BROCADE NETWORKING:
EXPLORING SOFTWARE-DEFINED NETWORK

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Software-Defined Networking

Summary

- Separate control and data planes
- Networks are becoming:
  - More programmatic
  - Faster at adapting to business needs
  - More efficient, reducing costs and power consumption
- Powerful abstractions
  - Hide physical infrastructure complexity
  - Make behavior more provable
- Enable an ecosystem of technology providers
Who is behind SDN 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:
  - ONF WEB - https://www.opennetworking.org/
  - OpenFlow Homepage - www.openflow.org
Why Software Defined Networking?
Optimize the network to fit business requirements

• Eliminate Complexity
  • Network Architecture defined by application (one touch) verses every switch/router.

• Increase Flexibility
  • Programmatic verses fixed CLI options.

• Increase Feature Velocity
  • Write custom features in days verses waiting for feature to be added to vendor OS (months).

• Drive Automation
  • Application driven networking with global view for advanced automation.
### Solution Examples

**An attempt to reach the benefits of an SDN strategy**

<table>
<thead>
<tr>
<th>OpenFlow</th>
<th>Quantum Module (OpenStack)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Moves control plane to application running on controller. An example of SDN technology.</td>
<td>• Provides network control from Opencloud orchestration engine.</td>
</tr>
<tr>
<td>• Leaves application up to user.</td>
<td>• Doesn’t completely decouple the control plane, not TRUE SDN.</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>NetConf</th>
<th>Vendor Specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>• API to control networking elements.</td>
<td>• Scripting tool kits.</td>
</tr>
<tr>
<td>• NOT TRUE SDN.</td>
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</table>
Traditional Network Architecture

Well established and rigid...

Control plane is integrated into hardware. Forwarding logic determined by each individual switch (CLI config and switch to switch protocol exchanged).

Switch hardware forwards traffic based on logic received from control plane.

Ethernet is simply the physical layer and data link layer – just a “pipe”
Software Defined Networks

Control plane is decoupled from hardware.

Switch hardware continues to forward traffic based on logic received from control plane.
Software Defined Networks

Hybrid Mode

Switch supports forwarding traffic based on local or abstracted control plane

Switch hardware forwards traffic based on either local control plane or SDN control plane
The Path to Software-Defined Networking

Only Brocade provides a clear path with your existing investment

SDN-ready network
- SDN-ready
  - Simpler & automated
  - Open
  - High performance

SDN-enabled network
- SDN-Enabled
  - Programmable
  - Hybrid-mode
  - Non-disruptive

Software-Defined Network
- Software-Defined
  - Predictive
  - Flexible
  - Intelligent

Start now with no risk
Layer in value-added services
Transform your infrastructure
What is OpenFlow

Building an SDN Solution

- Component of an SDN solution.
- Protocol that defines communication between a switch and network controller.
- Does not provide any mechanism to actually “network”, but rather provides the framework for a server (OpenFlow Controller) to communicate (OpenFlow Channel) with a switch (OpenFlow Enabled).
- Applications (can be as simple as scripts), must be layered on top of the controller to determine network logic.
What OpenFlow is NOT

• OpenFlow $\neq$ SDN
  • OpenFlow is a component of an SDN strategy.

• OpenFlow $\neq$ turn-key solution
  • OpenFlow requires an application, OpenFlow controller and OpenFlow enabled Switch.

• OpenFlow $\neq$ OpenStack
  • OpenStack is an open source orchestration platform for datacenters providing a front end to implement and operate a computing stack (server, storage, networking) using multiple vendors (servers, storage, operating systems, networking devices and hypervisors).

• OpenFlow $\neq$ Commodity hardware.
  • OpenFlow allows high performance hardware to be utilized to it’s full potential.
OpenFlow Specification

- Evolving Standard

- OpenFlow v1.0 (03/2010)
  - Most widely used version
  - Flows based on Layer 2 and Layer 3 fields (IPv4 only)
  - Single flow table
  - All available controllers today support v1.0.

- Newer Versions – “locked” through 2012 at (v1.3) to allow vendor catch up
  - v1.1 (2/2011) – MPLS tags, Virtual Interfaces (GRE etc)
  - v1.2 (12/2011) – IPv6
  - v1.3 (5/2012) – PBB, miscellaneous features.
Carrier-grade OpenFlow enables Cloud-scale deployment

Brocade MLX
Cloud-scale Routers

- Provider core, metro, cloud-scale DC core
- 32 100 GbE ports, 256 10 GbE ports
- 15.36 Tbps forwarding capacity
- Dual stack IPv4/v6, MPLS

Brocade CES, CER
Compact Switches and Routers

- High-performance Ethernet edge routing
- 24 to 48 1 GbE with 10 GbE
- Deep buffers
- Dual stack IPv4/IPv6, MPLS

• Maximum service performance:
  • OpenFlow enabled in hardware for flows up to 100 G
• Flexible deployment:
  • Hybrid mode for simultaneous support of OpenFlow and traditional L2/L3 forwarding
• Investment protection:
  • Programmable network processors ideal for evolving standards
## Brocade Cloud-Optimized Networking with SDN

Architecture for building the software-defined network

<table>
<thead>
<tr>
<th>Cloud-Optimized Network Stack</th>
<th>Enabling Technologies</th>
<th>Key Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cloud Management Layer</strong></td>
<td>Cloud APIs: OpenStack, VMware, Microsoft, CloudStack, etc.</td>
<td>Automation and orchestration</td>
</tr>
<tr>
<td><strong>Services Layer</strong></td>
<td>Programmatic Control: OpenFlow; OpenScript</td>
<td>Personalization and monetization</td>
</tr>
<tr>
<td><strong>Network Virtualization Layer</strong></td>
<td>Overlay Networking: VXLAN, NVGRE, STT; MPLS</td>
<td>Flexibility and efficient asset utilization</td>
</tr>
<tr>
<td><strong>Network Fabric Layer</strong></td>
<td>Any-to-any connectivity: Ethernet Fabrics; TRILL; IP routing</td>
<td>Reliability and simplicity</td>
</tr>
</tbody>
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Brocade Cloud-Optimized Networking with SDN

**Carrier Cloud Data Center**

- OpenStack and REST API
- Brocade SDN Applications
- OpenFlow Controller Partnership
- VXLAN and OpenFlow Support
- Brocade ADX
- Brocade “Starlifter”
- Brocade MLXe
- Brocade VDX

**SERVICES**
- Network Analytics
- Traffic
- Service
- Load
- Packet
- Firewall

**LOGICAL**

**INFRASTRUCTURE**

**100 GbE Core Network**

**Enterprise Branch**

**Enterprise Data Center**

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Reference
Internet2
OpenFlow Enabled 100GbE Nationwide Backbone

Internet 2
- 49 Custom Location Facilities
- 15,500 miles of dark Fiber
- 8.8 Tbps of Optical Capacity
- Hybrid Mode with protected OpenFlow traffic

(Ref.: Robert P. Vietzke, Internet2)
Internet2 NDDI Initiative

Network Development and Deployment Initiative

• Platform for network innovation

• Collaboration between Internet2, Indiana University and the Clean Slate Program at Stanford University

• Goal: Provide a radically new platform upon which researchers and students will be able to innovate

• OpenFlow provides an API that allows researchers to control the network directly

• New Internet2 service called “Open Science, Scholarship and Services Exchange (OS3E)” on top of the NDDI infrastructure

(Ref.: Robert P. Vietzke, Internet2)
How is SDN being Introduced in NDDI?

“Protected” Production IP Network with OpenFlow Overlay

- Hybrid port mode
  - OpenFlow overlay runs concurrently with traditional MPLS/IP routing
  - OpenFlow enabled on existing production network without disruption
- Protected
  - OpenFlow experimentation by researchers does not affect production traffic
  - OpenFlow/Production traffic isolation in hardware
Internet2 Innovation Platform

• Massive bandwidth through a 100GbE Layer 2 connection

• Address traditional bottleneck and aggregation points to pass high-bandwidth traffic and provide performance monitoring / verification thru implementation and support of a Science DMZ

• Introduce SDN capabilities to support the development and deployment of new applications

(Ref.: Robert P. Vietzke, Internet2)