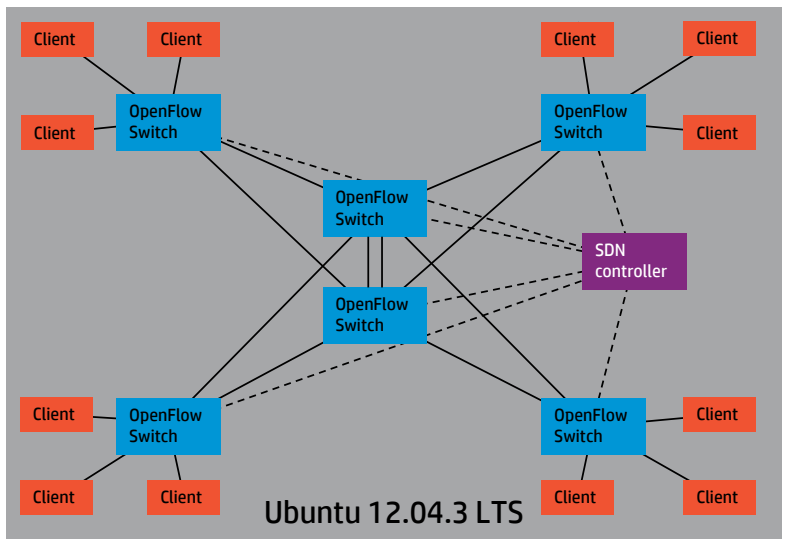
Demo setup



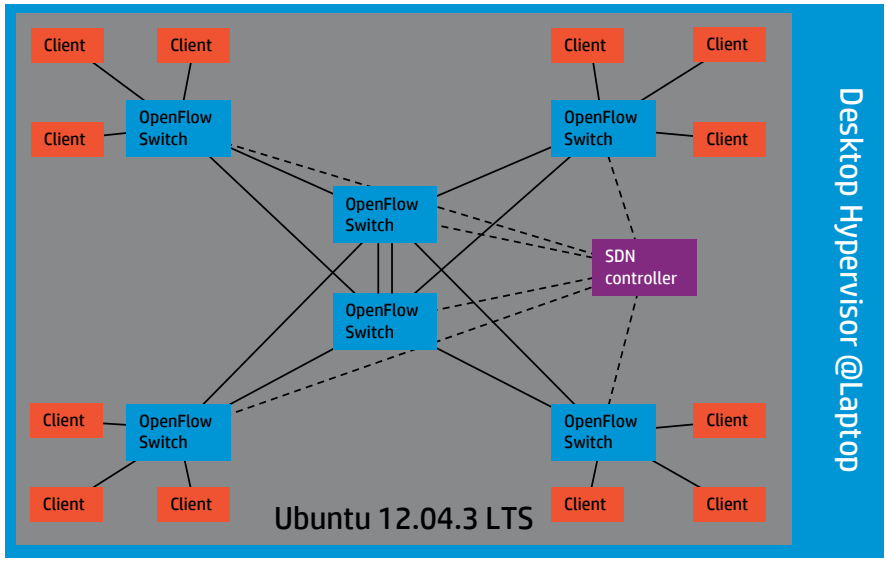
Demo setup



Demo setup



Demo setup



Thank you