Introduction to Software Defined Networks (SDN) and its relevance in the DC

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What is Software Defined Networking (SDN)?

Many Definitions

- Openflow
- Controller
- Openstack
- Overlays
- Network virtualization
- Automation
- APIs
- Application oriented
- Virtual Services
- Open vSwitch
- …
Session Objective

At the conclusion of this session you will:

Understand what SDN Means to Cisco

Cisco ONE Strategy
SDN Definition
“SDN Is...”

Simplified Operations

Enhanced Agility

New Business Opportunities

Diverse Drivers

Common Concepts

Different Executions

Enhanced Agility

New Business Opportunities

Develop solutions at software speeds: I don’t want to work with my network vendor or go through lengthy standardization.

“SDN Is...”

“A way to optimize link utilization for customized flow management and between Data Centers”

“A solution to build a very large scale layer-2 network”

“A means to do traffic engineering without MPLS”

“A means to get assured quality of experience for my cloud service offerings”

“A means to scale my fixed/mobile gateways and optimize their placement”

“A way to distribute policy/intent, e.g. for DDoS prevention, in the network”

“A means to reduce the CAPEX of my network and leverage commodity switches”

“A solution to build virtual topologies with optimized multicast forwarding behavior”

“A way to optimize broadcast TV delivery by optimizing cache placement and cache selection”

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Real Business Values of SDN

**Flexibility:**
IT groups can become more *agile*; deployment backlogs are less problematic
Departments are more easily able to **self-select services** – including internal, 3rd party and external cloud services

**Automation:**
Easily **add features** (protect, segment, provision, add policies) to new workloads, groups, branches, employee devices and cloud resources

**Visibility drives speed:**
- **Holistic view** of application connectivity and external needs (branch, device)
- **Applications can ask for resources**, routes, and access instantaneously
  Heat maps (by application) of traffic across the campus and data center

**Revenue generation (for SPs):**
Service providers can provide more **value-added services** to customers
Innovation in software can accelerate service delivery and create stickiness
Software defined networking (SDN) is an approach to building computer networks that separates and abstracts elements of these systems.
In other words...

In the SDN paradigm, not all processing happens inside the same device.
## Control Plane and Data Plane

**Two fundamental terms to begin understanding the concepts around SDN**

<table>
<thead>
<tr>
<th>Processing Plane</th>
<th>Where it runs</th>
<th>How fast these processes run</th>
<th>Type of processes performed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Plane</td>
<td>Switch CPU</td>
<td>In the order of thousands of packets per second</td>
<td>Routing protocols (i.e. OSPF, IS-IS, BGP), Spanning Tree, SYSLOG, AAA (Authentication Authorization Accounting), NDE (Netflow Data Export), CLI (Command Line interface), SNMP</td>
</tr>
<tr>
<td>Data Plane</td>
<td>Dedicated Hardware ASIC’s</td>
<td>Millions or Billions of packets per second</td>
<td>Layer 2 switching, Layer 3 (IPv4</td>
</tr>
</tbody>
</table>
Over the years… this network paradigm has remained mostly intact…
Where did this SDN “thing” come from?
Stanford University – Clean Slate Project

“…explore what kind of Internet we would design if we were to start with a clean slate and 20-30 years of hindsight.”

http://cleanslate.stanford.edu/
Clean Slate led to the development of…
OpenFlow is a Layer 2 communications protocol that gives access to the forwarding plane of a network switch or router over the network.
First statement for today…
Openflow does not equal SDN

Openflow is one flavor, or a subset, of SDN
“…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…”

https://www.opennetworking.org/images/stories/downloads/white-papers/wp-sdn-

“…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,
“I wish we had done [the separation] in the Internet design, but we didn’t”

“In a very interesting way you have an opportunity to reinvent this whole notion of networking”

“Just because it says software-defined networking doesn’t mean they’re the same thing. That’s like ‘cloud…They’re not the same thing, and similarly you can invest in an arbitrarily large number of software-defined networks.”

http://slashdot.org/topic/datacenter/vint-cerf-sdn-is-a-model-for-a-better-internet/
Industry Standards

Technical Advisory Group Chair, Working Groups: Config, Hybrid, Extensibility, Futures/FPMOD/OF2.0

Open Source Cloud Computing project

802.1 Overlay Networking Projects, Cisco Innovations: FEX Architecture

IEEE

ONF Open Networking Foundation

W3C

ONRC Research

International Telecommunication Union

Open Stack

MEF

Overlay Working Groups: NVO3, L2VPN, TRILL, L3VPN, LISP, PWE3
API Working Groups: NETCONF, ALTO, CDNI, XMPP, SDNP, I2AEX
Controller Working Groups: PCE, FORCES

Working Groups: Quantum API Donabe
Cisco Innovations: OpenStack API for Nexus OpenStack Extensions

Open Network Research Center at Stanford University

Working Groups: NVO3, L2VPN, TRILL, L3VPN, LISP, PWE3
API Working Groups: NETCONF, ALTO, CDNI, XMPP, SDNP, I2AEX
Controller Working Groups: PCE, FORCES
And Data Centers Need to Evolve

**Distributed**
- Manual Provisioning
- Limited scaling
- Rack-wide VM mobility

**Fabric Based**
- Policy-based Provisioning
- Scale Physical and Virtual/Cloud
- DC-wide/Cross-DC VM Mobility

**Application Driven**
- Service-centric Provisioning
- Flexible – Anywhere, Anytime
- Cross-cloud VM Mobility

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Network Programmability Models

1. Programmable APIs
   - Application
   - Vendor-specific APIs

2a. Classic SDN
   - Application
   - Vendor-specific APIs
   - Control Plane
   - OpenFlow

2b. Hybrid “SDN”
   - Application
   - Vendor-specific APIs
   - Control Plane
   - OpenFlow and/or Vendor specific
   - Overlay Protocols

3. Network Virtualization/Virtual Overlays
   - Application
   - Vendor-specific APIs
   - Control Plane
   - Virtual Control Plane
   - Virtual Data Plane
   - Overlay Protocols

- Control Plane
- Data Plane
- NX1KV VEM
- NX1KV VSM
Cisco ONE
SDN Delivery Options

Software API Application Control

- Writing to single onePK API
- Infrastructure Controlled by Applications
- Wide-reach, beyond Data Center

Controller

- Policy-based Provisioning
- Scale Physical & Virtual/Cloud
- DC-wide/Cross-DC VM Mobility
- onePK API exposes Fabric capabilities

Overlays

- Policy-based Provisioning
- Multiple Tunnels (Visibility?)
- Scaling (Overlay disjoint from Physical)
- onePK API in Nexus 1000V (late CY13)
Cisco Open Network Environment (Cisco ONE)
Programmable, Application Centric

Industry’s Most Comprehensive Networking Portfolio
- Hardware + Software
- Physical + Virtual
- Network + Compute

Applications

1. Platform APIs
   - One Platform Kit (onePK)
   - Programmatic APIs for Network HW (IOS, IOS-XR, NX-OS)
   - Evolutionary, Investment Protection

2. Controllers And Agents
   - SDN:
     - Controller SW (onePK, Openflow, ...)
     - OpenFlow 1.x support

3. Overlays Networks
   - Open Clouds with Nexus 1000V
     - Multi-hypervisor
     - Multi-service
     - Multi-cloud
     - Openstack support

www.cisco.com/go/one
Conversation is Maturing, becoming Pragmatic…

Programmable networks can be built in many ways
  With or without Openflow – can leverage other protocols (e.g. PCEP*)
  With or without controller/SDN – can leverage built-in APIs (e.g. onePK)

Controller must program & manage flows
  Provisioning, Monitoring tools are NOT “controllers” – they existed before SDN

Controller north-bound APIs remain proprietary

Network virtualization and server virtualization impact infrastructure differently
  Server virtualization enables server consolidation (increases efficiency)
  Network virtualization enables broader VM mobility, scalable multi-tenancy (drives more traffic on the network)
  Unlike servers, network has always been a shared resource – it has always been Efficient!

Hybrid deployment models are critical to most customers
  Provides evolutionary deployment model
  Protects customers’ investment in network equipment, processes & operations, people skills

Need smarter, high-performance hardware / ASICs
  High performance, Low latency, Non-oversubscribed, Overlay aware, Multi-protocol

*PCEP: Path Computation Element Communication Protocol
onePK: One Platform Kit
onePK Architecture

C, JAVA, Python, REST, Programmatic Interfaces

onePK API Presentation

onePK API Infrastructure

IOS / XE (Catalyst, ISR, ASR1K)

NXOS (Nexus Platforms)

IOS XR (ASR 9K, CRS)
onePK API Libraries

**Initial Service Sets**

**Element**
- Element Capabilities
- Configuration Management
- Interface/Ports Events
- Location Information

**Utilities**
- Syslog Events and Queries
- AAA Interface
- Path Trace

**Discovery**
- Network Element Discovery
- Service Discovery
- Topology Discovery

**Developer**
- Debug Capabilities
- Tracing Interfaces
- Management Extensions

**Data Path**
- Packet/Flow Classifiers
- Copy/Punt/Inject
- Statistics

**Policy**
- Interface Policy
- Interface Feature Policy
- Forwarding Policy
- Flow Action Policy

**Routing**
- Read RIB Routes
- Add/Delete Application Routes
- RIB Events (Route up/down)
Open Network Environment – Flexibility to Choose
Protocols, APIs and Deployment Models
onePK Use Case: Automated Network Provisioning

- Automate network configuration
- Use the same process and tools currently in use for servers
**Business Problem:** Need to modify specific fields within select data packets to achieve a desired network behavior.

**Solution:** Developer uses **onePK** to extract, modify and re-insert specific packets using match, modify and forward techniques.

**Benefits:** Quickly and efficiently modify network behavior or traffic flows based on needs.

**Examples:**
- Special off-box “secret” Crypto
- Packet/flow visibility
Cisco ONE Controller
Controller to Node Interactions

Reactive

Unknown Flow

Controller

Communication over SSL/TLS

Profile Forwarder src 10.0.10.20
If srcIP=10.0.10.20
Then forward Ethernet 3/1

Proactive

Flow programmed Into FIB Table

Application Flow

If srcIP=10.0.10.20
Then forward Ethernet 3/1

src
10.0.10.20
Controller to Node Interactions

- **Controller**
  - Communication over SSL/TLS
  - Profile Forwarder src 10.0.10.20
    - If srcIP=10.0.10.20
    - Then forward Ethernet 3/1

- **Flow programmed Into FIB Table**

- **Application Flow**

- **Micro Flow**

- **Aggregate Flow**
Use case Custom Routing with onePK
The SDN reaches beyond the Data Center

Unique Data Forwarding Algorithm Highly Optimized for the Network Operator’s Application
Use case Campus “Slicing”
Common Deployment in Higher-Ed today – Partition network for multiple user-communities

Solution

- Topology Independent Forwarding
- Integrated slicing management
- Programmatic Interfaces (Eg. REST)
- OpenFlow experimental support (v1.0)
- Controller experimental SW

Consistent policy management for maximum flexibility and Innovation
Cloud technology stacks
Multi-Hypervisor and Multi-Orchestration Strategy

- **Cloud Portal and Orchestration**
  - vCloud Director/DynamicOps
  - System Center
  - Open Source
  - CIAC/OpenStack/Partners

- **Virtual Network Infrastructure**
  - ASA 1KV vWAAS CSR 1KV vPath
  - ASA 1KV vWAAS CSR 1KV vPath
  - ASA 1KV vWAAS CSR 1KV vPath
  - ASA 1KV vWAAS CSR 1KV vPath

- **Hypervisor**
  - vSphere
  - Hyper-V
  - Open Source (Xen, KVM)
  - vSphere, Hyper-V, Xen, KVM

- **Computing Platform**
  - Nexus 2K-7K + ASR 9K (Edge)

- **Physical Network**
  - Nexus 2K-7K + ASR 9K (Edge)

- **Storage Platform**
  - EMC²

- **Solutions:** Vblock, FlexPOD, VMDC, VXI/VDI, HCS, Cross-DC Mobility
Cisco Open Network Environment (ONE)

Industry’s Most Comprehensive Portfolio

Hardware + Software
Physical + Virtual
Network + Compute

Multi-layer API
Programmatic APIs
One Platform Kit (onePK)
- Programmatic APIs for Network HW (IOS, IOS-XR, NX-OS)

Controllers and Agents
SDN:
- Controller SW (OpenFlow, onePK)
- OpenFlow Agents

Virtual Overlays
Open Clouds with Nexus 1000V
- Multi-hypervisor
- Multi-service
- Multi-cloud
- Openstack support

Applications

Virtual Overlay (w/ Controller)
Key Takeaways: Cisco ONE for Virtual Networks
Network Programmability Enabled Via Cisco Position of Strength

1. Multi-hypervisor, Multi protocol, Multi-services + Open Standards across all interfaces
2. No compromise security, robustness and resiliency – battle tested
3. Consistency across Physical, Virtual and Cloud environments
4. Troubleshooting, Visibility, Support
5. Investment protection – Consistent OSes, Tools, Processes, Partners, Separation of Duties
Logical Progression for Customers

Nexus 1000V

- Available Today
- Multi-Hypervisor
- Separate Control and Data Plane

Cisco ONE Controller

- Available end of CY13
- Separate Control and Data Plane of Physical and Virtual
We can propose you

>> To attend the Cloupia deep dive event on the 7th of May.

>> To test UCS Manager, Nexus 1000v, Nexus 7000, OTV, VXLAN,…
   Request your CLOUDLAB account http://cloudlab.cisco.com
   Use hdepra@cisco.com as sponsor

>> To check our DC Belux public references case:
   Rossel, Barco, NRB, SMALS, Subaru, Nova Natie
   http://www.scoop.it/t/cisco-data-center-belux-references/

>> And to visit our DC booth to get a private demo:
   ◆ Orchestration in the Data Center with Cloupia
   ◆ Unified Computing with UCS
   ◆ Extend you UCS domain to multiple DC’s with UCS Central
   ◆ Simplify a virtual deployment with Nexus-1000v, Adapter-Fex and VM-Fex
   ◆ Build a Unified Fabric with FCOE
   ◆ Extend Applications across two physical Data Centers with OTV
Thank you.