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
- …
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 Execution

Enhancements

Enhanced Opportunities
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
What is SDN?
(per Wikipedia definition)

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…”


“…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

802.1 Overlay Networking Projects, Cisco Innovations:
FEX Architecture

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

Open Source Cloud Computing project

MEF

ONF OPEN NETWORKING FOUNDATION

W3C

IETF

IEEE

ONRC RESEARCH

Open Network Research Center at Stanford University

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

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

Overlay Working Groups:
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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
   - Data Plane
   - NX1KV
   - VSM

2b. Hybrid "SDN"
   - Application
   - Vendor-specific APIs
   - Control Plane
   - Data Plane
   - OpenFlow and/or Vendor specific

3. Network Virtualization/Virtual Overlays
   - Application
   - Vendor-specific APIs
   - Virtual Control Plane
   - Virtual Data Plane
   - Overlay Protocols
   - NX1KV
   - VSM
SDN Delivery Options

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

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

- 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

OPEN NETWORK ENVIRONMENT

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

- ABILITY TO SPAN LAYERS
  - Packet classifiers
  - Marking
  - Copy/Punt Inject
  - Statistics

- Quantum API
  - Interface descriptions
  - L2 network provisioning
  - L3 and IP Addr. Mgmt.

- onePK Developer Environment
  - Element
    - Element Capabilities
    - Configuration Management
    - Interface/Ports Events
    - Location Information
  - Utilities
    - Syslog Events and Queries
    - AAA Interface
    - Netflow Events
    - DHCP Events
  - Developer
    - Debug Capabilities
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    - Interface Feature Policy
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    - Topology Discovery

- RICHNESS OF FEATURES
  - Utilities
    - Syslog Events
    - AAA Interface
    - Netflow Events
    - DHCP Events
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  - Network Element Discovery
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- Policy
  - Interface Policy
  - Interface Feature Policy
  - Forwarding Policy
  - Flow Action Policy

- Routing
  - Protocol Change Events
  - RIB Table Queries

- Developer portal

- ISVs

- Training & Certification

ISVs

Training & Certification
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

**Profile Forwarder**

- **src** 10.0.10.20

**If** srcIP = 10.0.10.20 Then forward Ethernet 3/1

**Communication over SSL/TLS**

**Flow programmed Into FIB Table**

**Proactive**

**Unknown Flow**

**Reactive**

- Application Flow

- Controller

- Profile Forwarder src 10.0.10.20
  If srcIP=10.0.10.20
  Then forward Ethernet 3/1
Controller to Node Interactions

Flow programmed into FIB Table

Application Flow

Communication over SSL/TLS

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

 Aggregate Flow

Micro 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

<table>
<thead>
<tr>
<th>Cloud Portal and Orchestration</th>
<th>Virtual Network Infrastructure</th>
<th>Hypervisor</th>
<th>Computing Platform</th>
<th>Physical Network</th>
<th>Storage Platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>vCloud Director/DynamicOps</td>
<td>ASA 1KV vWAAS CSR 1KV vPath</td>
<td>vSphere</td>
<td>Nexus 2K-7K + ASR 9K (Edge)</td>
<td></td>
<td>EMC²</td>
</tr>
<tr>
<td>System Center</td>
<td>ASA 1KV vWAAS CSR 1KV vPath</td>
<td>Hyper-V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open Source</td>
<td>ASA 1KV vWAAS CSR 1KV vPath</td>
<td>Open Source (Xen, KVM)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIAC/OpenStack/Partners</td>
<td>ASA 1KV vWAAS CSR 1KV vPath</td>
<td>vSphere, Hyper-V, Xen, KVM</td>
<td></td>
<td></td>
<td></td>
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</table>

### Solved: 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

Virtual Overlays (w/ Controller)

Virtual Overlays

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

Applications

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

Device

Device

Device

Open NETWORK ENVIRONMENT
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