Outline

• What is Trellis?

• Why Trellis?

• Trellis Roadmap
Trellis
Multi-purpose leaf-spine fabric designed for NFV
Trellis – Multi-purpose Leaf-Spine Fabric

Access & Trunk VLANs
IPv4 & IPv6 & MPLS SR
IPv4 & IPv6 Multicast
DHCP L3 relay (IPv4/v6)
vRouter BGPv4/v6(ext.)

ONOS Cluster

L2 bridged
L3 routed
IP multicast
Disaggregation – Bare-metal + Open-Source

**Leaf Switch**
- 8 x 40G ports uplink to different spine switches
- ECMP across all uplink ports
- 32 x 40G ports downlink to leaf switches

**Spine Switch**
- 8 x 40G ports uplink to different spine switches
- ECMP across all uplink ports
- 24 x 40G ports downlink to servers

**Leaf/Spine Switch Software Stack**
- OCP Software (ONL, ONIE)
- OF-DPA
- Indigo OF Agent
- OpenFlow 1.3

**Bare-Metal Hardware**
- OCP Bare Metal Hardware
- BRCM ASIC

**Software to Controller**
- OpenFlow 1.3

**BRCM**
- Broadcom Merchant Silicon ASICs

**ONIE**
- Open Network Install Environment

**ONL**
- Open Network Linux

**OCP**
- Open Compute Project

**Indigo OF Agent**
- OpenFlow Datapath Abstraction

**Disaggregation**
- Bare-metal + Open-Source
Fabric ASIC Pipeline* (BRCM’s OF-DPA)

Why OF-DPA?

Allows programming of all flow-tables & port-groups via OpenFlow 1.3

Achieves Dataplane Scale
Switches simultaneously connect to several controller instances. Only 1 controller instance is master, several other instances are backups.

Mastership is decided by controllers. Switches have no say.

Controller instances simultaneously connect to several switches. Any controller instance can be master or backup for any switch.

Spreading mastership over controller instances contributes to scale.
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Controller instances simultaneously connect to several switches. Any controller instance can be master or backup for any switch.

Losing controller instances redistributes switch mastership. Switches continue to retry lost connections.

Management watchdog can reboot lost controller instances.

Spreading mastership over controller instances contributes to scale.
Trellis – CORD Network Infrastructure

Trellis Provides Common control over underlay & overlay networks, including

• Service Composition for Tenant Networks
• Distributed Virtual Routing
• Optimized Delivery of Multicast Traffic Streams

Trellis is the enabling Network Infrastructure for CORD
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Why Trellis?

• Trellis is designed for Service Providers & NFV
Trellis in CORD

Service Creation and Orchestration

Control Plane VNFs as SDN apps

Multiple-vendor ONT/ONUs & RG

XGS-PON Whitebox OLT (EdgeCore)

Bare-metal Open-source Leaf-Spine Fabric

Dataplane VNFs in Edge Compute

3rd Party Service VNFs

Metro Routers
Why Trellis?

• Trellis is designed for Service Providers & NFV

• SDN allows simpler/easier/optimized features
vRouter in Software?

Management (CLI, SNMP, NetCONF)

Control Plane (OSPF, BGP ..)

Dataplane

Management (CLI, SNMP, NetCONF)

Control Plane (OSPF, BGP ..)

Dataplane

VNF = vRouter VM (vCPE, vBNG, vPGW, vBRAS)

Underlay Network

VNFM (VNF Manager)

Issues:
Hairpinning
Embedded control plane complicates scale-out

Issue: Still hairpinning through a load-balancer
vRouter Operation

Overlay Control

Underlay Control

vRouter app

ONOS

Quagga (or other)

OSPF I-BGP

Router

External
vRouter Operation
vRouter Operation

Trellis vRouter ➔ Implemented as a big distributed router ➔ Presents entire n/w infrastructure as a single router to outside world
Why Trellis?

- Trellis is designed for Service Providers & NFV
- SDN allows simpler/easier/optimized features
- SDN + Programmable pipelines == New features
SDN + Programmable Pipelines

P4

ONOS

OpenConfig

control

configuration

P4Runtime

gNMI

config
Why Trellis?

- Trellis is designed for Service Providers & NFV
- SDN allows simpler/easier/optimized features
- SDN + Programmable pipelines == New features
- Open-source == SP ownership & customizability
• What is Trellis?
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Trellis Features Used in CORD

- Bridging & VLANs (Access/Trunk/Native)
- IPv4 Unicast & Multicast Routing
- vRouter – BGPv4 & Static Routing

Trellis Features To-Be-Used in CORD

- Dual-Homing
- IPv6
- DHCP L3 relay
- Pseudowires
Upcoming ONOS 1.12 release (Dec 2017)

- Dual-homing (released 1.11.1) fixes for known issues
- Pseudowire support
- Initial QoS support
- IPv6 additional features
  - DHCPv6 relay additional features (contributed by Nokia)
  - IPv6 Multicast (contributed by Nokia)
  - IPv6 Router Advertisement app (contributed by Infosys)
- Support for New ASICs & Bare-metal switches
  - Broadcom Qumran (QMX)
  - Cavium Xpliant
  - Quanta switches (QCT LY8)
  - Barefoot Tofino using P4 (not in 1.12 release)
## Roadmap

See here for complete roadmap

https://docs.google.com/spreadsheets/d/1SmKxsZ9iHtLHoEtysntsJ98tLf_cYT_qXuuO7eAUtt4/edit?usp=sharing

<table>
<thead>
<tr>
<th>#</th>
<th>Feature</th>
<th>Use Case</th>
<th>Status</th>
<th>Notes</th>
<th>OF-DPA Dependency (Indicates version onwards)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>L2 switching within a rack handled at leaf switches</td>
<td>Platform</td>
<td>available in CORD 1.1 (Aug'15)</td>
<td>Note: recently reported (Dec'15) by Johan BRCM CSP#117220 (unreferenced flow group causes implicit forwarding) - patch available for 2.0 GA</td>
<td>ofpda.i.12.1.1 (Dec'15)</td>
</tr>
<tr>
<td>2</td>
<td>L3 forwarding across racks using ECMP hashing and MPLS segment routing.</td>
<td>Platform</td>
<td>available in CORD 1.0 (Aug'16)</td>
<td></td>
<td>ofpda.i.12.1.1 (Dec'15)</td>
</tr>
<tr>
<td>3</td>
<td>vRouter integration for using the fabric as the dataplane for vRouter, to interface with upstream router and provide reachability to publicly routable IP addresses.</td>
<td>Platform</td>
<td>available in CORD 1.0 (Aug'16)</td>
<td></td>
<td>ofpda.i.12.1.1 (Dec'15)</td>
</tr>
<tr>
<td>4</td>
<td>VLAN cross-connect feature to bridge QNQ packets between OLT I/O blades and vSwitch containers</td>
<td>R-CORD / AT&amp;T</td>
<td>available in CORD 1.0 (Aug'16)</td>
<td>Caveat: can only bridge based on outer VLAN, and can only bridge OLT to server in the same rack - requires PW support to overcome this limitation - see F15</td>
<td>ofpda.i.12.1.1 (Dec'15)</td>
</tr>
<tr>
<td>5</td>
<td>IPv4 multicast forwarding and pruning for IPTV streams (with vRouter integration) from upstream router to residential subscribers</td>
<td>R-CORD / AT&amp;T</td>
<td>available in CORD 1.0 (Aug'16)</td>
<td></td>
<td>ofpda.i.12.1.1 (Dec'15)</td>
</tr>
<tr>
<td>6</td>
<td>Support for OF-DPA 3.0 EAO</td>
<td>Platform</td>
<td>available in ONOS 1.8 &amp; CORD 2nd release (Dec'15)</td>
<td>CORD-311, Workaround made for BRCM CSP#1100576 (cannot add flow to point to empty group)</td>
<td>OF-DPA 3.0 EAO (Jul'16)</td>
</tr>
<tr>
<td>7</td>
<td>DHCP relay app support with fabric (includes ability to directly connect drop-server to fabric, or place it behind external router)</td>
<td>Platform / Comcast</td>
<td>available in ONOS master (Mar’17)</td>
<td>CORD-522</td>
<td>OF-DPA 3.0 EAO (Nov’16)</td>
</tr>
<tr>
<td>8</td>
<td>Ability to statically configure and route a prefix to a configurable Next-Hop</td>
<td>Comcast</td>
<td>available in ONOS master (Mar’17)</td>
<td>CORD-523</td>
<td>OF-DPA 3.0 EAO (Nov’16)</td>
</tr>
<tr>
<td>9</td>
<td>Support for 802.1x authentication (without blocking support - see F12)</td>
<td>R-CORD / Comcast</td>
<td>available in ONOS master (Mar’17)</td>
<td>CORD-527</td>
<td>OF-DPA 3.0 EAO (Nov’16)</td>
</tr>
<tr>
<td>10</td>
<td>IPv6 support including ICMPv6 NDP, vRouter(BGP-v6) and static routes</td>
<td>Platform / Comcast</td>
<td>available in ONOS master (Mar’17)</td>
<td>CORD-520</td>
<td>OF-DPA 3.0 EAO (Jan’17)</td>
</tr>
<tr>
<td>11</td>
<td>Access/Trunk port configuration for bridging - includes the ability to route between vlans (v4 and v6), configure static routes, dhcp for tagged hosts, and native-vlan support on trunk ports</td>
<td>Platform / Comcast / M-CORD</td>
<td>available in ONOS master (Mar’17)</td>
<td>CORD-800, CORD-906</td>
<td>OF-DPA 3.0 EAO (Jan’17)</td>
</tr>
<tr>
<td>12</td>
<td>Multiple Quagga support for vRouter HA preferably with ability to connect quagga to leaf switches in different racks</td>
<td>Comcast / Platform</td>
<td>under development, scheduled for June’17</td>
<td>CORD-903.904.965</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Support for multi-homing of servers to dual ToRs, with changes in routing and bridging to accommodate hosts reachable via two ToRs</td>
<td>Platform / Comcast</td>
<td>under development, scheduled for June’17</td>
<td>CORD-256</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Support to create and update ACLs for blocking traffic</td>
<td>Platform / Comcast</td>
<td>scheduled for beyond June, 2016</td>
<td>CORD-254</td>
<td></td>
</tr>
</tbody>
</table>
• **What is Trellis?**
  - Multi-purpose leaf-spine fabric
  - Built with → bare-metal hardware + open-source software + SDN
  - Overlay + Underlay when used in CORD

• **Why Trellis?**
  - Designed for SP use cases & NFV
  - SDN allows simpler, easier & more-optimized features
  - SDN + P4 = new features in hardware
  - Open-source gives SP’s ownership & full customizability

• **Trellis Roadmap**
  - Different roadmaps for Trellis, and the use of Trellis in CORD