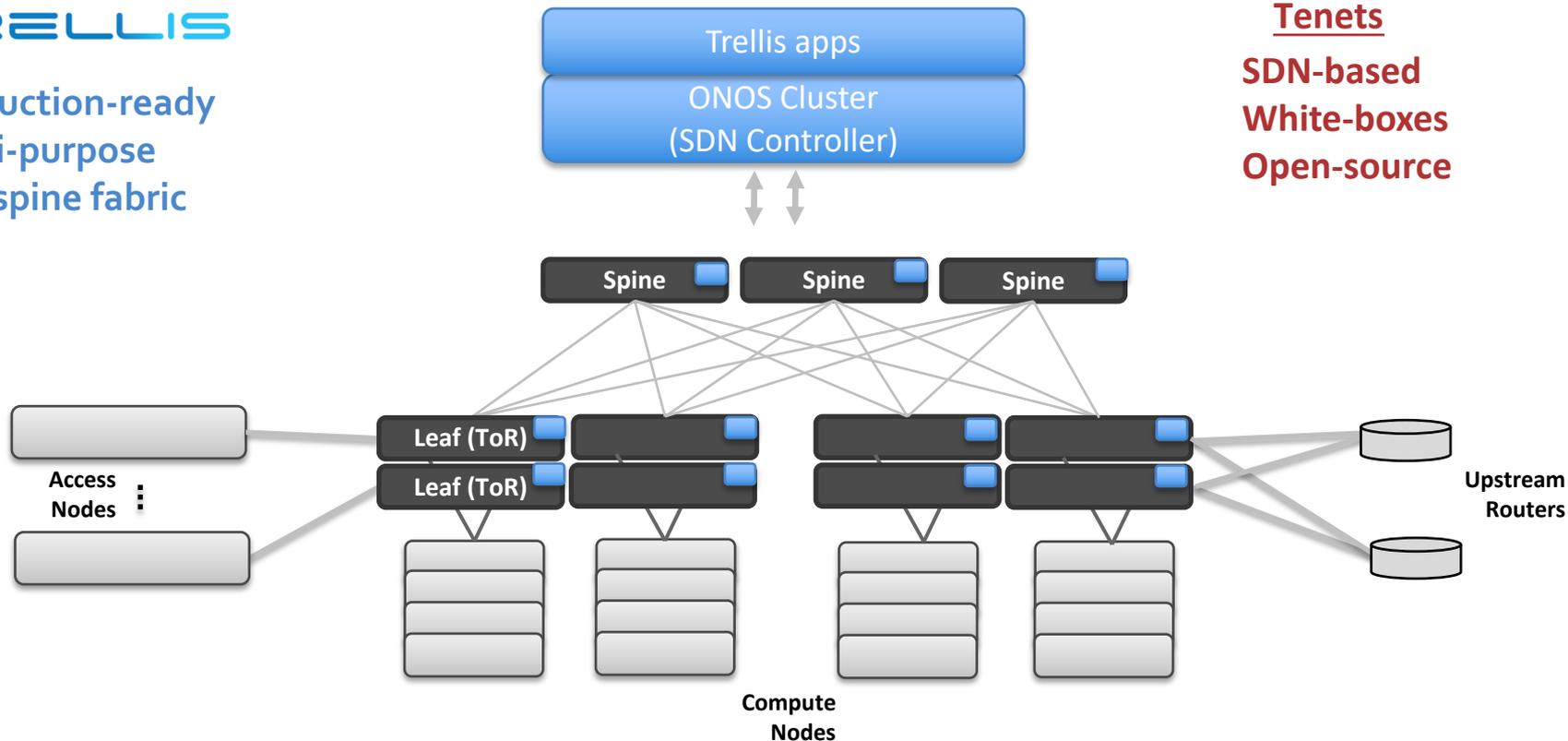




**Saurav Das**

**VP Engineering  
ONF**

Tenets  
SDN-based  
White-boxes  
Open-source

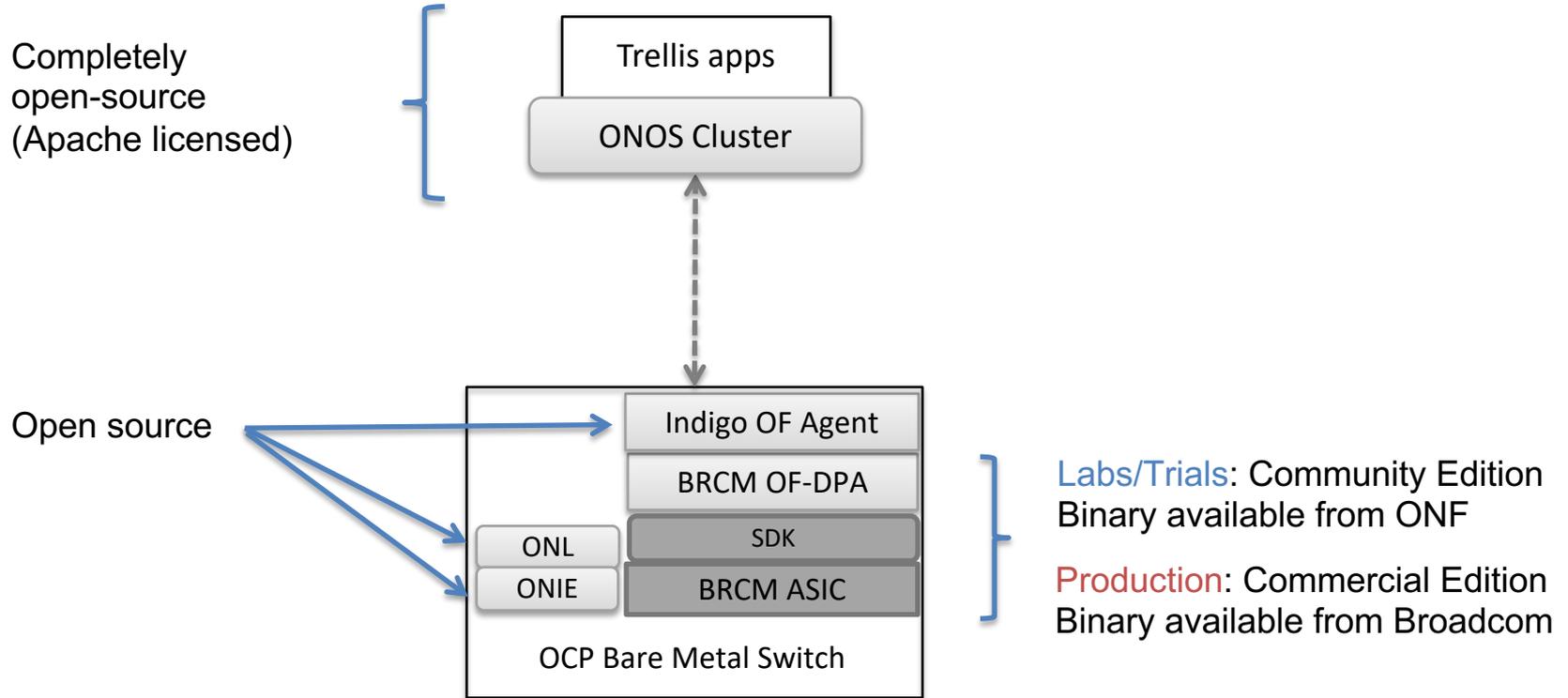


Legend:

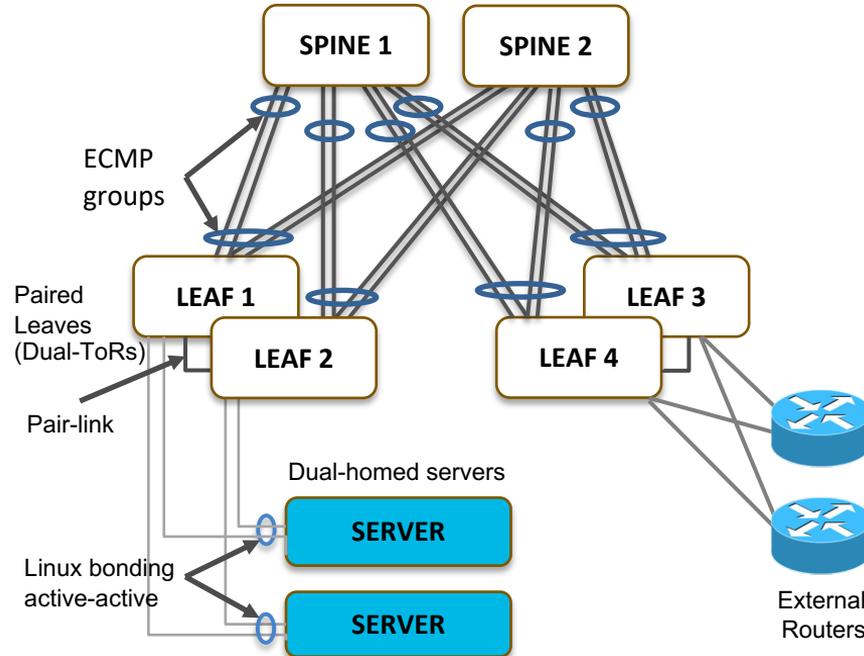
Trellis Software Component

Trellis Compliant Bare-metal Hardware

# System Components



# Trellis Redundancy



## Specifications

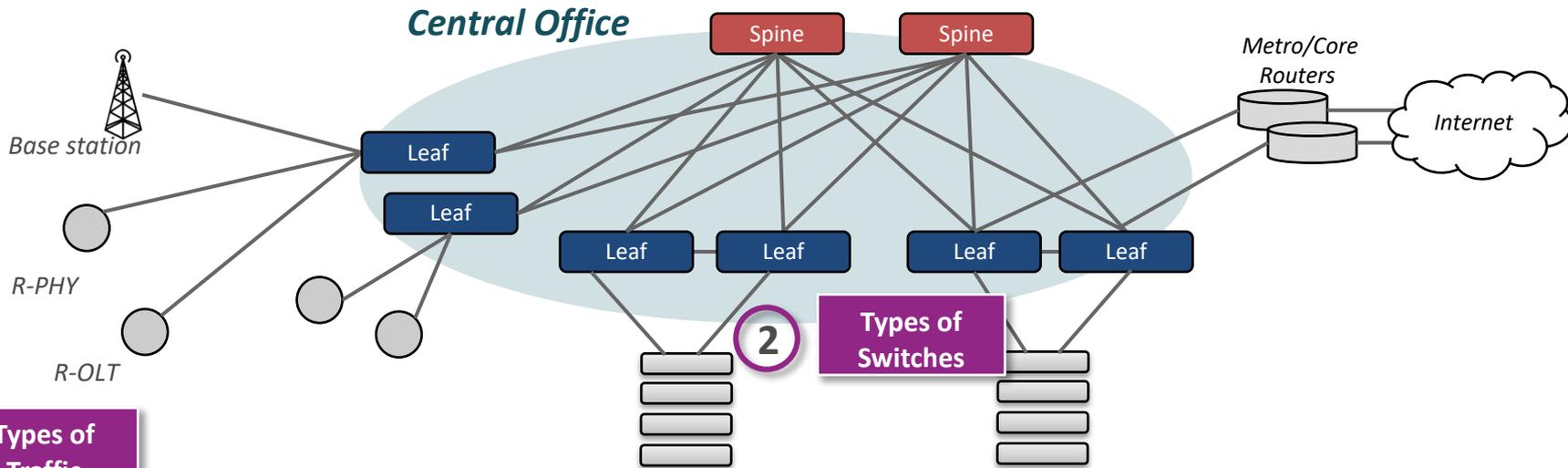
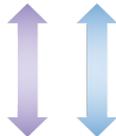
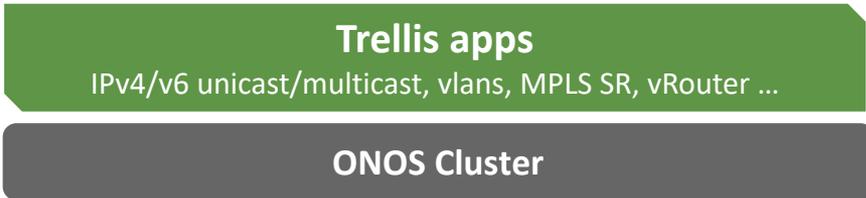
FEATURES	DESCRIPTION
SDN Features	<ul style="list-style-type: none"> <li>• ONOS cluster of all-active N instances affording N-way redundancy and scale, where N = 3 or N = 5</li> <li>• Unified operations interface (GUI/REST/CLI)</li> <li>• Centralized configuration – all configuration is done on controller instead of each individual switch</li> <li>• Centralized role-based access control (RBAC)</li> <li>• Automatic host (end-point) discovery – attached hosts, access-devices, appliances (PNFs), routers, etc. based on ARP, DHCP, NDP, etc.</li> <li>• Automatic switch, link and topology discovery and maintenance (keep-alives, failure recovery)</li> </ul>
L2 Features	Various L2 connectivity and tunneling support <ul style="list-style-type: none"> <li>• VLAN-based bridging                             <ul style="list-style-type: none"> <li>◦ Access, Trunk and Native VLAN support</li> </ul> </li> <li>• VLAN cross connect                             <ul style="list-style-type: none"> <li>◦ Forward traffic based on outer VLAN id</li> <li>◦ Forward traffic based on outer and inner VLAN id (QinQ)</li> </ul> </li> <li>• Pseudowire                             <ul style="list-style-type: none"> <li>◦ L2 tunneling across the L3 fabric</li> <li>◦ Support tunneling based on double tagged and single tagged traffic</li> <li>◦ Support VLAN translation of outer tag</li> </ul> </li> </ul>
L3 Features	IP connectivity <ul style="list-style-type: none"> <li>• IPv4 and IPv6 unicast routing (internal use of MPLS Segment Routing)</li> <li>• Subnetting configuration on all non-spine facing leaf ports; no configuration required on any spine port</li> <li>• IPv6 router advertisement</li> <li>• ARP, NDP, IGMP handling</li> <li>• Number of flows in spines greatly simplified by MPLS Segment Routing</li> <li>• Further reduction of per-leaf flows with route optimization logic</li> </ul>
DHCP Relay	DHCP L3 relay <ul style="list-style-type: none"> <li>• DHCPv4 and DHCPv6</li> <li>• DHCP server either directly attached to fabric leaves, or indirectly connected via upstream router</li> <li>• DHCP client directly either attached to fabric leaves, or indirectly connected via LDRA</li> <li>• Multiple DHCP servers for HA</li> </ul>
vRouter	vRouter presents the entire Trellis fabric as a single router (or dual-routers for HA), with disaggregated control/data plane <ul style="list-style-type: none"> <li>• Uses open-source protocol implementations like Quagga (or FRR)</li> <li>• BGPv4 and BGPv6</li> <li>• Static routes</li> <li>• Route blackholing</li> <li>• ACLs based on port, L2, L3 and L4 headers</li> </ul>
Multicast	Centralized multicast tree computation, programming and management <ul style="list-style-type: none"> <li>• Support both IPv4 and IPv6 multicast</li> <li>• Dual-homed multicast sinks for HA</li> <li>• Multiple multicast sources for HA</li> </ul>
Troubleshooting & Diagnostics	<ul style="list-style-type: none"> <li>• Troubleshooting tool – T3: Trellis Troubleshooting Tool</li> <li>• Diagnostics one-click collection tool 'onos-diags'</li> </ul>
Topology	<ul style="list-style-type: none"> <li>• Single leaf (ToR) or dual-ToR (dual-homing)</li> <li>• Supports typical leaf-spine topology, 2 to 4 spines, up to 10 leaves</li> <li>• Multi-stage leaf-spine fabric (leaf-spine-spine-leaf)</li> <li>• Can start at the smallest scale (single leaf) and grow horizontally</li> </ul>

## Specifications (continued)

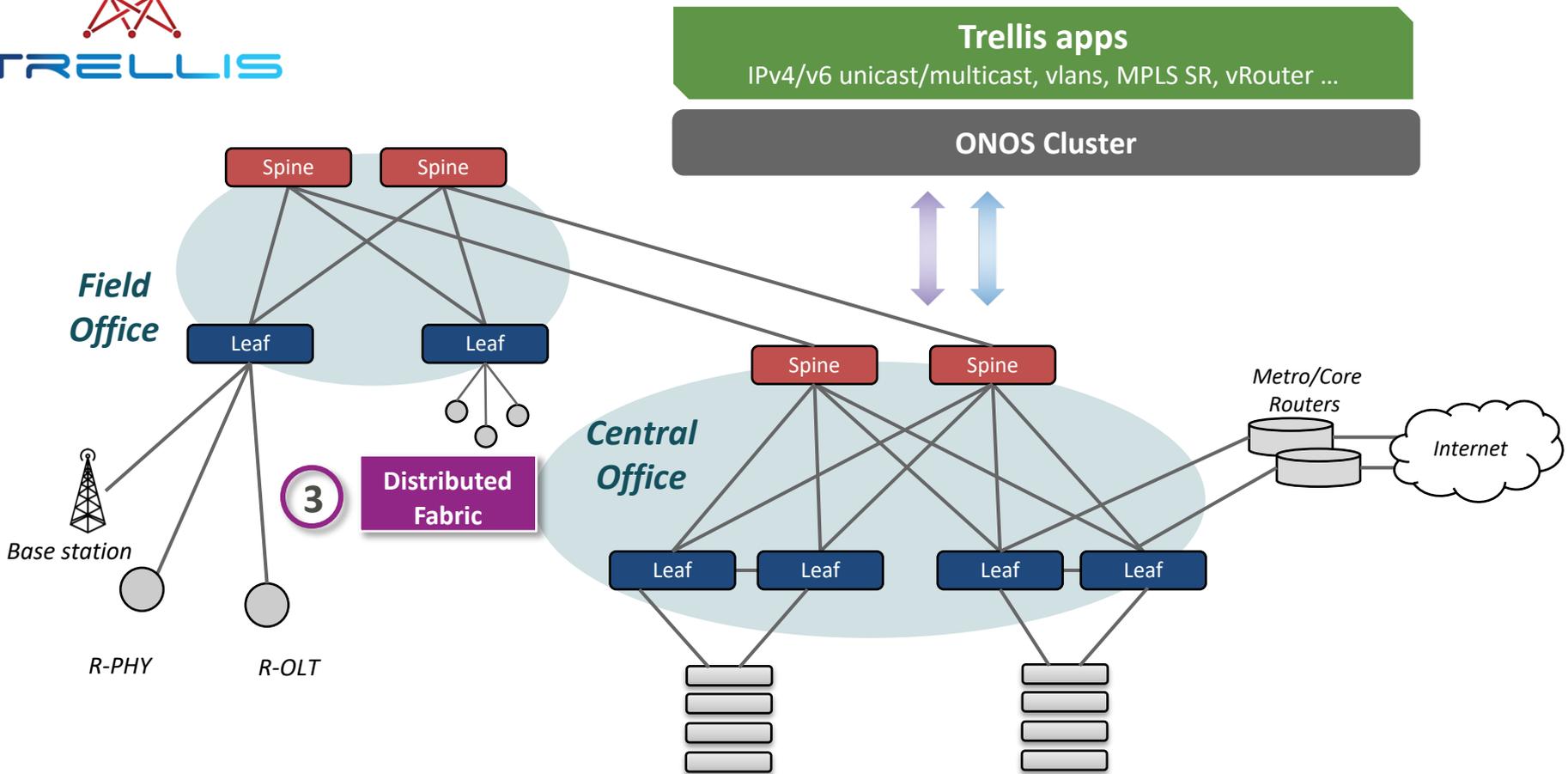
FEATURES	DESCRIPTION
Resiliency	Provides HA in following scenarios <ul style="list-style-type: none"> <li>• Controller instance failure (requires 3 or 5 node ONOS cluster)</li> <li>• Link failures</li> <li>• Spine failure</li> </ul> Further HA support in following failure scenarios with dual-homing enabled <ul style="list-style-type: none"> <li>• Leaf failure</li> <li>• Upstream router failure</li> <li>• Host NIC failure</li> </ul>
Scalability	<ul style="list-style-type: none"> <li>• (in production) Up to 50k routes, 110k flows, 8 Leaf, 2 Spines, with route optimization enabled</li> <li>• (in pre-production) Up to 120k routes, 250k flows, 8 Leaf, 2 Spines, with route optimization enabled</li> </ul>
Security	<ul style="list-style-type: none"> <li>• TLS-secured connection between controllers and switches (premium feature)</li> <li>• AAA 802.1x authentication</li> <li>• MACSec (L2 encapsulation)</li> </ul>
P4-ready	<ul style="list-style-type: none"> <li>• Support for Stratum, P4Runtime and gNMI and P4 programs</li> <li>• Innovative services enabled by programmable pipeline                             <ul style="list-style-type: none"> <li>◦ BNG – PPPoE, anti-spoofing, accounting and more</li> <li>◦ GTP encap/decap</li> </ul> </li> </ul>
Overlay Support	Can be used/integrated with 3rd party overlay networks (e.g. OpenStack Neutron, Kubernetes CNI)
Orchestrator Support	Can be integrated with external orchestrator, logging, telemetry and alarm service via REST apis and Kafka events
Controller Server Specs	Recommended (per ONOS instance) <ul style="list-style-type: none"> <li>• CPU: 32 Cores</li> <li>• RAM: 128GB RAM. 65GB dedicated to ONOS JVM heap (based on 50K routes)</li> </ul>
Whitebox Switch Hardware	<ul style="list-style-type: none"> <li>• Multi-vendor: Edgcore, QCT, Delta, Inventec</li> <li>• Multi-chipset                             <ul style="list-style-type: none"> <li>◦ Broadcom Tomahawk, Trident2, Qumran</li> <li>◦ Barefoot Tofino</li> </ul> </li> <li>• 1/10G, 25G, 40G to 100G</li> <li>• Refer to <a href="https://docs.trellisfabric.org/supported-hardware.html">docs.trellisfabric.org/supported-hardware.html</a> for the most up-to-date hardware list</li> </ul>
Whitebox Switch Software	<ul style="list-style-type: none"> <li>• Open source ONL, ONIE and Indigo OF client</li> <li>• (in production) OF-DPA software commercial version – contact Broadcom</li> <li>• (in labs/trials) OF-DPA software community version available from ONF (for switch models based on Trident and Tomahawk, not Qumran)</li> <li>• (in labs/trails) Stratum available from ONF</li> </ul>
Documentation	<a href="https://docs.trellisfabric.org">docs.trellisfabric.org</a>

- Trellis is designed for **service provider access/edge**

## Why Trellis?

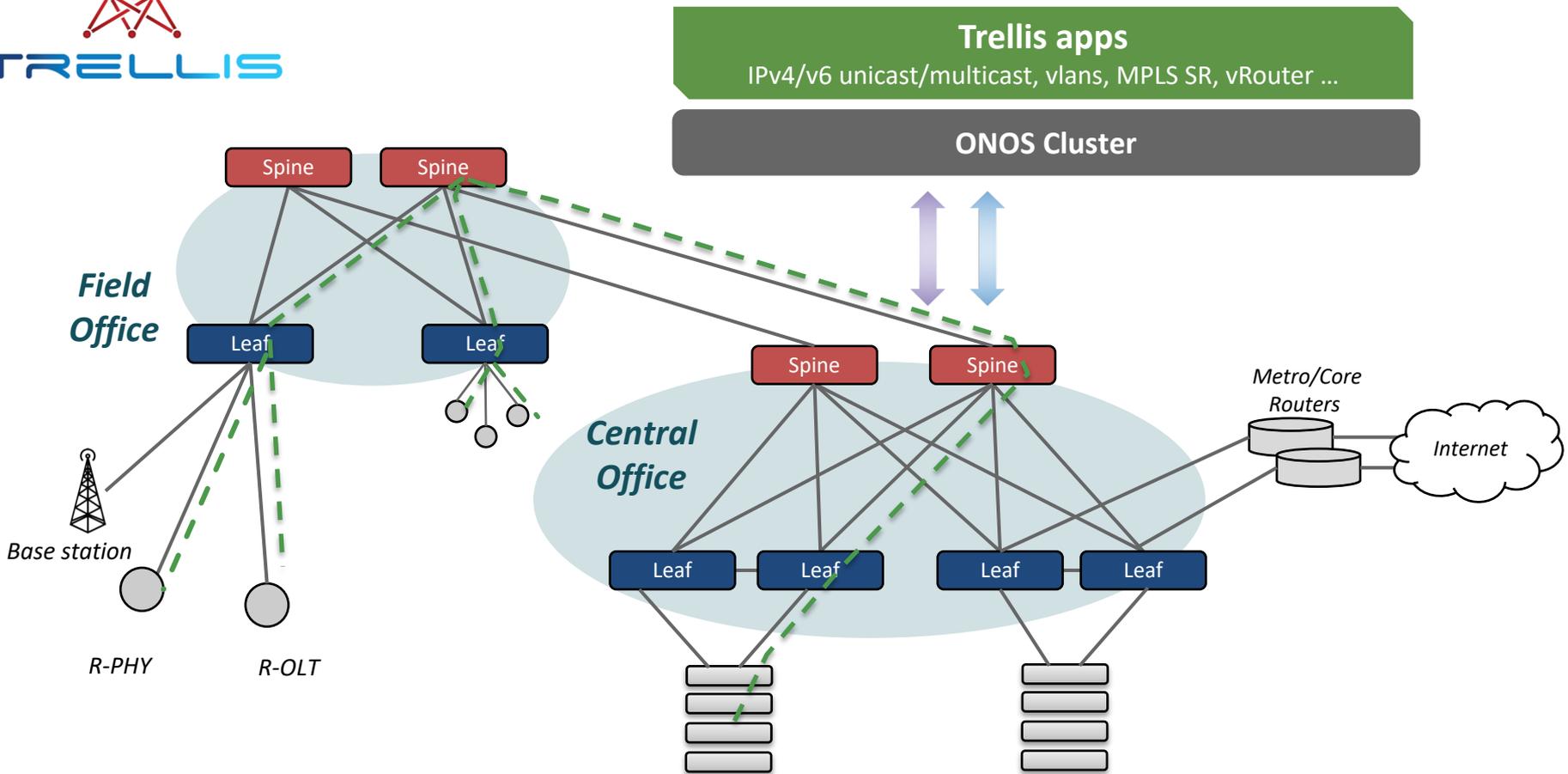


**Optimized for Service Provider Access/Edge**



# Why Trellis?

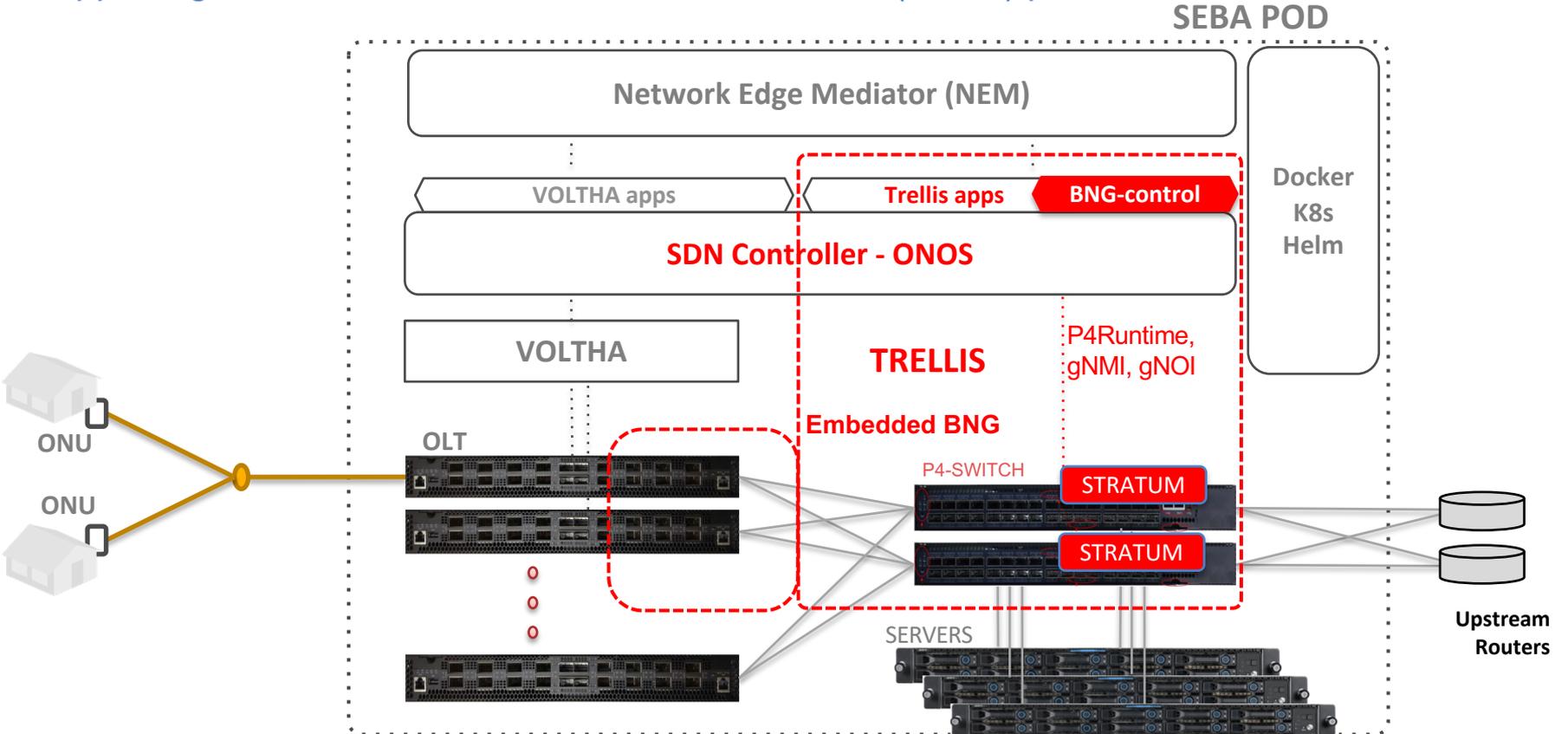
- Trellis is designed for **service provider access/edge**
  - Traffic types/encapsulations, topologies, ASICs
- SDN **simplifies and optimizes** features



# Why Trellis?

- Trellis is designed for **service provider edge**
  - Traffic types/encapsulations, topologies, ASICs
- SDN **simplifies and optimizes** existing features
  - Learn more at **Trellis** booth
- SDN & P4 switches **enable new features**

# Trellis enhanced with embedded & disaggregated BNG using P4, supporting ONF's SDN Enabled Broadband Access (SEBA) platform

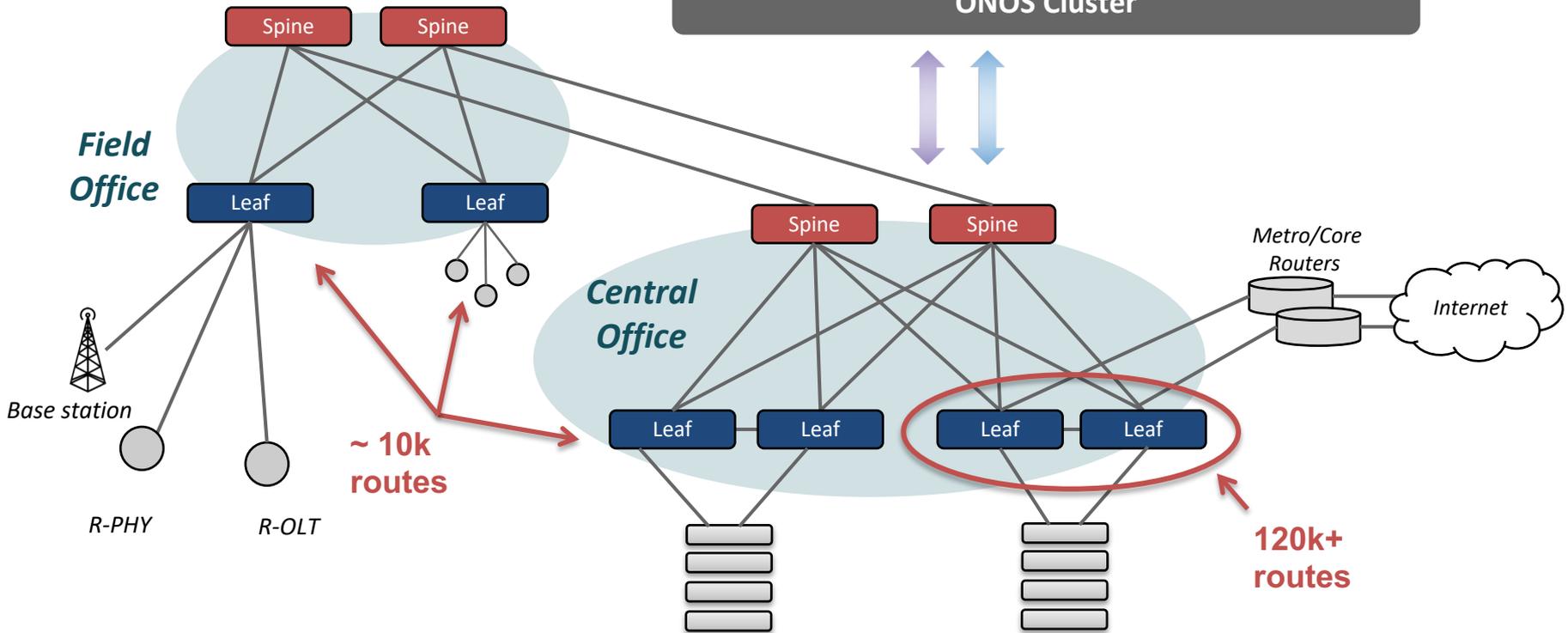


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  - Learn more at **SEBA BNG** booth
- Open-source -> **ownership & customizability**

**Trellis apps**  
IPv4/v6 unicast/multicast, vlans, MPLS SR, vRouter ...

**ONOS Cluster**

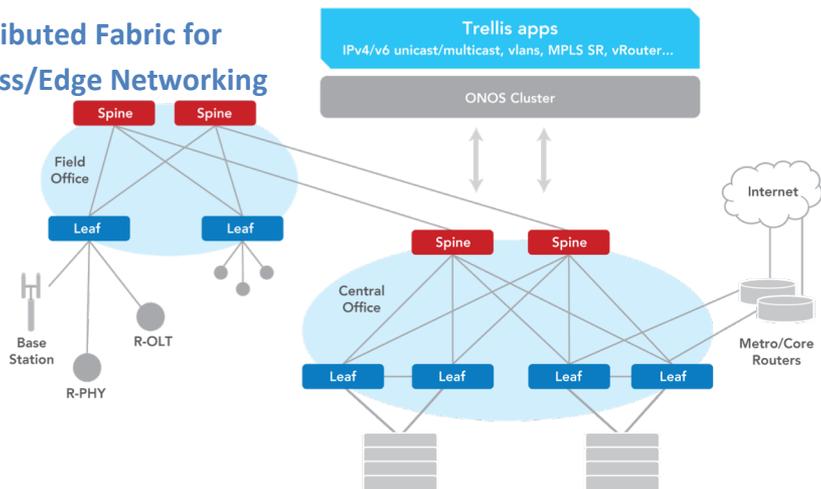


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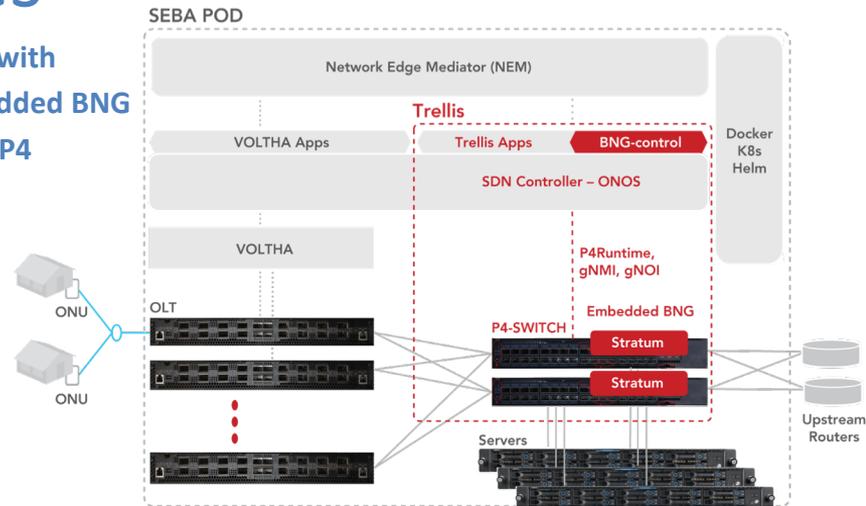
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- Open-source -> **ownership & customizability**
  - Learn more at **Comcast** booth

# Use Cases

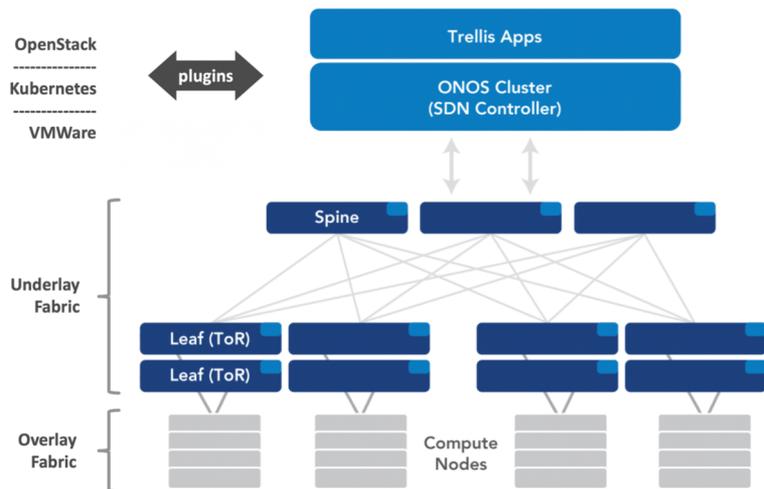
## Distributed Fabric for Access/Edge Networking



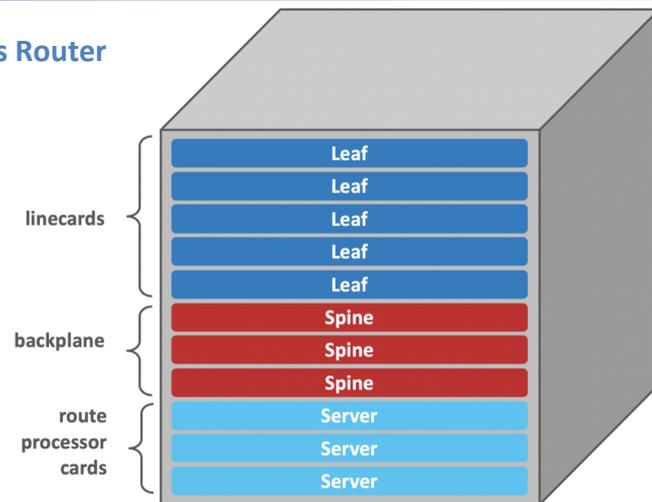
## SEBA with Embedded BNG using P4



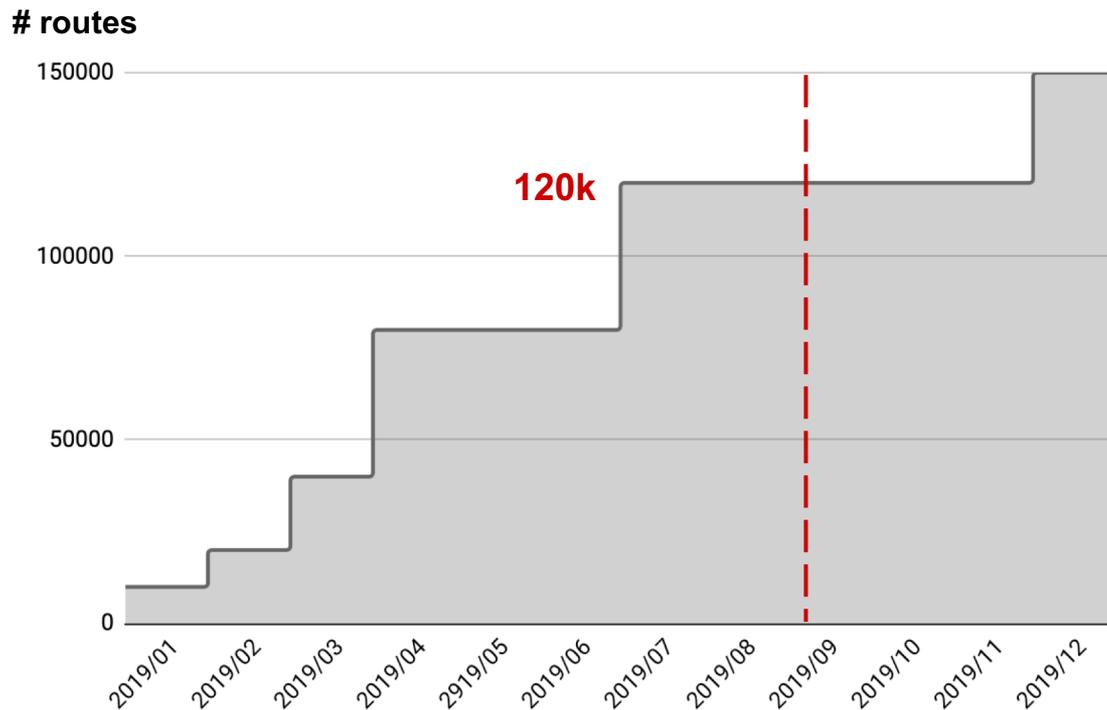
## Enterprise DC Fabric



## Chassis Router



# Trellis Continues to Scale





TRELLIS

<https://www.opennetworking.org/trellis/>

<https://docs.trellisfabric.org>



and more...





# Bringing Trellis into Production Deployments

George Tchapanian  
Edgecore Networks



# Accton Technology and Edgecore Networks



## Accton Technology

- Leading Network ODM: Systems, networking, and OEM customers (Tier 1 OEMS)
- Founded 1988, IPO Taiwan 1995
- 4,000 + employees worldwide, > 700 network engineers, R&D Centers
- Volume manufacturing in China and Taiwan (TAA Compliant)
- One Stop Shop!



## Edgecore Networks

- Brand Business; wholly owned subsidiary of Accton
- Go-to-market business to network operators – Data Center, Telecom, and Enterprise
- Manages customer, partner and open community relationships
- Leading contributor of network designs to **OCP**, **TIP** and **LF** Active participant
- **ONF** – Charter Partner and leading ONF Strategic Initiative – Building Reference Designs (HW and SW).

# Accton

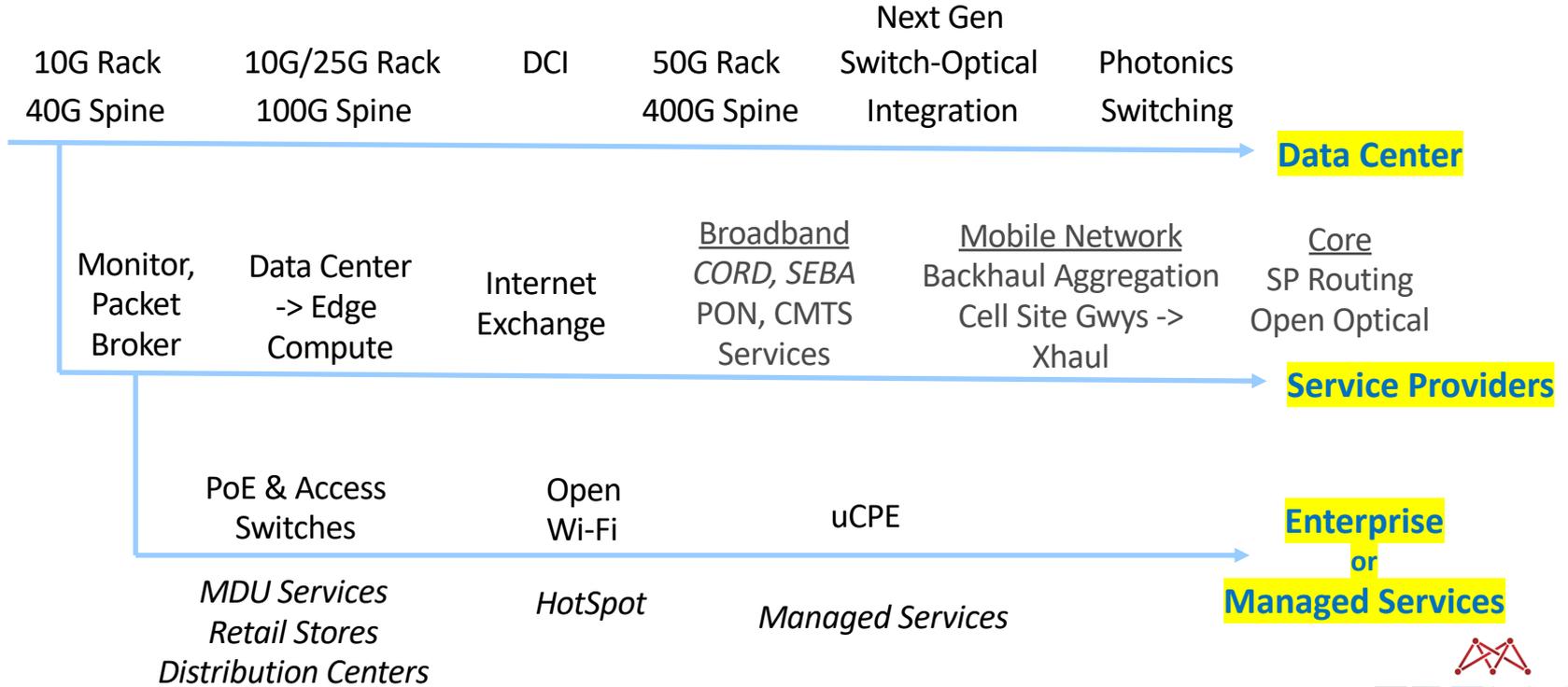
## Making Partnership Work



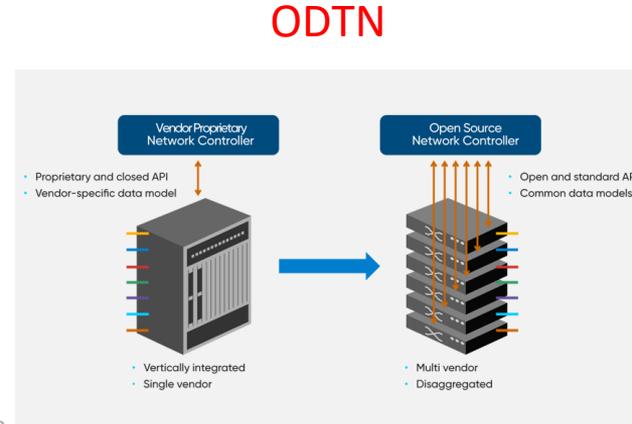
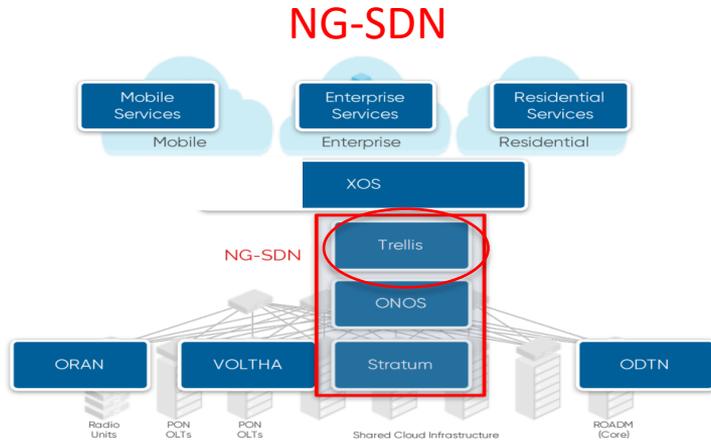
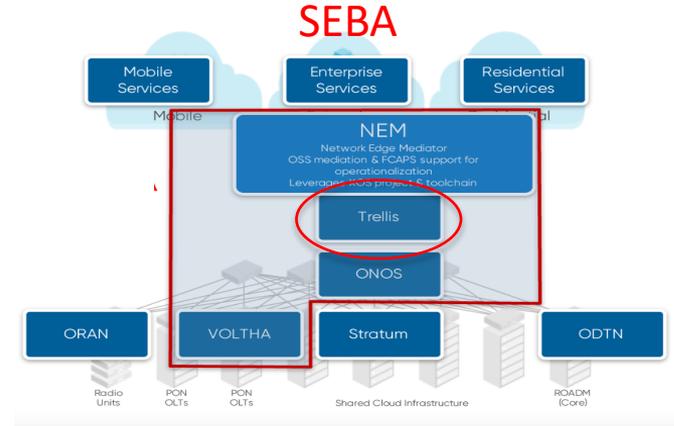
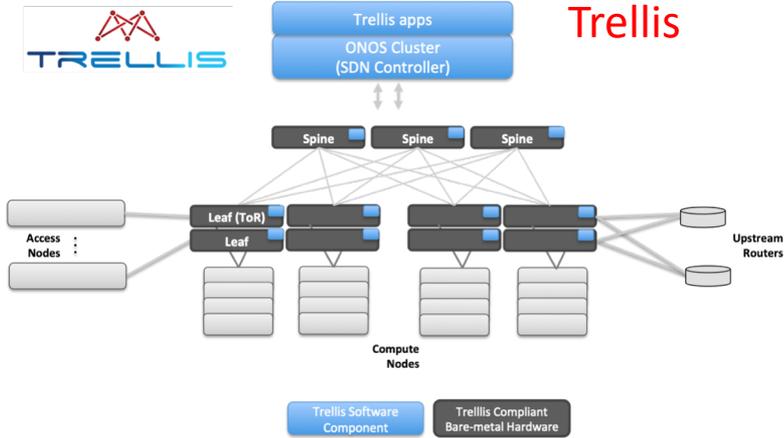
> 10M Ports Shipped 2018

# Open Networking Evolution

## Edgecore Investment and Leadership in each Segment & Use Case

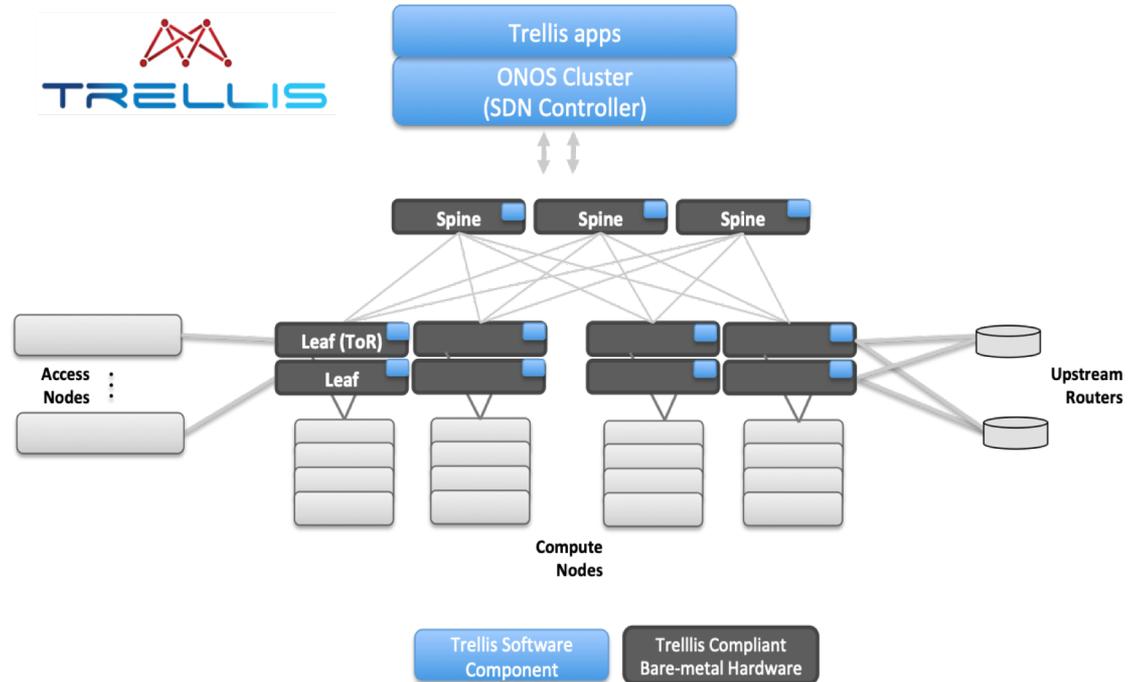


# Edgecore Contributions in ONF Exemplar Designs and Solutions



# ONF Trellis building block

- Trellis is common in most ONF reference exemplar designs
- Trellis contains generic Leaf/Spine fabric, Compute nodes, Controller, and networking functions



# Most Network Design Contributions to Open Source

## Industry Firsts: 10G to 400G Data Center, Telco /MSO Switches

### OCP-Accepted™ Designs & Products

- 1G Rack Mgmt Switch *Helix4*
- 10G TOR Switch *Trident II*
- 40G Spine Switch *Trident II*
- 100G TOR & Spine Switch *Tomahawk*
- 100G TOR & Spine Switches *Trident3*
- 64 x 100G Spine Switch *Tomahawk II*
- 32 x 400G *Tomahawk III*
- 10G/100G Edge Switch *Qumran*
- Open Rack Switch Adapter

### Design Contributions in OCP Review

- 100G OMP800 Chassis *Tomahawk*
- 100G OMP1600 Chassis *Tomahawk*
- 25G TOR Switch *Tomahawk*
- MiniPack AS8000 *Tomahawk III*

### Partner Designs, Edgecore OCP-Inspired™ Product

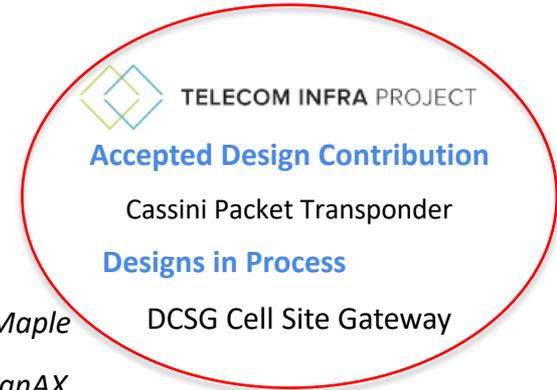
- Wedge40-16X *Facebook*
- Wedge100-32X *Facebook*
- Wedge100BF-32X *Barefoot*
- Wedge100BF-65X *Barefoot*

### OCP Telco Working Group

- ASXvOLT16 10G OLT *BCM Qumran & Maple*
- AS7316-26XB Cell Site Gateway *QumranAX*
- AS7926-40XK and -80XK Aggregation Routers *Jericho2 in OCP Review*

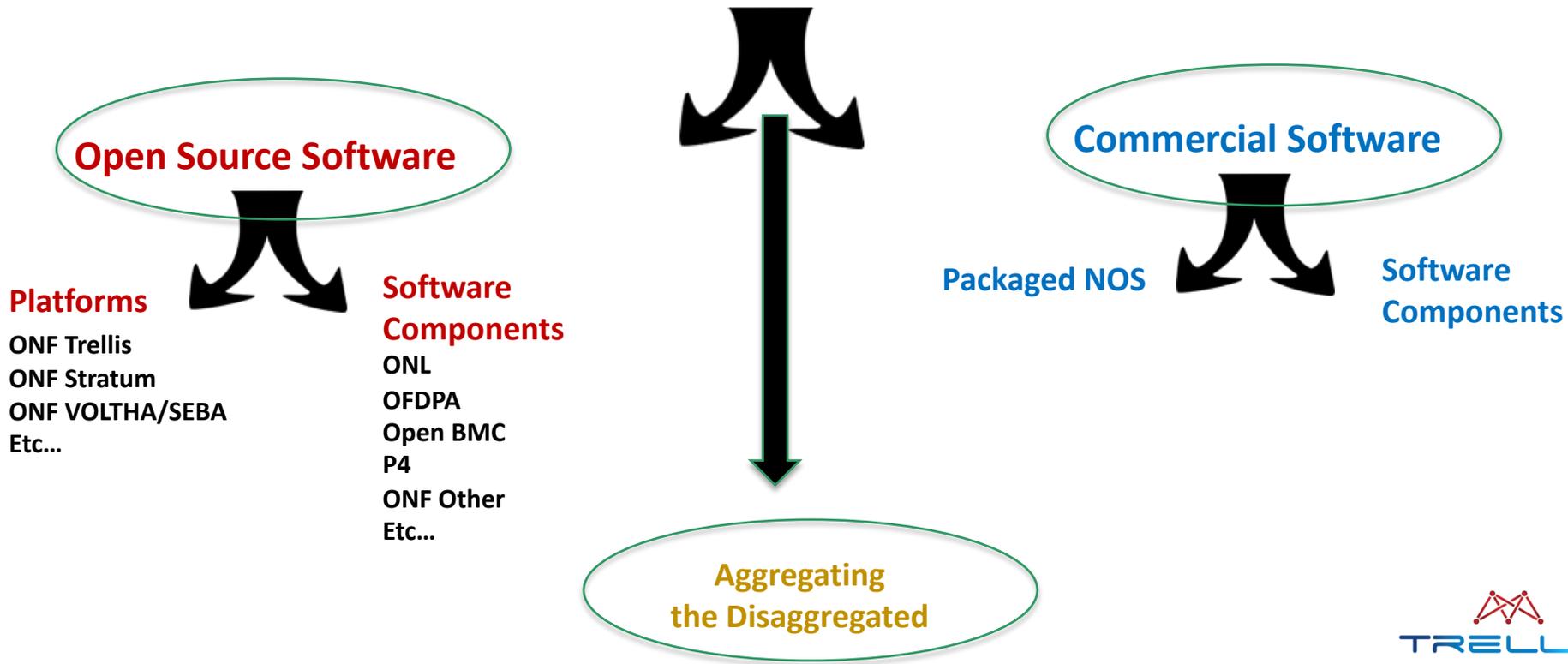
### OCP-Accepted™ Access Products

- 1G PoE Switch *Helix4*
- 802.11ac Wave1 Wi-Fi APs *BCM*
- 802.11ac Wave2 Wi-Fi APs *QCA*

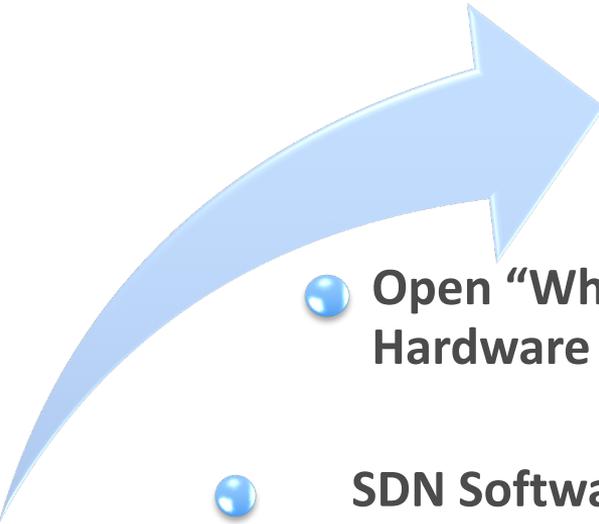


# Software Paths in Open Networking

Open Network Hardware: whitebox, bare metal, disaggregated



# Proven Benefits of Open Networking



**Freedom Automation Innovation**

- Open “Whitebox” Hardware

- SDN Software Control

- Open Technology



Capex/Opex Reduction

Disaggregation - Modularity

Feature and velocity of deployment



TRELIS



ONF  
CONNECT

# GTM: Edgecore Open Networking

- Open Hardware Leadership
- Open Software Value / Enablement Leadership  
(Ecosystem Partnership)
- Integration  
(Ecosystem Partnership)



# Partnerships / Ecosystem Bringing Trellis to Market

- Leading SDN design – ONF Trellis



- Leading Open Networking Infra Supplier - Edgecore



- Leading System Integration partner- Infosys





# Thank You



[www.edge-core.com](http://www.edge-core.com)



# NAVIGATE YOUR NEXT



Trellis  
ONF Production Ready  
Solution

Nitesh Bansal  
SVP and Global Head, Engineering Services

# Who are we?



A next-generation technology services company



**\$11.8B**  
Revenues



**228,000+**  
People Globally



**1,000+**  
Clients  
**45** Countries



**8 out of top 10**  
Telecom companies have chosen  
**Infosys as Strategic Partner**



We help our clients:

**DESIGN**  
next-generation  
Networks

**TRANSFORM**  
OSS, BSS, Digital and  
Telecom Networks

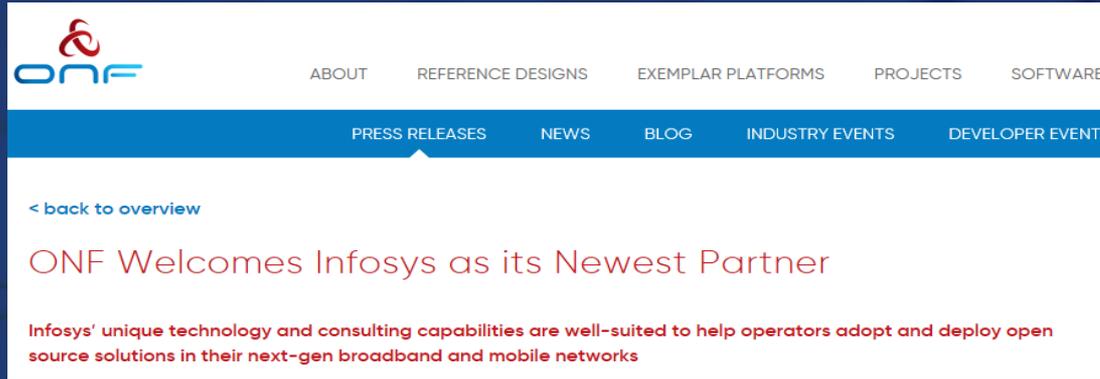
**BUILD**  
new-age solutions for  
Telecom Networks

**OPERATE**  
across the value-chain  
by enabling the 'digital thread'

# Infosys is invested & committed to Open Networking Software



Infosys was the first SI to become the supply chain partner of ONF



Infosys brought ONF to Asia in July 2019



Accelerating Open Networking Software Deployment  
Leading to Digitization and Transformation of Networks



Contributing R&D efforts to Open-source projects in ONF



**200+**  
Engineers enabled on  
ONF Platforms



# Infosys Contributions to Trellis



New feature commits: 25



Code Commits: 70



Bug Fix commits: 45



Complex Features: 10



Hardening and Production Ready



System Up Time



Scale



Test Automation

200+ Automated Test-cases

Service outages



Infosys has partnered with ONF to address some of the key performance and reliability issues



# Bringing Trellis to the Market



Infosys is partnering with ONF and Edgecore to bring Trellis to the market

Hardened and carrier-grade release

Fully SLA driven commercial support model

Single neck to choke

Back to back agreements with all ecosystem players in the stack



# The future roadmap



## Release 2 – Dec 2020

- Hitless Upgrades
- P4, Stratum Integration
- Automated Regression suite

## Release 1 – Jun 2020

- Performance and Scale Optimization
- Fully Integrated Support Model
- Metro-Ethernet Capabilities

## MVP – Dec 2019

- SDN Management Plane
- Unified Dashboard

## Infosys Network Controller



Apps

ONOS Core

Adaptors /  
Plugins

SDN-M



# THANK YOU