SOFTWARE DEFINED NETWORKS AND NETWORK FUNCTIONS VIRTUALISATION APPLICATIONS IN HIGHER EDUCATION

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What is a SDN – Software Defined Network

The Brains of the network

- SDN can be thought of as the Brains of the network, it is a centralised intelligence that monitors and controls, the network infrastructure

The Four Planes of Operation

These are closely bound together in today's networking equipment

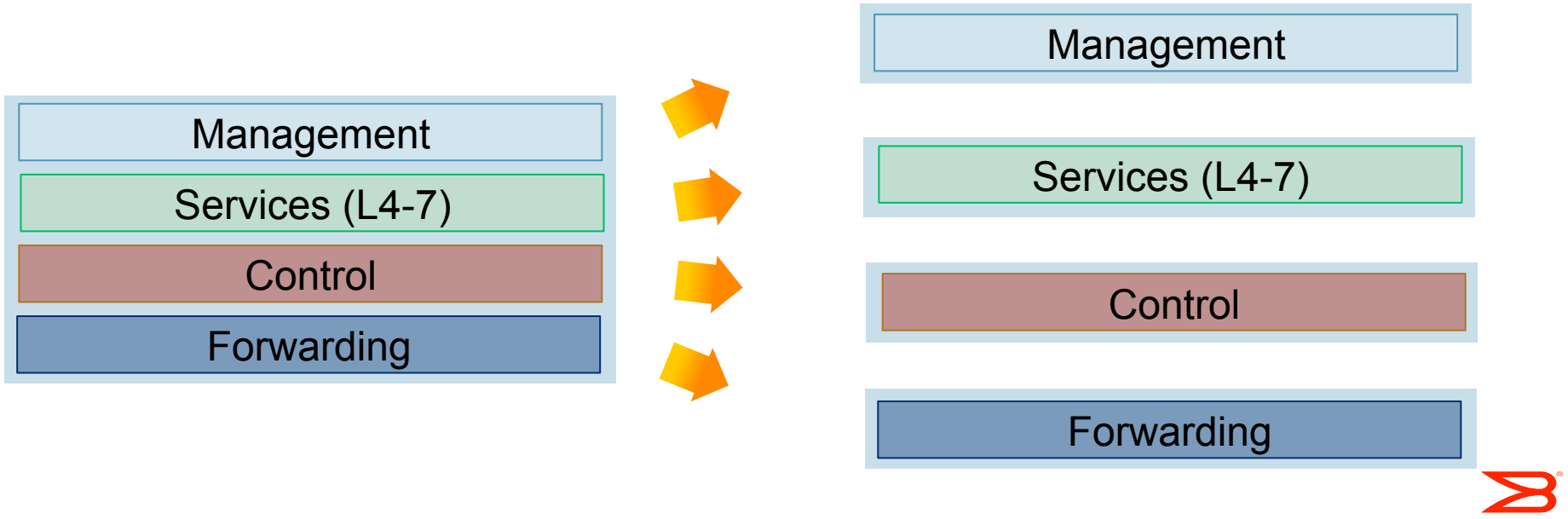
Today's telecommunications equipment has four district planes of operation closely embedded together on a box level:-

- **The Forwarding plane** – Moving the packets
- **The Control plane** – Deciding where packets go
- **The Services Plane** – Providing specific functions (L4 – L7)
- **The Management plane** – Monitoring and Configuring

SDN – Splits Apart These Operations

Separate network into four planes – Forwarding, Control, Services and Management

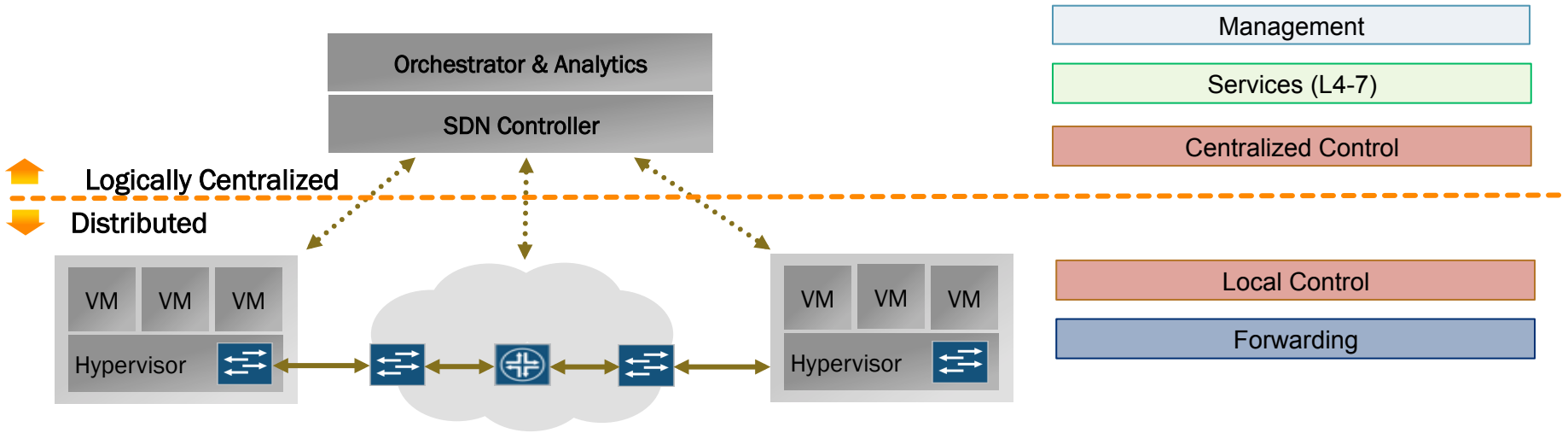
- We gain the ability to optimize each plane
- And we enable functions to be centralized or distributed



In A Typical SDN Network

We centralise what we can and distribute what we must

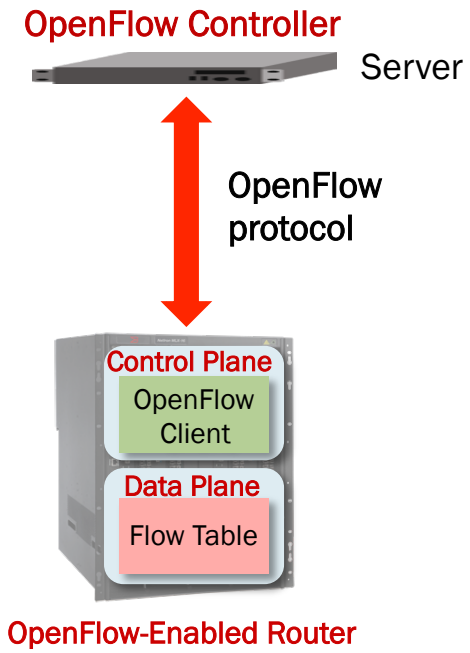
- Centralize: Management, most Services, some Control Plane
- Distribute: Forwarding, some Control Plane



OpenFlow began at Stanford University

With the Clean Slate Program

- OpenFlow-enabled router supports an OpenFlow Client (control plane software)
- OpenFlow Client communicates with an OpenFlow Controller using the OpenFlow protocol
  - OpenFlow Controller runs on a server
- OpenFlow-enabled routers support the abstraction of a Flow Table, which is manipulated by the OpenFlow Controller

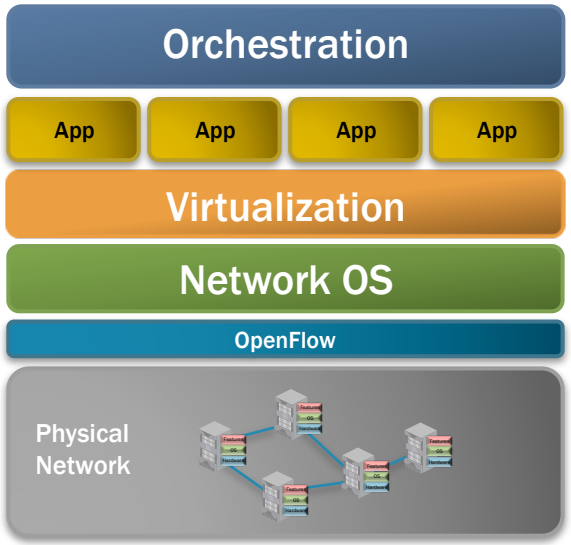


The ONF and OPENFLOW

Open Networking Foundation (ONF)

- ONF launched publicly in March, 2011
- Support from more than 70 major companies
- The ONF defines OpenFlow and API specifications
- Founding members of ONF:

Deutsche Telekom · Microsoft · facebook · verizon wireless · Google · YAHOO!



ONF SDN Model
(simplified)

Brocade's History with SDN/OpenFlow

A strategic technology innovation effort launched in 2010

- Public endorsement of OpenFlow at Brocade Technology Day (June 2010)
- 1st public demo of OpenFlow at Open Networking Summit, Oct. 2011
  - NEC PFC demonstration with CER at NEC booth
- 1st ONF OpenFlow Plugfest, March 5-9, 2012
  - MLXe and CER with pre-alpha OpenFlow feature successfully interworked with the following controllers, NEC PFC, BigSwitch, NTTData, and Indiana University (ON-SS), and FlowVisor.
- 2nd Open Networking Summit, April 16-18, 2012
  - Demonstration of OpenFlow on MLXe and CER at Brocade booth
  - NEC PFC demonstration with MLXe at NEC booth
- Interop Las Vegas May 7-10, 2012
  - NEC PFC demonstration using MLXe
  - MLXe and CER as part of OpenFlow Lab

What is NFV ?

- NFV or (Network Functions Virtualisation) is the virtualisation of functions within the network such a routers, firewalls etc. Today we have individual physical boxes within communication networks for particular functions
- NFV uses the same techniques that have been used in IT systems for years to create virtualised compute and storage architectures, however, in this case we are virtualising network functions such a firewalls, routers etc
- Having network functions on demand, scalable and flexible within networks will be the most important change driving new network designs in the coming years

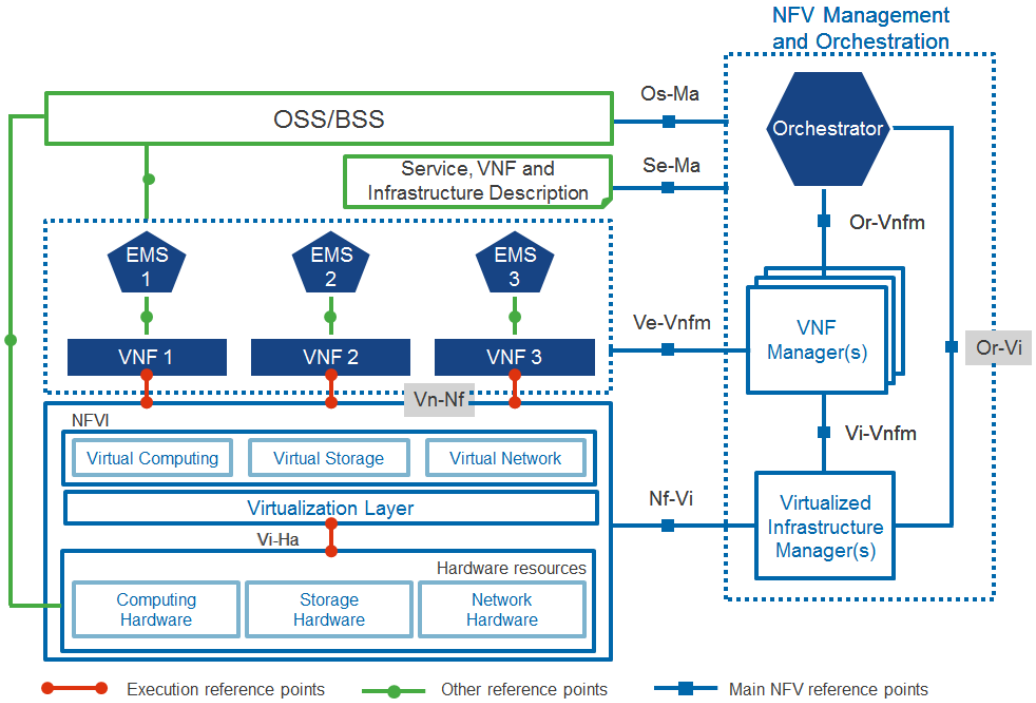
The ETSI NFV Foundation Architecture

In October 2012, an industry specifications group, "Network Functions Virtualisation“, Published a white paper at a conference in Darmstadt, Germany on software-defined networking and OpenFlow

The group, part of the European Telecommunications Standards Institute (ETSI), was made up of representatives from the telecommunications industry from both Europe and beyond.

The NFV Architectural Framework

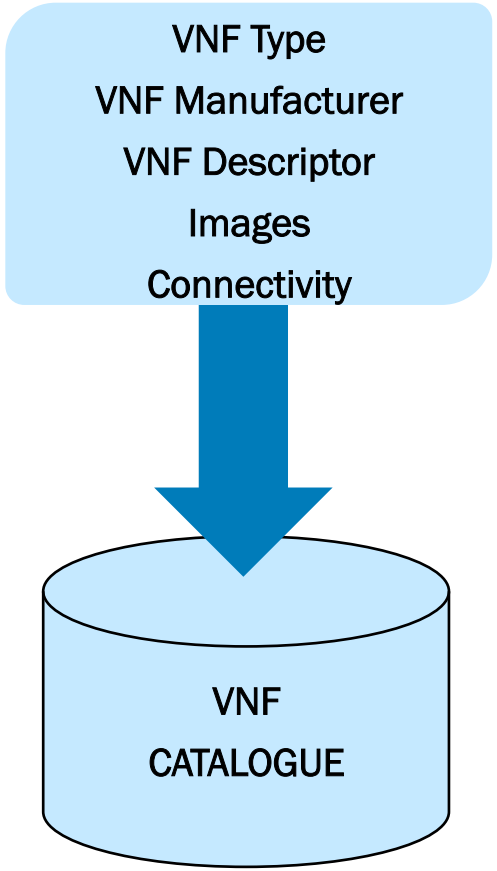
The NFV framework shows interfaces between various functional blocks:-



For further information please see
http://portal.etsi.org/portal/server.pt/community/NFV/367

1 On Boarding

- Here a digitally signed software package is received from a software vendor and submitted into the virtual network function catalogue
- The package contains information on how to construct the Virtual Network Function for example
    - The number of virtual machines for each possible version of the function
    - The compute, storage and interface requirements for each VM
    - The virtual machine images to be loaded
    - The connectivity between the VMs described in a service graph
    - The external interfaces



2 Instantiation

- The NFV orchestrator having received an instantiation instruction make a request to the infrastructure layer for the resources required to build the virtual machines; compute, storage etc.
- The resources are then locked down and the Orchestrator in combination with the VNF manager provisions the VMs
- The VMs are populated with the required images for the Virtual Network Function Components (VNFCs)
- The connectivity is provisioned by the orchestrator from the information in the VNF descriptor (service graph). The orchestrator provisions the external and internal connectivity

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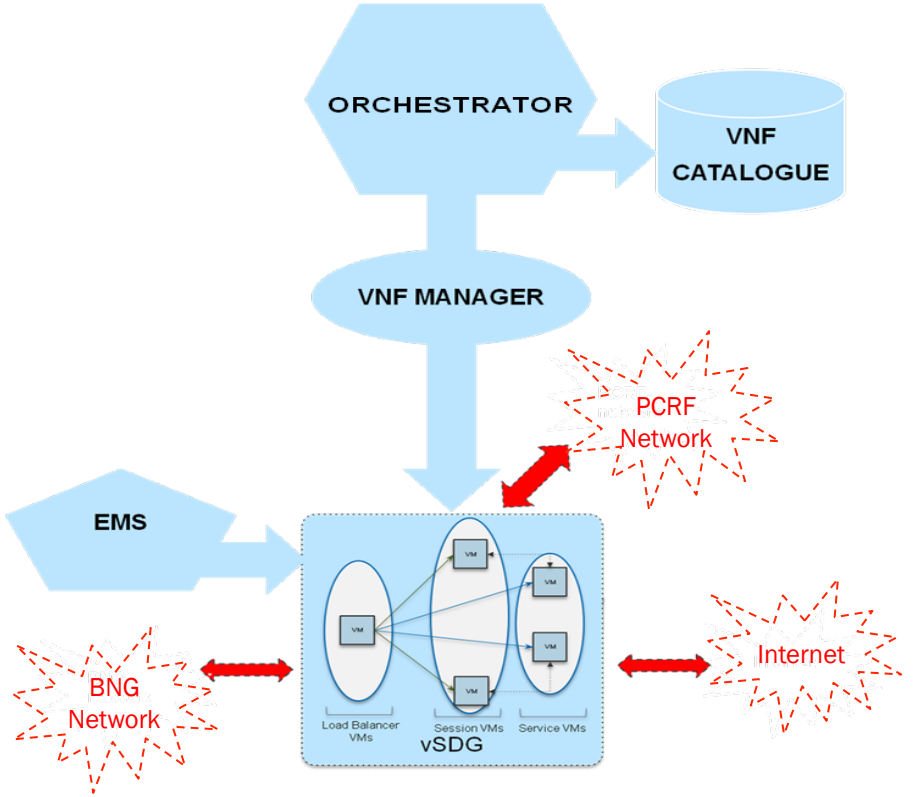
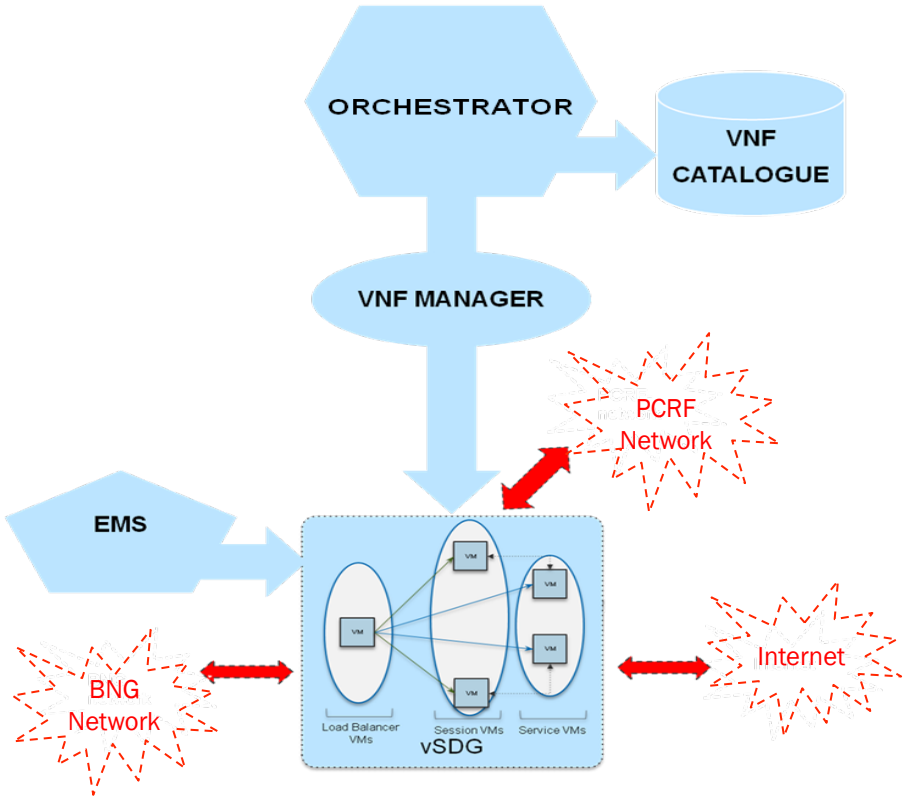


3 Configuration

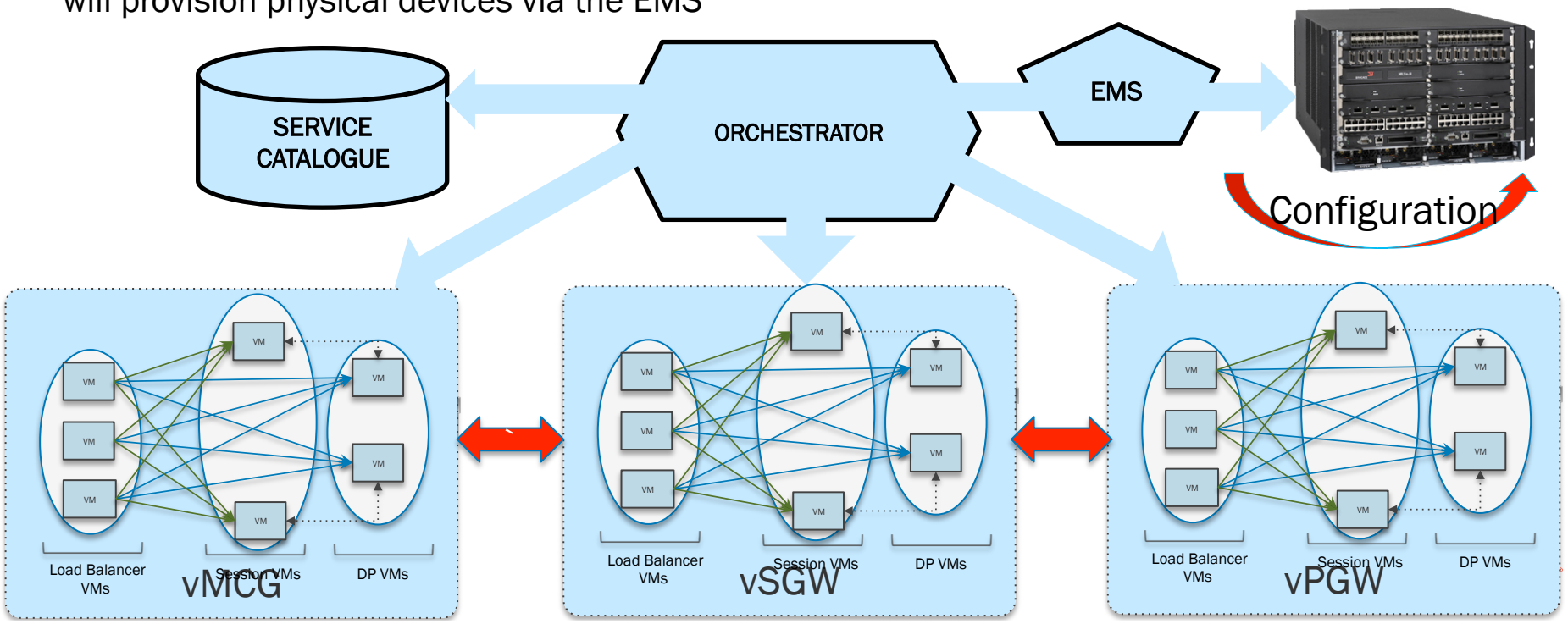
- Once the virtual network function is booted it is a very similar situation to switching on a physical box and then having it become visible on the EMS and the EMS pushing a configuration to the box.

- It is important to realise here that the EMS will not see the internal connectivity of the VNF and is not responsible dealing with internal VNF management. The EMS just sees the holistic unitary high level function

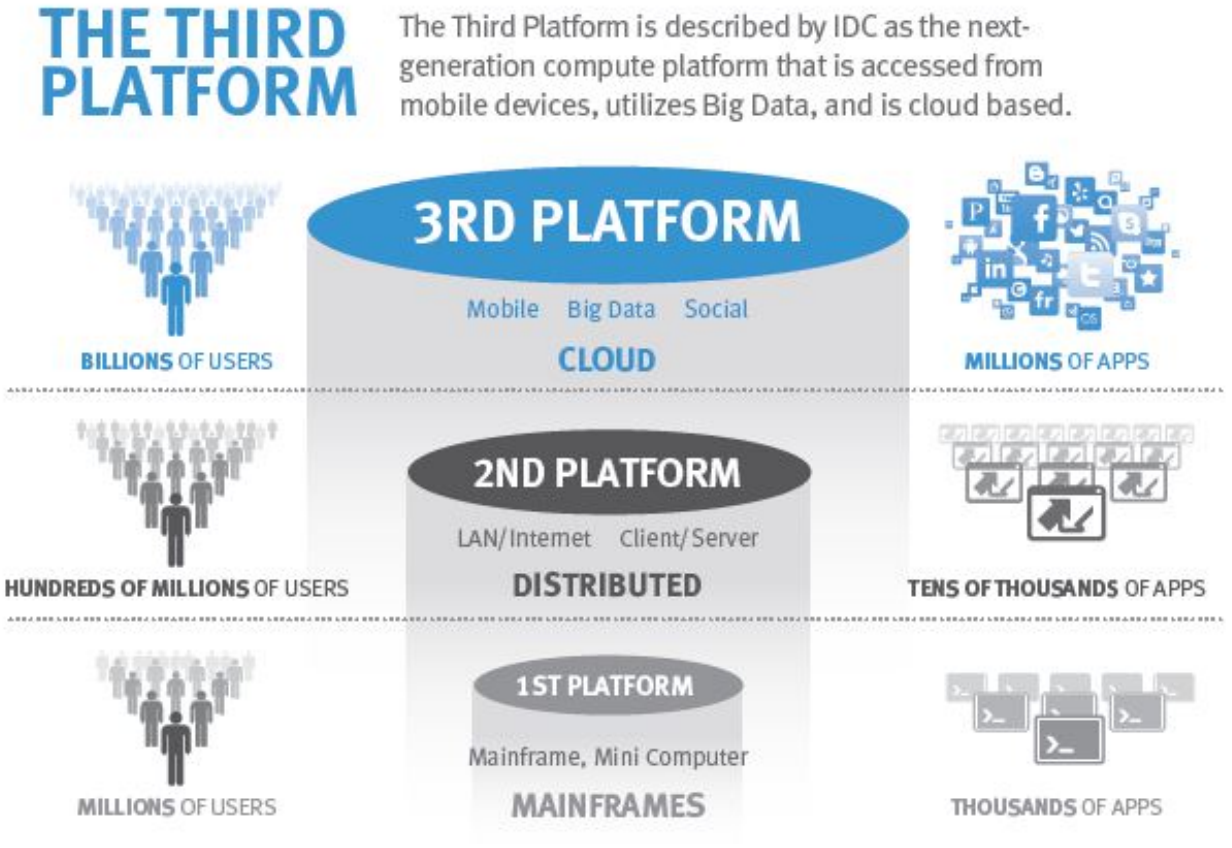


4 Building a Service Chain

- As well as the concept of a VNF catalogue there is also the concept of a service catalogue the service catalogue will have details of various services containing multiple VNFs connected together and the orchestrator can provision this by receiving an Instruction to provision the whole chain. The chain can contain both physical and virtual devices, generally the orchestrator will provision physical devices via the EMS



What is the Third Platform?

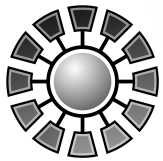


BROCADE

The transformational network architecture required to deliver this evolution

GOODBYE STATUS QUO IP NETWORK.

HELLO NEW IP



OPEN

RAPID INNOVATION

USER-CENTRIC

SOFTWARE DEFINED

The New IP Framework

What is Openstack ?

Solution, community, foundation

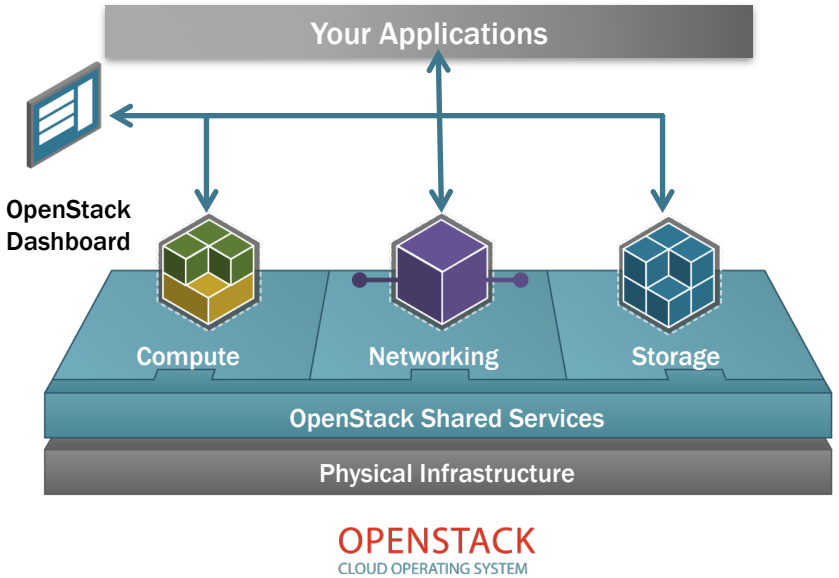
Solution: Open source cloud management framework for private and public clouds

Foundation: Created by Rackspace and NASA

- July 2010: Merged and open sourced Cloud Software (storage) and Nebula (compute)
- September 2012: Launched OpenStack Foundation as a vendor-neutral consortium

Community: 15,000+ participants—independents, vendors, user organizations

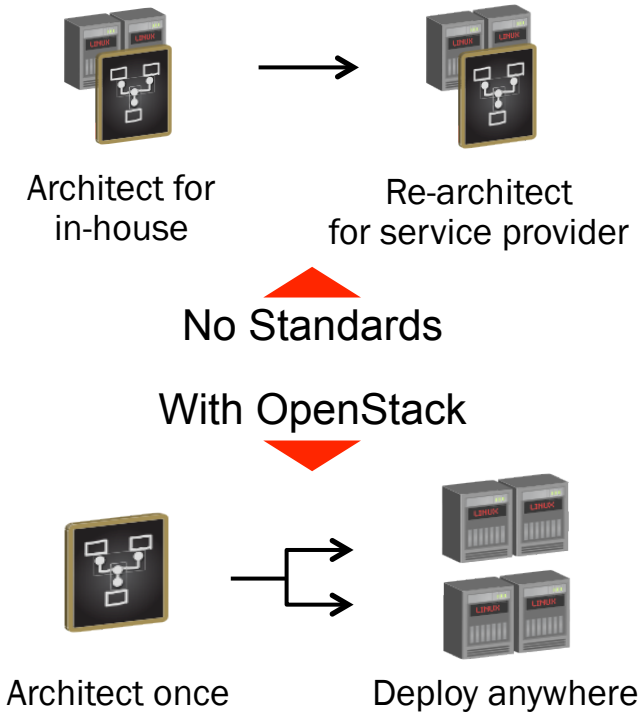
- Becoming the de facto open source standard for cloud orchestration



Openstack enables workload mobility

Between clouds – Private and Public

- Enables interoperability between clouds by seamlessly federating virtual workloads across them
  - Portability: Vendor and technology agnostic
- Is extensible to meet specific deployment needs
  - Vertical flexibility (plugin)
  - Horizontal flexibility (API extension)
- Is designed to be massively scalable
  - Very large groups of virtual private servers, terabytes, or even petabytes of data



OpenStack Taxonomy – But changing

Five major Components

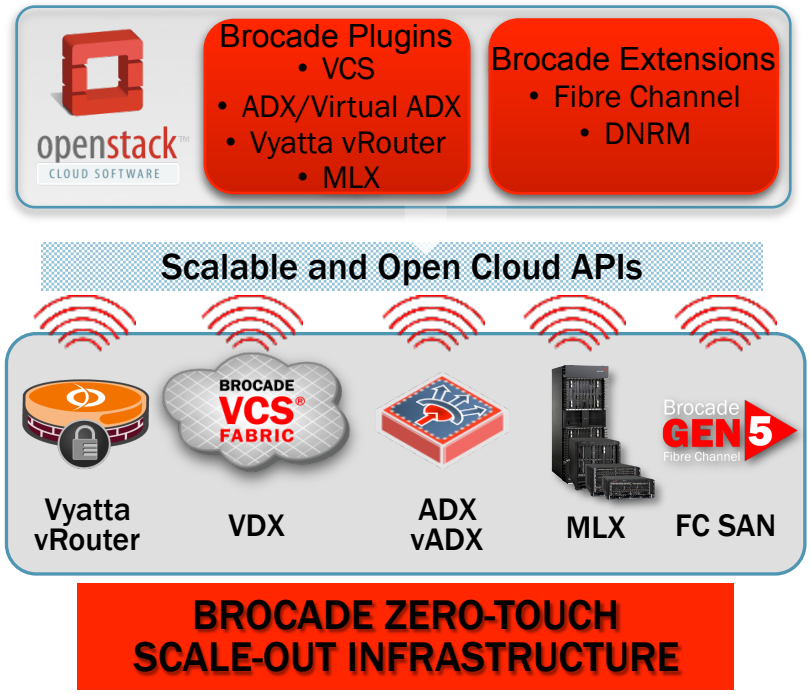
Cloud Core Services	OpenStack Project	Amazon Web Services Equivalent	Rackspace Equivalent
Virtual Machines	Nova	EC2	Cloud Servers
Object Store	Swift	S3	Cloud Files
Block Storage	Cinder	EBS	Cloud Block Storage
Virtual Networks	Neutron	VPC	Cloud Networks
Dashboard	Horizon	AWS Mgmt Console	Cloud Control Panel

Source: http://www.pistoncloud.com/cloud-technology/what-is-openstack/

Brocade OpenStack Solutions for an Open Cloud

Self-service cloud networking resources on-demand

- Brocade joined in May 2011, became a corporate sponsor in September 2012
- Brocade supports OpenStack users with plugins for its entire data center portfolio
- Brocade is leading industry efforts to champion:
  - Fibre Channel zone management
  - Dynamic network resource management
  - Inter-data center multitenancy



The Industry First

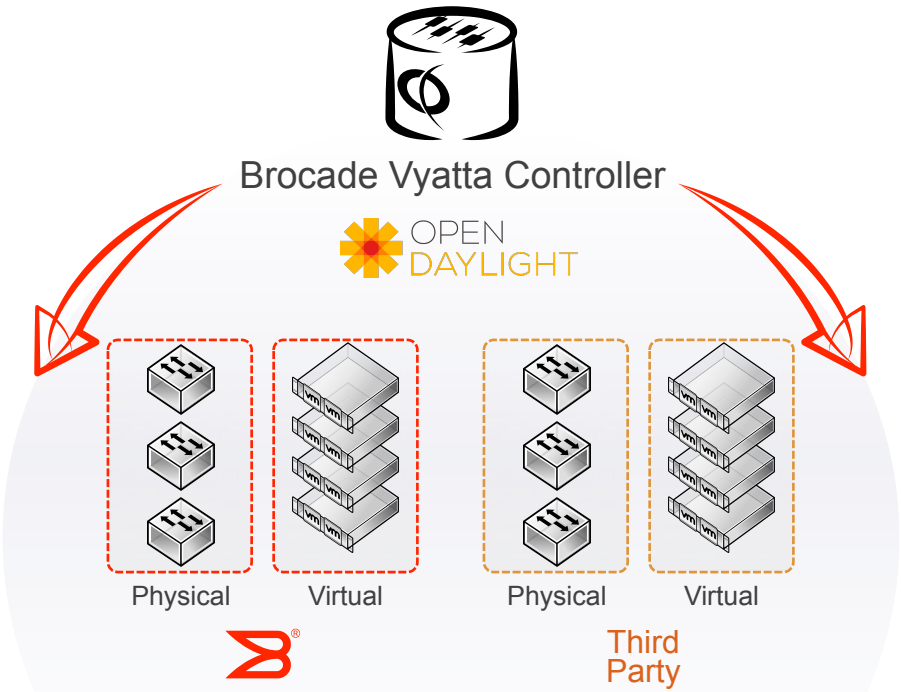
The Brocade Vyatta Controller

Broad Capability

- Controls L2–7
- Controls Physical or Virtual
- Controls Brocade and 3rd Party Products

Innovative Offering

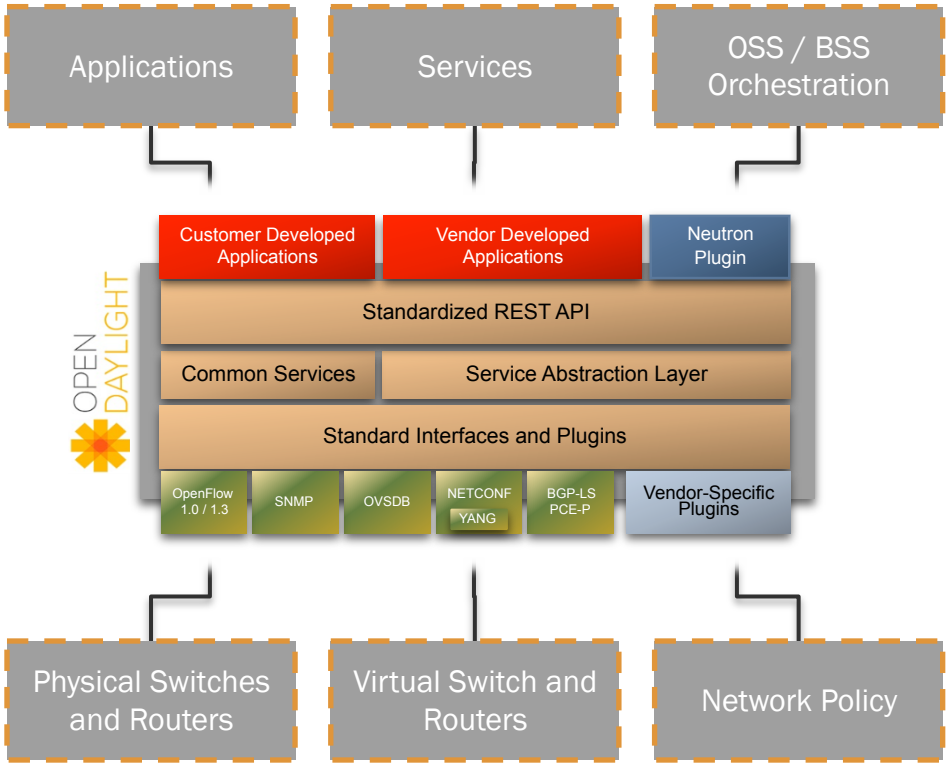
- Open Source
- Supported software roadmap
- Enabling customer services



Bringing openness, reliability and choice to SDN

OpenDaylight Project—Operated by the Linux Foundation

Foundation for the Brocade Vyatta Controller



- The leading open-source SDN controller
  - More than 200 developers from 41 member companies AND individuals from user organizations
  - 1.7+ million lines of code
- Open industry forum: most networking providers, many SDN ecosystem firms
- Addresses service provider & enterprise needs
- Platform-independent “narrow waist”—standardization point that allows for optimization and innovation above and below

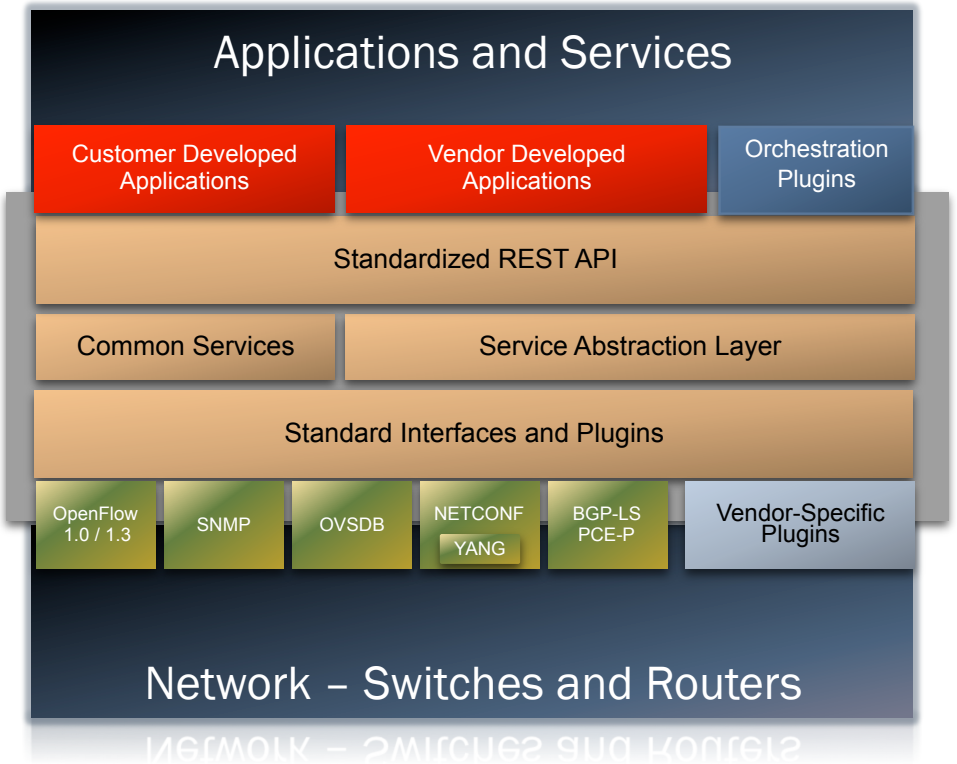
What a Controller Does

A Controller is a Platform That:

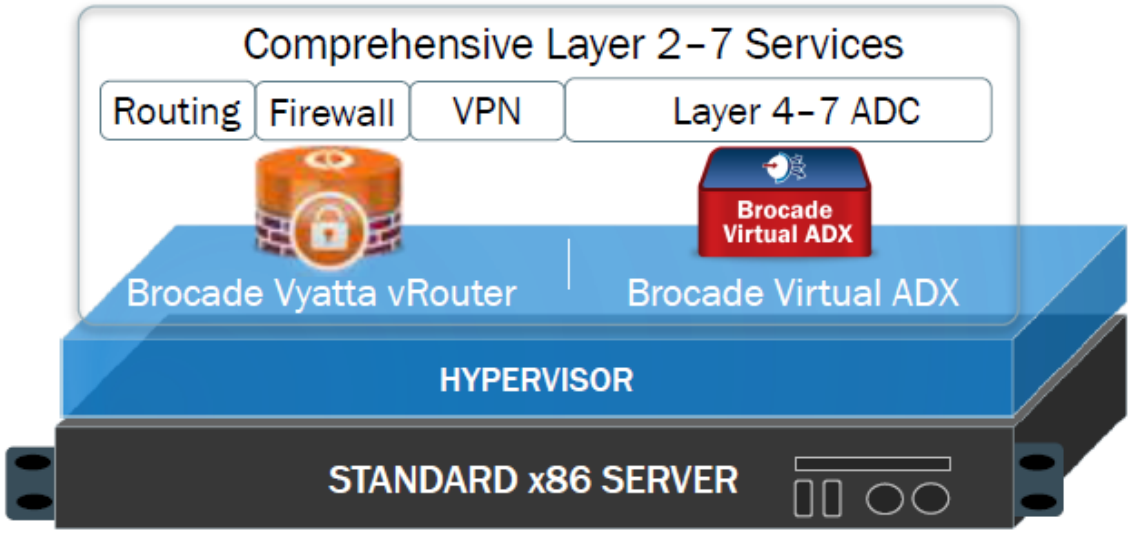
Allows software developers to innovate applications that get information from the network and control the network

CONTROLLER PLATFORM

Allows network equipment suppliers to create plugins and information models for their equipment that improve manageability and lowers costs



Brocade is leading in creating new virtualised networking products



Industry-Standard x86 Server

Hypervisor and Cloud Agnostic

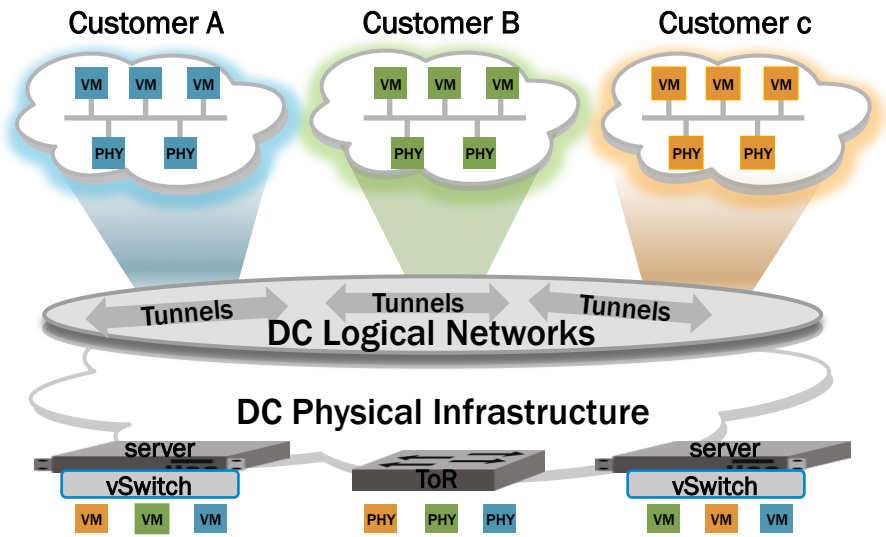
On-Demand Resources at Scale

SDN Use Cases

SDN Will Evolve Through Value-Added Applications

Data Center Network Virtualization

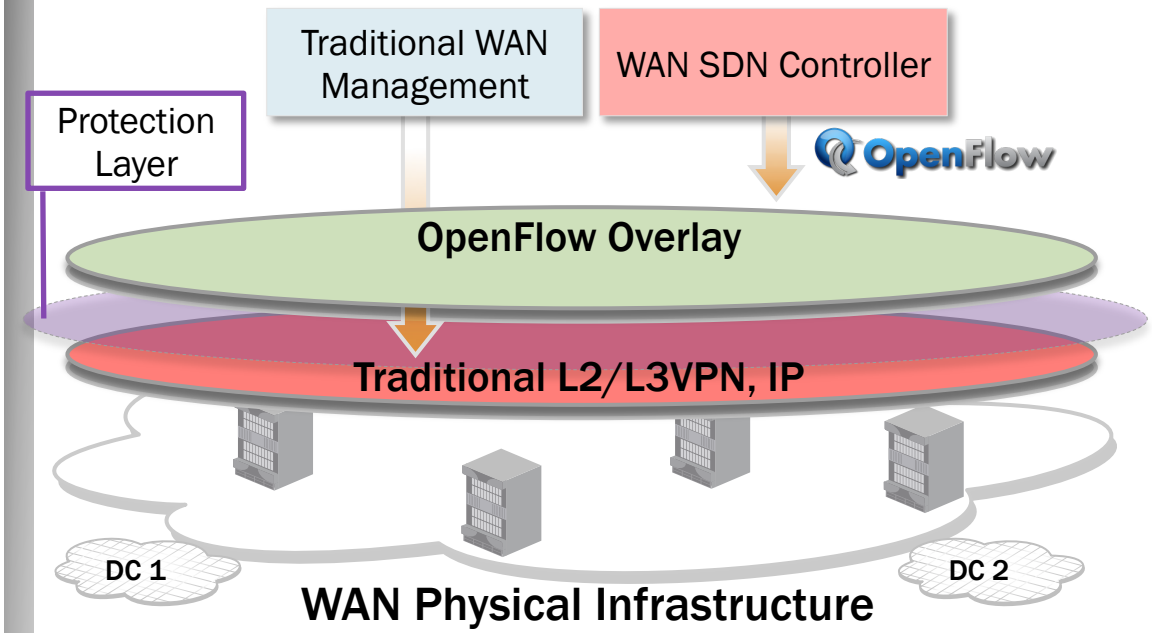
Scalable Cloud Services



- Tunnels enable physical network abstraction (logical network)
  - VxLAN, NVGRE, STT
- Software Switches (vSwitches) connect virtual machines
- ToRs connect physical machines
- SDN Gateways enable scalable connectivity into the logical network

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

Internet2 WAN Use Case

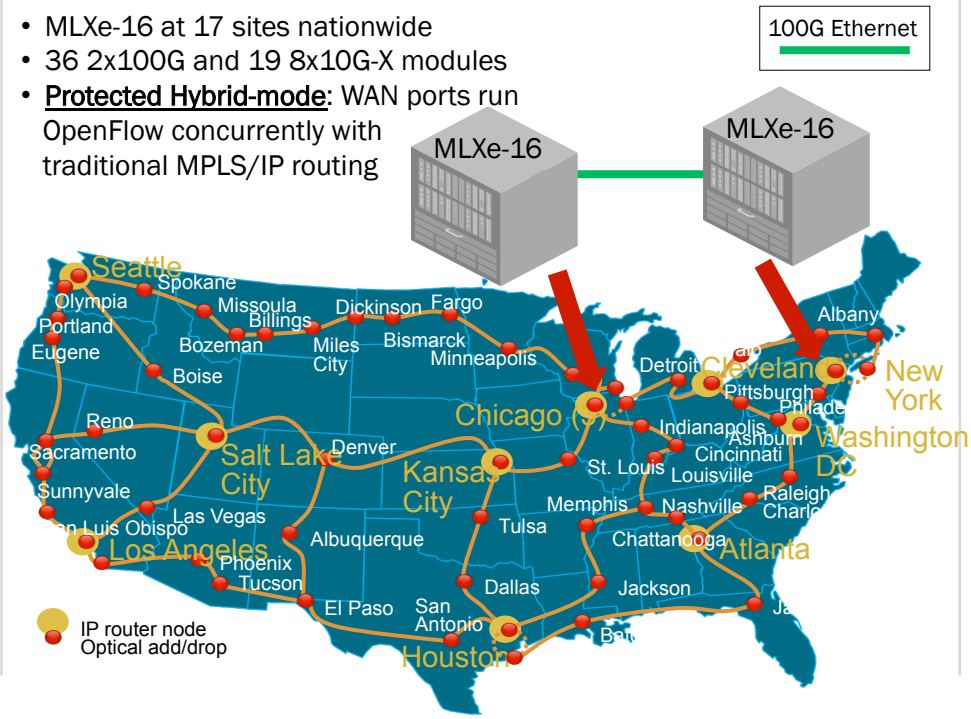
Internet2 is an advanced networking consortium for the research and education community developing and deploying revolutionary Internet technologies. I2 wanted to create a new Innovation Platform to provide massive bandwidth to address network bottlenecks and introduce Software-Defined Networking (SDN). They are building out this network with Brocade's MLXe, 100 GbE, and true Hybrid Mode OpenFlow.

Problems

- Needed a high-performance networking platform for member Research & Education IP and peering services
- Required 100 GbE to provide massive bandwidth needed for elephant flows
- OpenFlow enabling simultaneous SDN and IP routing
- Development of a new persistent Open Exchange with persistent & dynamic VLANs

Solution

- MLXe-16 at 17 sites nationwide
- 36 2x100G and 19 8x10G-X modules
- **Protected Hybrid-mode**: WAN ports run OpenFlow concurrently with traditional MPLS/IP routing

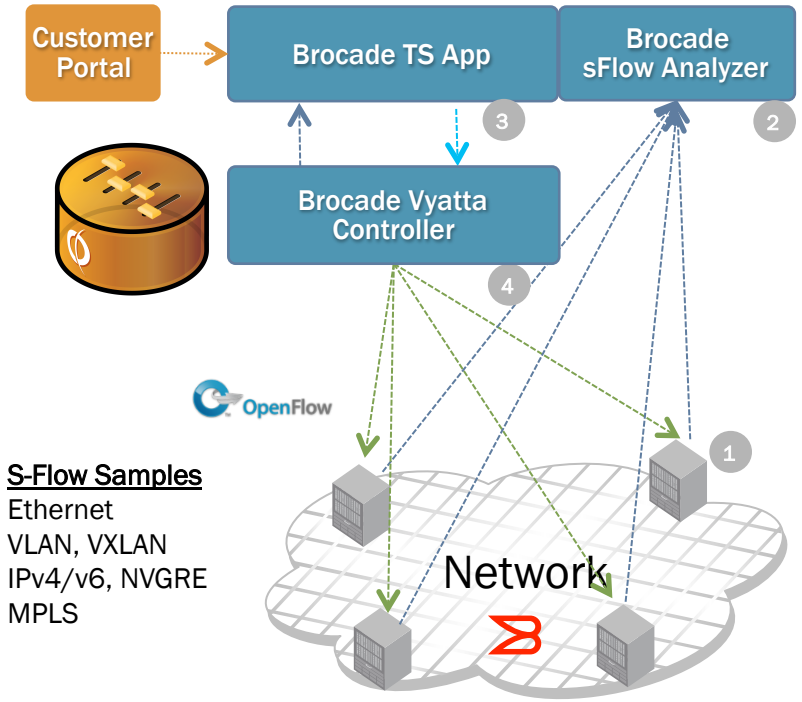


Benefits

- MLXe provides highest density 10GbE and 100GbE
- Brocade enables their Open Exchange with **SDN via OpenFlow on the MLXe**
- SDN via OpenFlow enables I2 member institutions to innovate SDN applications concurrent with high-speed routing & MPLS
- OpenFlow network as an overlay on top of a "protected" MPLS/IP WAN network

Volumetric Attack Mitigation

Value proposition: Less expensive, Easy out-of-the-box install



S-Flow Samples
Ethernet
VLAN, VXLAN
IPv4/v6, NVGRE
MPLS

1. Data Center Devices

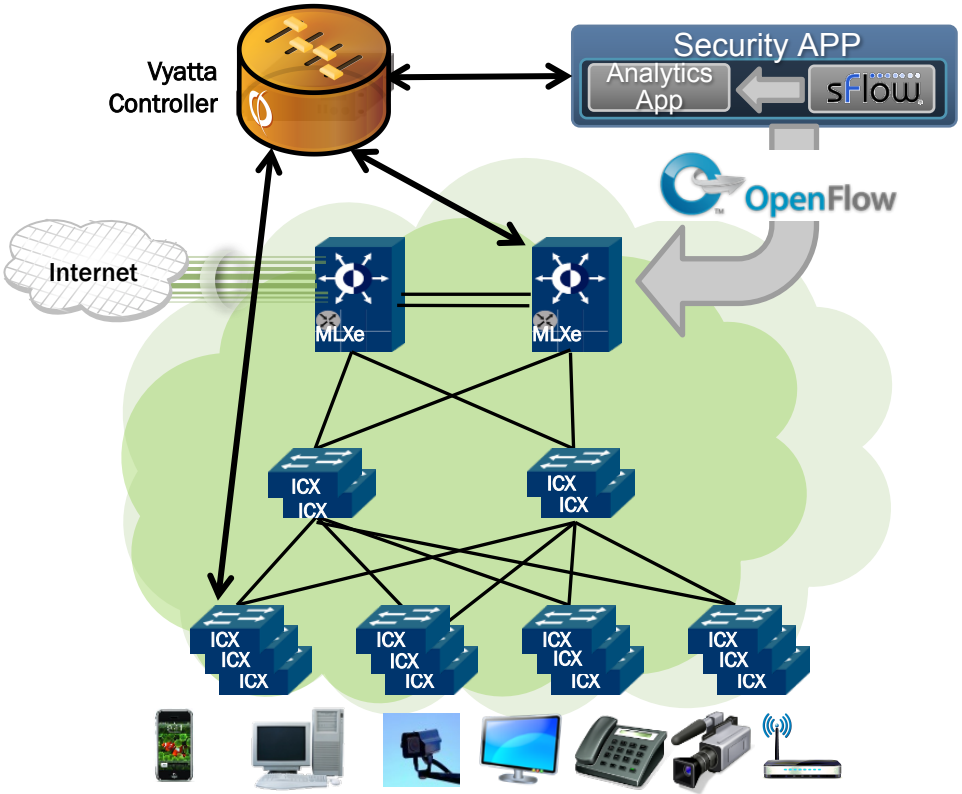
   Send sFlow samples to the collector
2. sFlow Analyzer

   Analyze and report Volumetric Flow trigger
3. Traffic steering application with policy based UI and REST APIs

   Instruct controller to redirect volumetric flows
4. Vyatta Controller

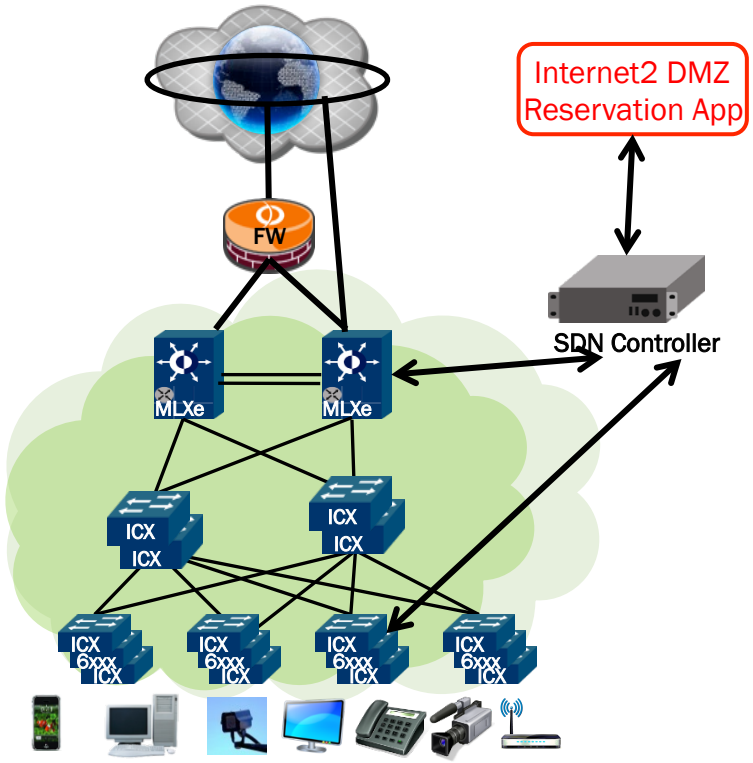
   Program OpenFlow 1.3 rules in MLX and ICX

Context-Aware Policy Enforcement



- sFlow to monitor traffic
- Analytic application identifies behavior
- Policy activated upon threat detection
- Security application programs flow action in controller
- Vyatta Controller pushes appropriate OpenFlow entries

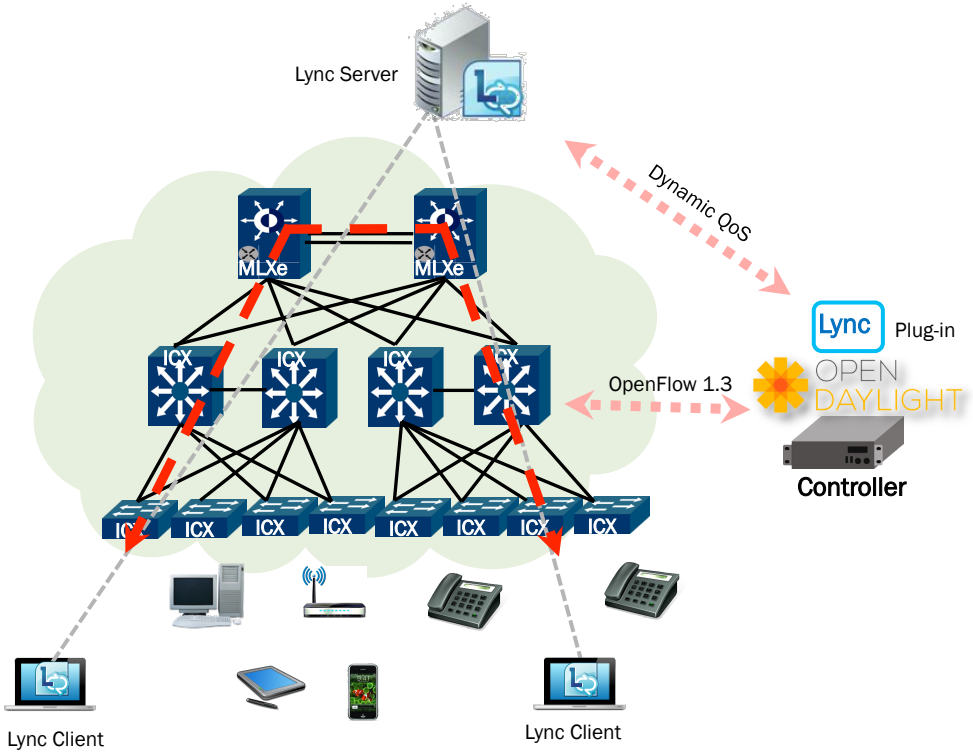
Science DMZ – App Flow



- User logs in as trusted user
- Connects to Internet2 Reservation App
- User AAA for services requested
- Resources identified and request sent to SDN controller
- Controller pushes appropriate OF entries to pre-emptively create path
- Trusted traffic routed around firewall
- All other traffic sent to firewall

SDN-Based Adaptive and Automated QoS

Application detects voice/video delays, dynamically requests prioritization



Benefits

- Fully automated and adaptive call admission and control
- Single trusted source of QoS management
- Eliminates the need to QoS tag at the switch port level
- Dynamic replacement of manual switch-by-switch provisioning of static QoS policies

THANK YOU