Trellis
An Open-Source, White-Box, SDN Based Leaf-Spine Fabric

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Outline

• What is Trellis?
• Trellis features
• Why Trellis?
• Recent activities (in 2018)
• Deployments & use cases
• Ecosystem & roadmap
What is Trellis?

Production-ready multi-purpose leaf-spine fabric designed for NFV
Way Too Complicated?

Trellis supports simpler configurations too!
Single Leaf Pair
Single Leaf Pair with Upstream
Single Stage
Single Stage with Leaf Pairs & Upstream
Trellis in Production
Trellis Features

- **Bridging** with Access & Trunk VLANs (within a rack)
- **Routing** (inter-rack)
  - IPv4 & IPv6 Unicast routing with MPLS Segment-Routing
  - IPv4 & IPv6 Multicast routing
- **Dual-homing** for compute-nodes and external routers
- **Multi-stage** fabrics (2 layers of spines)
- **vRouter** - entire fabric behaves as a single router
  - BGP (v4/v6) support for external connectivity
  - Static routes, route blackholing
- **DHCP L3 relay** (v4/v6)
- **MPLS Pseudowire**
- **Q-in-Q termination**
- **T3** (Trellis Troubleshooting Tool), **onos-diags**
Trellis Features / Bridging & Routing

Bridging

Routing

Pop MPLS Label

Push MPLS Label
Trellis Features / Multicast (1/3)

Single-homed source, single-homed sink
Trellis Features / Multicast (2/3)

Single-homed source, dual-homed sink
Dual-homed source, dual-homed sink
Trellis Features / Dual-Homing
Pair link is only used to recover local failure
Trellis Features / Dual-Homing / Failure (2/2)
Trellis Features / Multi-Stage

- Retain MPLS Label
- Push MPLS Label
- Pop MPLS Label
Trellis Features / vRouter

Data plane traffic

BGP v4/v6 session

OF/P4RT

FPM
vRouter

- Control / data separation
- Entire fabric as a big router
- Also supports static routes and route blackholing
Trellis Features / DHCP L3 Relay
Trellis Features / Pseudowire
Trellis Features / Q-in-Q Termination

- Double-tagged packet

- Untagged packet

- Push/pop double-tag

- Works with single switch too
Various ASIC/Vendor Support

- Broadcom Qumran, Tomahawk, Trident2 switches from EdgeCore, QCT, Delta, Inventec (WIP)
- Preliminary support P4-based Tofino switches from EdgeCore, Delta, Inventec
- Preliminary support for Mellanox Spectrum switches
- Preliminary support for Cavium Xpliant switches
Deployments & Use Cases

• Trellis in Comcast
  - Utilizes almost all Trellis features
  - Trellis is installed and monitored by Kubernetes
  - Integrates with in-house VNFs, logging, telemetry and alarm systems

• Trellis in CORD / SEBA
  - Utilizes bridging, routing, multicast, cross connect, dual homing
  - L2 load balance (WIP)
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
Recent Activities (in 2018)
Production Readiness

December 2017 - November 2018

Support Comcast
- Support Comcast design/dev/QA/ops teams - issue analysis; root-cause;
- Recommend best-practices/ training
- Design discussions for new features & architectural improvements
- Daily scrum (-May ’18)
- Documentation

Support Other teams
- Broadcom
- Nokia
- Harmonic

Deliver New Features
- Pseudo wires for in-band control
- Routing in H-Agg based topologies
- Multicast improvements
- Dual-homing improvements
- DHCP v4/v6 Relay
- IPv6 Router Adv.
- ISSU architectural discussions/progress
- Other small features

ONOS Stability & Scale
- Focus on stability of ONOS distributed stores (9 releases of Atomix in 4 months)
- Scale investigation ongoing

Tooling
- T3 - Trellis Troubleshooting Tool
- onos-diags - Diagnostics collection tool
- Mininet scripts - Software-emulated test environment

QA & Bug Fixes
- Developing automated feature tests (220 new tests in the 4 months)
- Extending framework for hardware based tests
- 180 tickets resolved
Stratum/P4 Integration

Trellis

ONOS

ONOS NB API

OpenFlow (OF-DPA)

ONOS

P4Runtime gNMI, gNOI

Controller

OFagent

Stratum

Stratum

Local Ctrl

Network Config

Pipeline Config

Switch

Thin Switch

Hybrid

Server

VNFs

VNF

VNF

Server

VNFs

ASIC

ASIC

ASIC

Controller

Switch

Server

VNFs
Ecosystem & Roadmap
Distributed DevOps Model

- **Analyze issues** reported by Harmonic in their setups
- **Code review** patches they submit to ONOS
- Design discussions for new features
- Bringing up ONF pod housed in San Jose

- Bringing up ONF pod hosted by Flex
- QA collaboration

- **Report issues found; ~75 cases**
- Create automated tests to reproduce
- **Validate fixes / releases**
- Help with issues in their setup
- **Design discussions** for new features
- Daily scrum

- Deliver **features**; meet ops needs
- Deliver **stability**, scale, perf, tools
- Support Comcast design/dev/QA teams – issue analysis; root-cause; **recommend best-practices/training**
- **Design discussions** for new features
- Daily scrum
- **Documentation**

- Report issues found in hw
- Validate T2 versions of switch software EdgeCore builds for us

- **Design discussions** for apps/features created by Nokia
- **Code review** submitted patches (40 changesets; 4-5 patchsets/change)
- Validate some features; report issues

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Roadmap

- Scale & Performance improvements
- Dual homing for Access nodes (like OLTs)
- In Service Software Upgrades (ISSU)
- Stratum/P4 integration
- BNG features (e.g. PPPoE termination, hierarchical QoS)
- 5G user plane features
Next-Gen SDN Demo

Mixed P4/OpenFlow multi-vendor white-box switches
Broadcom, Barefoot, Edge-Core, Inventec, Delta

ONOS

P4Runtime

OpenFlow

Trellis
(Segment routing, multicast, vRouter, etc)

In-band Network Telemetry (INT)

VNF Offloading Control (S/PGW)

netcfg
- Devices
- Ports
- DHCP relay

fabric.p4
- L2/L3/MPLS
- INT
- GTP termination

Upstream BGP routers

Internet

Telemetry collector
Barefoot DeepInsight

P4 SmartNIC
Netcope

 mixed reports

fabric.p4
- L2/L3/MPLS
- INT
- GTP termination

Telemetry collector
Barefoot DeepInsight
Thank You

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