Understanding SDN, OpenFlow, and Network Virtualization

Open Network Exchange

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What is SDN? And Why Should I Care?

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Goals of the presentation

1. Define/describe SDN
2. Identify the drivers and inhibitors of SDN
3. Discuss the SDN design philosophy and enabling technologies.
4. Discuss related industry consortiums
5. Identify what IT organizations should do to get ready for SDN

Non-Goals

1. Read all the bullets
Level of Understanding of SDN – Circa July 2012

- Over a third of IT organizations admitted to having no knowledge of SDN.
- Almost a half of those who do claim knowledge, claim only a very basic knowledge.
- Few vendors have well articulated SDN strategies.
- Good News: Until June 2012, no hype cycle.
- Bad News: A cloud of confusion.
Initial Drivers of the SDN Hype Cycle

- June 2012 Cisco announces its Open Network Environment (ONE) initiative
- July 2012 VMware announces its intention to acquire Nicira for $1.26 billion
Primary definitions of SDN

- Running some network functionality in software.
- Providing direct programmatic interfaces into switches and routers.
- Distributed virtual switching with separation of the control and data planes with a programmatic interface into the control plane.
- The separation and centralization of the control plane with a programmatic interface into the control plane.
Common High Level View of SDN

SDN Controller Platform

Northbound API

Southbound API

Switch

vSwitch

vSwitch

Switch
Two Types of SDN Switch

- **SDN Pure Switch**
  - All of the control functions of a traditional switch (i.e., routing protocols that are used to build forwarding information bases) are run in the central controller.
  - The functionality in the switch is restricted entirely to the data plane.
  - Should be possible to build very inexpensively.

- **Hybrid SDN Switch**
  - Has all of the network functionality of a traditional switch
  - Also has OpenFlow functionality
  - Many existing switches can be converted to be a hybrid SDN switch by the addition of an OpenFlow agent in firmware
The Southbound API

- The Southbound API allows for physical and virtual switches to communicate with the SDN controller.

- Possibilities include:
  - OpenFlow
  - Extensible messaging and presence protocol (XMPP)
  - Network configuration protocol
  - Others
The Northbound API

- The Northbound API makes the control information of the network available to applications.
- This could be traditional network services such as firewalls or load balancers.
- It could be an orchestration engine such as OpenStack.
- The Northbound API is currently not standardized.
Where’s the Value?

- App
- App
- App
- App

Northbound API

SDN Controller Platform

Southbound API

Switch

vSwitch
Open Networking Foundation (ONF)

- Industry consortium founded in 2011
- Founded by Deutsche Telekom, Facebook, Google, Microsoft, Verizon and Yahoo!
- Goal: Make OpenFlow-based SDNs the norm for networks
- Roughly 95 members
Open Networking Foundation (ONF)

Types of vendors:

- Switch vendors: Cisco, Extreme, HP, NEC, IBM, Plexxi
- Telecom service providers: Colt, Verizon, Deutsche Telekom
- Merchant Silicon Vendors: Broadcom, LSI, Intel
- Network Appliance Vendors: Riverbed, Radware, Infoblox, A10
- SDN/Network Virtualization: Big Switch, Nicira (now part of VMware), Vello, NEC, IBM
- Hyperscale data center providers: Facebook, Google
- Test equipment vendors: Ixia, Spirent
- Management vendors: Netscout
The OpenFlow protocol

- Developed at Stanford
- V1.0 published in December 2009; V1.3 published in June 2012. V1.4 should be published in June or July 2013.
- In 2012 the ONF conducted two PlugFests
- In a pure OpenFlow switch, all of the control functions are run in the SDN controller
The OpenFlow protocol

When a packet arrives at an OpenFlow switch:

- The header fields are compared to the table entries
- If a match is found, the packet is either forwarded to the specified port or dropped
- If a match is not found, the packet is sent to the controller
- The controller informs the switch how the packet is to be processed and to create a new flow entry

<table>
<thead>
<tr>
<th>The OpenFlow V1.0 Flow Table Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingress Port</td>
</tr>
<tr>
<td>-------------</td>
</tr>
</tbody>
</table>
Open Daylight Consortium

- Announced April 8, 2013
- “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.”
- A Linux Foundation collaborative project
Members of the Open Daylight Consortium

- **Platinum Members:**
  - Big Switch
  - Citrix
  - Juniper
  - Brocade
  - Ericsson
  - Microsoft
  - Cisco
  - IBM
  - Red hat

- **Gold Members:**
  - NEC
  - VMware

- **Silver Members**
  - Arista
  - Dell
  - HP
  - Intel
  - Plumgrid
  - Fujitsu
  - Nuage Networks
Object Management Group

In April 2013 Dell joined the Object Management Group and suggested that it form a Software-Defined Networking (SDN) standardization working committee within the OMG technology working groups.
Simple fact of life

- Few if any IT organizations want SDN

- What IT organizations want is to:
  - Solve current problems
  - Add value

- If SDN can help do that better than alternatives it wins in the marketplace!

- If not, just another media event
Drivers of SDN in the data center LAN

- Support the dynamic movement of VMs
- Improve network utilization
- Automate more provisioning and management
- Improve security
- Implement network-wide policies
- Reduce complexity
Possible Applications

- Network virtualization
- Network monitoring
- Load balancing
- Firewalls
- Forward packets over the least expensive path
- Dynamically adapt QoS parameters based on available bandwidth
- DDoS protection
- Drop suspicious packets
SDN in the WAN

- Google has implemented SDN in the WAN that interconnects their data centers (G-Scale WAN)
- Implemented in early 2012
- Uses pure OpenFlow switches developed by Google
- Google built their own Traffic Engineering (TE) application
- Google claims that they can run WAN links at up to 95% utilization
- Faster handling of failures
Software Defined Data Centers

- A software defined data center is where all infrastructure is virtualized and delivered as a service, and the control of this datacenter is entirely automated by software.

- Advocates include:
  - HP
  - Cisco
  - IBM
  - VMware
  - Microsoft
Inhibitors to SDN deployment

- Disagreement/confusion as to what it is
- Immaturity of current products and technologies
- Immature vendor strategies
- A new way of thinking
- Lack of integration with existing management and security tools
- Concerns over interoperability
- Lack of compelling use cases
Common Uses of the Term “Virtualization”

- To take something big and make it look like a number of small things. Example: A virtual server.

- To take a number of smaller things and make them look like a big thing. Example: Combining multiple data center switches into one larger logical switch.

- Taking a function that used to run in a dedicated appliance and running it in a virtual machine. Example: A virtual WAN optimization controller.

- Etc.
Traditional Network Virtualization

- Virtual Routing and Forwarding Instances (VRF)
  - Form of Layer 3 virtualization
  - A physical router supports multiple virtual router instances – each running its own routing protocol instance and maintaining its own forwarding table.

- Virtual LANs (VLANs)
  - VLANs partition an Ethernet network into as many as 4,096 broadcast domain
  - Rely on a 12 bit VLAN ID tag in the Ethernet header
  - Used to separate different types of traffic that share the same switched Ethernet LAN
Server Virtualization

- The majority of IT organizations have virtualized at least some of their data center servers.
- The adoption of virtual servers continues with a wider array of applications now being supported on virtual machines (VMs).
- Server virtualization created significant benefits and significant challenges:
  - Benefits: Cost savings and agility
  - Challenges: The dynamic movement of VMs
Server Virtualization: The Domino Affect

- The broad and growing deployment of server virtualization has put pressure on networking organizations.

- Pressure point #1: Be as agile and cost effective.

- Pressure point #2: Dynamically support the dynamic movement of VMs.
A Common Model of Network Virtualization

Source: VMware
Network Overlays: An overview

- VMs can migrate between physical servers for myriad reasons.
- If the VMs cross a Layer 3 boundary, it can require time consuming reconfiguration.
- Overlay tunneling techniques eliminate the problem by encapsulating traffic inside of IP packets so that the traffic can cross Layer 3 boundaries.
Network Overlays: An overview

- Multiple ways to implement overlay networks.
- Three proposed standards:
  - VXLAN
  - NVGRE
  - STT
- Endpoints are assigned to a virtual network by using a 24 bit identifier – 16 million possibilities.
- The endpoints belong to that virtual network regardless of their location on the underlying physical network.
Network Virtualization and SDN

- Can leverage OpenFlow to create virtual networks
- One technique: Use a filter in the SDN controller to isolate sets of MAC addresses
- This form of network virtualization is complimentary to network overlays
Components of an Enterprise SDN Strategy

- Definition of SDN
- Applicable use cases
- OpenFlow? XMPP?
- If OpenFlow, what version? What functionality?
- Move functionality to controller?
- Pure switches? Hybrid switches?
- Just to TOR? Core switches?
Components of the SDN Strategy

- L2 & L3? Some L4 to L7 functionality?
- Fit with existing infrastructure?
- Fit with other IT initiatives?
- Industry movement
- Internal application development?
- Security impact?
- Best of breed? System solution?
Components of the SDN Strategy

- What vendors to look at?
- Test plans
- How to manage and troubleshoot?
- Trigger points
- Risk mitigation
- Management/organizational buy-in
SDN References

- Ten Things to look for in an SDN Controller

- What is Software Defined Networking (SDN)?

- Understanding Software Networks
SDN References

- Complete Guide to Network Virtualization

- The Journey to SDN: Part 1
  http://www.sdncentral.com/sdn-blog/sdnjourney-jim-metzler-part1/2013/04/

- SDN: Market Opportunities and OpenFlow Reality
SDN References

- SDN: Your Next Network
  http://reports.informationweek.com/abstract/19/9083/network-infrastructure/sdn-your-next-network.html

- SDN: Deployment Plans and Tech Ecosystem
Thank You!
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