Software Defined Networks & Cisco Evolved Programmable Network

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Agenda

- SDN Introduction and SP Industry Initiatives
- Evolved Programmable Network – Infrastructure Layer
- SDN Control and Orchestration Layer
- Network Application Layer
  – DEMO

- Summary
SDN Introduction and SP Industry Initiatives
What is Software Defined Networking?

Separation of Control and Forwarding Plane
Centralized Management – Global View

Open and Programmable
Flexibility and Innovation at Software Speed
Application Interaction
Virtualized Resources
Simplicity, Automation

SDN Layers
“…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…”


“Open protocol that specifies interactions between de-coupled control and data planes………open standard that enables researchers to run experimental protocols in campus networks. Provides standard hook for researchers to run experiments, without exposing internal working of vendor devices……”

http://www.openflow.org/wp/learnmore/

Open source project formed by industry leaders and others under the Linux Foundation. “…OpenDaylight’s mission is to facilitate a community-led, industry-supported open source framework, including code and architecture, to accelerate and advance a common, robust Software-Defined Networking platform…”

http://www.opendaylight.org/
Self-Organizing Network (SON): ....Automation of some network planning, configuration and optimisation processes via the use of SON functions can help the network operator to reduce OPEX by reducing manual involvement in such tasks.

http://www.3gpp.org

Open source software for building public and private Clouds; includes **Compute (Nova)**, **Networking (Neutron)** and **Storage (Swift)** services.

http://www.openstack.org

“Open vSwitch (OVS) is a production quality open source software switch designed to be used as a vswitch in **virtualized server environments** .......Open vSwitch supports standard management interfaces (e.g. sFlow, NetFlow, IPFIX, RSPAN, CLI), and is open to programmatic extension and control using **OpenFlow and the OVSDB management protocol**”

http://openvswitch.org
NFV Initiative
- Initiative announced at “SDN and OpenFlow World Congress”, Darmstadt, Oct 2012

Use of cloud technology to support network functions
- Management, Control and Data plane components

Not technically related to SDN

Value Proposition
- Shorter innovation cycle
- Improved service agility
- Reduction in CAPEX and OPEX

ETSI based standardization

NFV = Transition of network infrastructure services to run on virtualised compute platforms – typically x86
NfV (Network Functions Virtualization)

Network infrastructure/Service **Functions** run on **Virtualized** x86 compute platforms.

- **Key Enabler: Cloud**
  - Hypervisor & x86 compute hardware
  - Network automation / orchestration

- **Benefits:**
  - Faster service provisioning/Agility
  - Shorter innovation cycle
  - CAPEX & OPEX Savings

- SDN complementary, but not mandatory
The SDN Proposal

The “purist” viewpoint

Conclusion: Derive the common themes and adapt to thrive
bring real value to SPs

Key Factors in SDN evolution

• SDN needs “simplification” and an Evolution of current environment
• Collaborative “Hybrid” Control plane adoption
• Abstraction layers and Programmability via API’s/Protocols
• Use case driven based on SDN models

“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…”
The Collaborative “Hybrid” Control Plane
Centralized Control Example - Network Optimization

Distributed – Head End TE Path Calculation

- Global topology view
- Local TE requirements
- Unpredictable TE tunnel placement
- Overall n/w sub-optimal tunnel placement

Centralized - PCE TE Path placement

- Global topology view
- Global TE requirements
- Predictable tunnel placement
- Network wide optimized tunnel placement

“centralised optimisation enables ~30% more traffic for the same installed capacity”
CT = time to: detect failure + signal to controller + calculate new path + disseminate + update FIBs

Major failure → multiple devices will be doing this at the same time
- Impulse load on controller and paths to controller, difficulty correlating of events, failure in paths to controllers
The Collaborative “Hybrid” Control Plane
True Service Level Benefits

- Distributed Components – Functions tightly coupled to data plane
  - IGP convergence, OAM and physical link state driven protection, Distributed SON

- Centralized Components – Functions where a holistic/abstracted view is required
  - PCE (Path Computation Element) Traffic Placement: 30% efficiency, Centralised SON

- Existing distributed control plane -> Augmented by centralised control plane function
- Enable a holistic Network Programming model
- Leverage and extend infrastructure at pace of the business
- Deploy common applications across all devices
- Extend/upgrade/add features without upgrading the network operating system
- Reduced time to market by leveraging common platform for building services
APIs and Agents
Linkage to OnePK Framework

Application Frameworks, Management Systems, Controllers, ...

“Protocols” → onePK → OpenFlow → I2RS → PCEP → BGP-LS → Quantum → OMI → Puppet → Netconf → ...

Management
Orchestration
Network Services
Control
Forwarding
Device

BGP
Diameter
Radius
SNMP

OpenFlow → I2RS → PCEP → BGP-LS → Neutron → ...

Netconf → OMI → Puppet → Netconf → ...

Operating Systems – IOS / NX-OS / IOS-XR

onePK API & Agent Infrastructure
REpresentational State Transfer (REST) is an API architecture style that can use HTTP to send messages between a client and server, piggyback on existing HTTP Internet.

- Using REST, applications can Create/Read/Update/Delete
- A REST service is platform-independent, language-independent
- App can be browser-based or standalone
Evolved Programmable Network - EPN
### Entering a New Era in the SP Network Evolution

#### TDM Era vs. IP NGN Era

<table>
<thead>
<tr>
<th>TDM Era</th>
<th>IP NGN Era</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managed</td>
<td>Autonomic, with Control &amp; Visibility</td>
</tr>
<tr>
<td>Configurable</td>
<td>Orchestrated with Self-service</td>
</tr>
<tr>
<td>Apps Independent of Network</td>
<td>App &amp; Network Interaction</td>
</tr>
<tr>
<td>Command Line Interface</td>
<td>Well-known Programmatic Interfaces</td>
</tr>
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#### Programmatic Network Era

- **Autonomic, with Control & Visibility**
- **Orchestrated with Self-service**
- **App & Network Interaction**
- **Well-known Programmatic Interfaces**
- **Open & Pluggable**
Open Network Strategy
Open SDN/NFV Innovations for an Evolved Programmable Network

ACCELERATE

OPTIMIZE

MONETIZE

Ultra HD

M2M

Cloud

Mobility

Always “ON”

On-Demand Services Anywhere

Fully Virtualized

Real-Time Analytics

Dynamic Scale

Open and Programmable

Seamless Experience

Automated

Intelligent Convergence

Application Interaction

Applications

Open APIs

Service Orchestration/Apps

VM/Storage Control

Access

Evolved Programmable Network
Deliver Ultra-High EPN Multi-Service Scalability Convergence without Compromise

**High Scale by Solution Architecture**
- Common high scale control plane
- Optimized forwarding resources
- Scalable EFP-based service termination

**Multi-service Hardware Design**
- Line rate in the access
- Per service HW structures at PE
- Scalable H-QoS
- Multicast Replication
- HW MAC Learning

**Modular IOS-XR**
- Scale as you grow
- Distribute processes between RP and LC
- Ultra-high Multi-Dimension Scale with superior stability

**HW Accelerated Ultra-High BFD and EOAM Performance & Scale**
- 3.3ms BFD
- 3.3ms CCM
- Fast failure detection
- Per LC scale
Evolved Programmable Network Family
Meeting the Needs of Today’s Challenges and Tomorrow’s Opportunities

Multi-Service Core Routing:
Drives 100GE multi-service density with MC Scale

CRS

NCS:
Flexible Network Fabric
Converging Core, Edge, Optical, Access, and Data Centre

ASR Series

Edge Portfolio:
Optimized 10GE/100GE Ethernet Density for Scalable Business, Consumer, Mobile, Video

UCS

NCS

Elastic Access Portfolio:
Converged TDM/Ethernet Aggregation
GPON for wholesale and Mobile & Cloud demarc

Data Centre
Dense 10GE/40GE/100GE
LAN/SAN Switching Fabric
Virtualized Compute

Access

Global Visibility and Programmability

Monetize IoE Opportunity
WAN + DC Physical and Virtual
Fixed and Mobile Convergence

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Presentation_ID
Network (Physical and Virtual Infrastructure)
Segment Routing (SR)

- Application Enabled Forwarding
  - Each engineered application flow is mapped on a path
  - A path is expressed as an ordered list of segments
  - The network maintains segments

- Simple: less Protocols, less Protocol interaction, less state
  - No requirement for RSVP, LDP

- Scale: less Label Databases, less TE LSP
  - Leverage MPLS services & hardware

- Forwarding based on Labels with simple ISIS/OSPF extension

- 50msec FRR service level guarantees

- Leverage multi-services properties of MPLS
A packet injected anywhere with top label 65 will reach Z

Forwarding state (segment) is established by IGP
- LDP and RSVP-TE are not required

MPLS Dataplane is leveraged without any modification
push, swap and pop: all what we need
segment = label

Nodal segment: Operator allocates a label from the SR registry to each node.
For example Z is given label 65

Adjacency segment: Node automatically allocates a local label for each adjacency.
For example Label 9001 allocated for adjacency O

A packet injected at node C with label 9001 is forced through datalink CO
Any explicit path can be expressed i.e. ABCOPZ
SDN Controller / Service Orchestration
SDN Controller – Strategic vision

- Two layered environment
- Elementary Infrastructure Functions
  - Basic capability to interact with the network
  - NB APIs
  - Device level APIs / Protocols
  - Baseline capabilities
- Controller application
  - Function specific applications
  - Utilises Infrastructure controller to interact with n/w
  - Potentially multiple controller applications running
- Other functions have their own controllers. Example OpenStack with Nova, Swift and glance
SDN Controller Examples
WAE, Tail-f/NCS & Opendaylight

WAE
WAN Automation Engine

NCS
Network Control System

ODL
Opendaylight
**WAN Automation Engine: Operational Model**

*Enables Software to Software (Not Human to Human) Interactions*

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**Orchestration Engine**

**Network Domain**

- WAN Automation Engine
  - Collection
  - Deployment

**Service, Network and Analytics REST APIs**

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**DC Domain**

**Content Sites**

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**WAN**

- R1
- R2
- R3

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**Cloud Consumer Customer Site**

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**Consumer Service Request**

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**Deployment**

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**Consumer Service**

**Request**

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**Enables Software to Software (Not Human to Human) Interactions**

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WAN Controller
Future Use-Case: Segment Routing with Centralized Control

ABCOPZ meets SLA. I account the BW.
I encode the path as nodal segment to C, adj segment to O, nodal segment to Z.
shortest-path 65 straight to Z provides the requested SLA.

Z with SLA (BW, lat)
OK, use {65}
OK, use {72, 9001, 65}

Congestion

Visualization/Analytics
Bandwidth Orchestration
Programming
API
Apps

A B C D
M N O P
Z
Network Application - Demo
Topology viewer & ACL provisioning using Opendaylight, REST, BGP-LS and Netconf/YANG
Summary
The Journey to true SDN/NFV Service Innovation

Simplify
• Convergence / Consolidation
• Network Function Virtualization
• Service Chaining
• Service Orchestration

Accelerate New Services
• Bandwidth on Demand
• Virtual Managed Services
• Security Services
• Premium Mobile Broadband
• Cloud DVR

Business Applications Integration
The network proactively adjusts to the application needs in real time

Seamless Experience
Always “On”
On Demand Services Anywhere
Application Interaction
Networks
Networks
Networks

On Demand Services Anywhere
Application Interaction
Networks
Networks
Networks