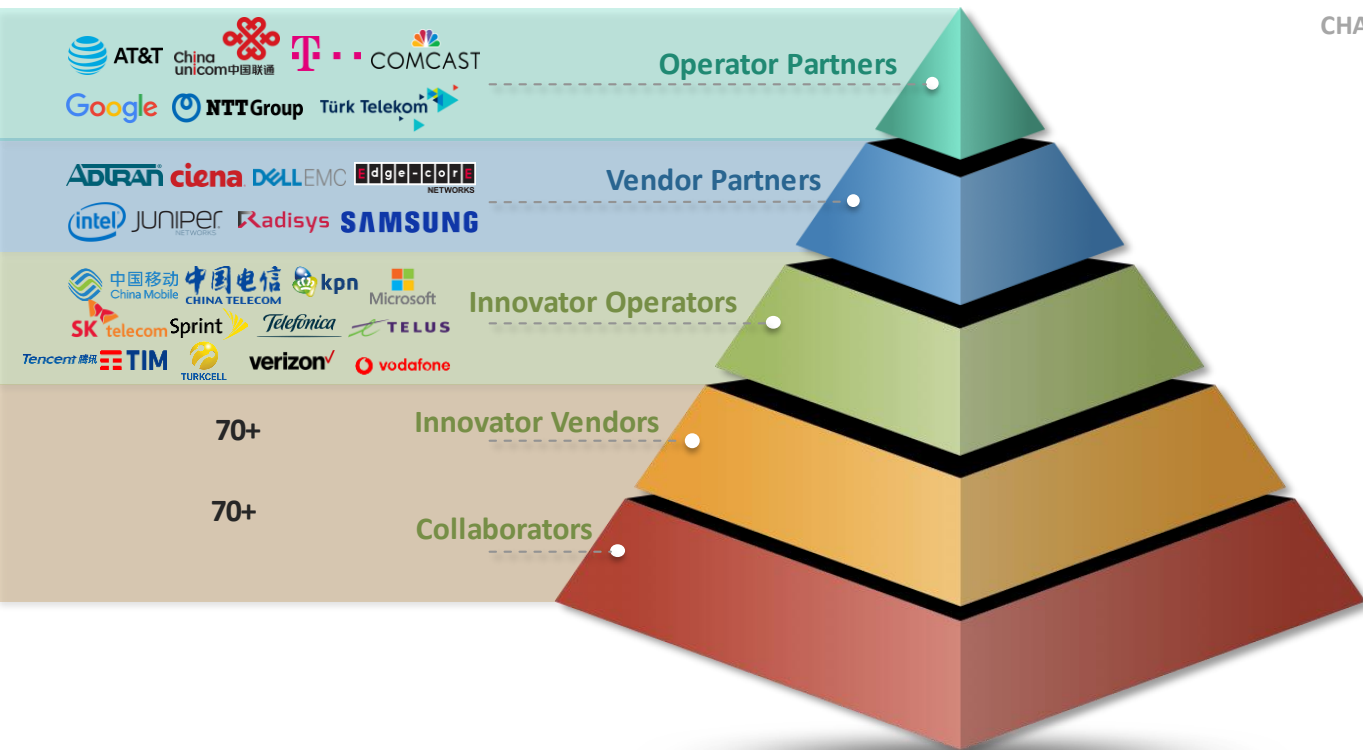# SEBA: SDN Enabled Broadband Access

Saurav Das
Director of Engineering, ONF

November 2, 2018

The ONF Ecosystem – 160+ Members Strong

Vibrant Operator Led Consortium Positioned for Success

ONF BOARD

CHAIR:	AT&T	Andre Feutsch - CTO
	T···	Jochen Appel - VP
	Google	Amin Vahdat - Fellow
	NTT Group	Dai Kashiwa - Director
	COMCAST	Rob Howald - VP
	China unicom中国联通	Shao Guanglu - SVP
	Telefonica	Patric Lopez - VP
	Türk Telekom	Firat Yaman Er - CSO
	STANFORD	Nick McKeown - Prof
	ONF STANFORD	Guru Parulkar, Exec Dir

Operator Partners: AT&T, China unicom中国联通, T···, COMCAST, Google, NTT Group, Türk Telekom

Vendor Partners: ADTRAN, ciena, DELL EMC, Edge-core NETWORKS, intel, JUNIPER NETWORKS, Radisys, SAMSUNG

Innovator Operators: China Mobile 中国移动, CHINA TELECOM 中国电信, kpn, Microsoft, SK telecom, Sprint, Telefonica, TELUS, Tencent 腾讯, TIM, TURKCELL, verizon, Vodafone

Innovator Vendors: 70+

Collaborators: 70+

ONF

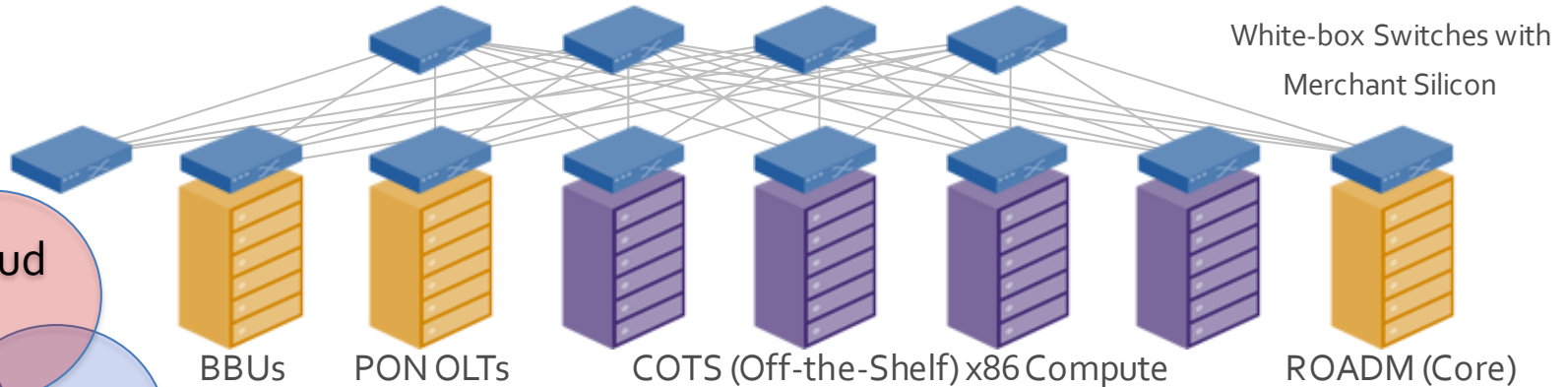# CORD: Central Office Re-Architected as a Datacenter

Residential
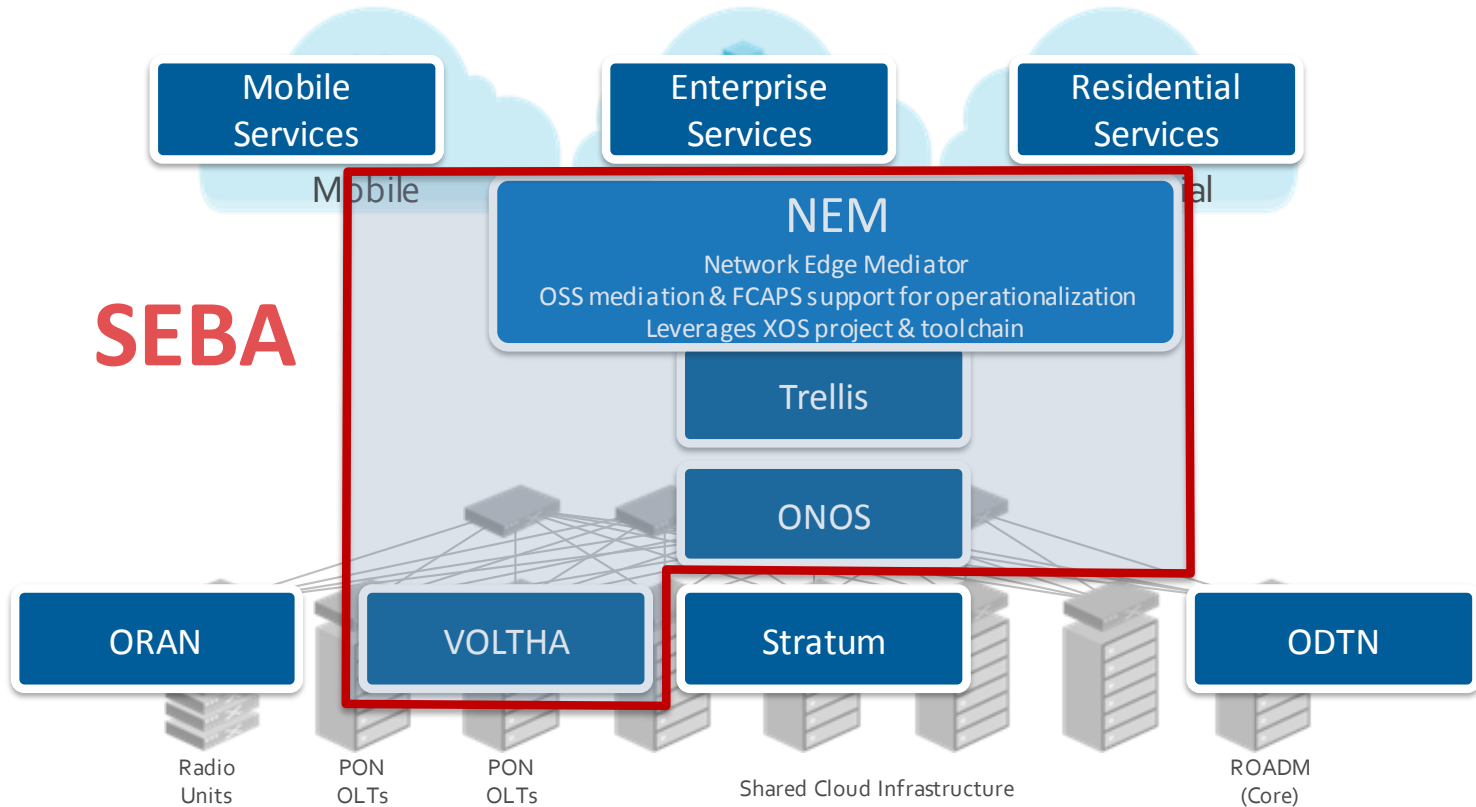vOLT, vSG, vRouter, vCDN

Mobile
vBBU. vMME, vSGW, vPGW, vCDN

Enterprise
vCarrierEthernet, vOAM, vWanEx, vIDS

Access Service Orchestration & Control

White-box Switches with

Merchant Silicon

Cloud

SDN   NFV

BBUs   PON OLTs   COTS (Off-the-Shelf) x86 Compute   ROADM (Core)

Economies of a datacenter, Agility of a cloud provider

ONF

SEBA Exemplar (built on CORD platform)

Mobile Services

Enterprise Services

Residential Services

SEBA

NEM
Network Edge Mediator
OSS mediation & FCAPS support for operationalization
Leverages XOS project & toolchain

Trellis

ONOS

ORAN

VOLTHA

Stratum

ODTN

Radio Units

PON OLTs

PON OLTs

Shared Cloud Infrastructure

ROADM (Core)

Outline

- VOLTHA – Disaggregated Residential Access

- Trellis – Multi-purpose Leaf-Spine Fabric

- CORD platform – service delivery at the edge

- SEBA Exemplar Implementation

- SEBA development & roadmap

#OpenCORD

VOLTHA: Disaggregated Residential Access

Traditional Residential Access
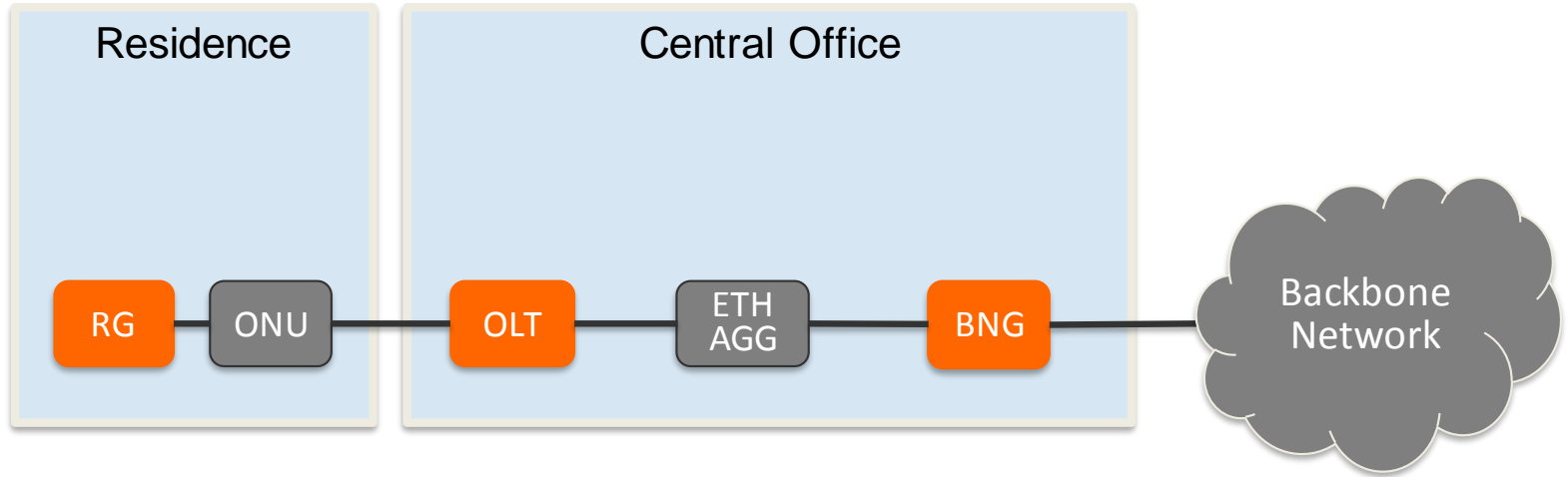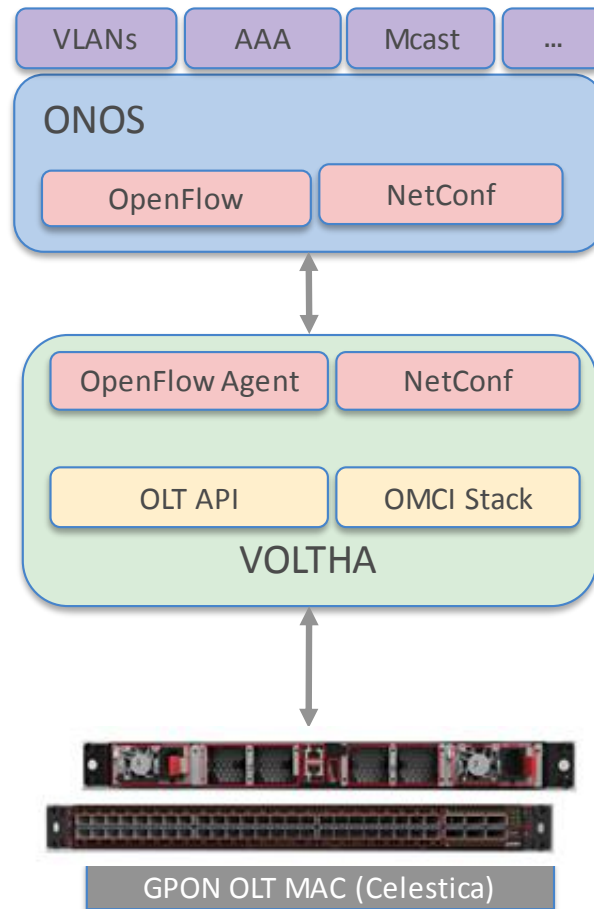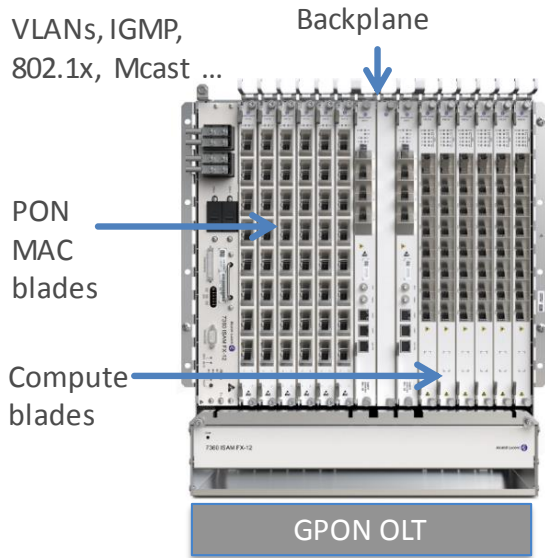

RG – Residential Gateway
OLT – Optical Line Termination
BNG – Broadband Network Gateway

Disaggregated Residential Access

Virtual OLT manages and abstracts PON
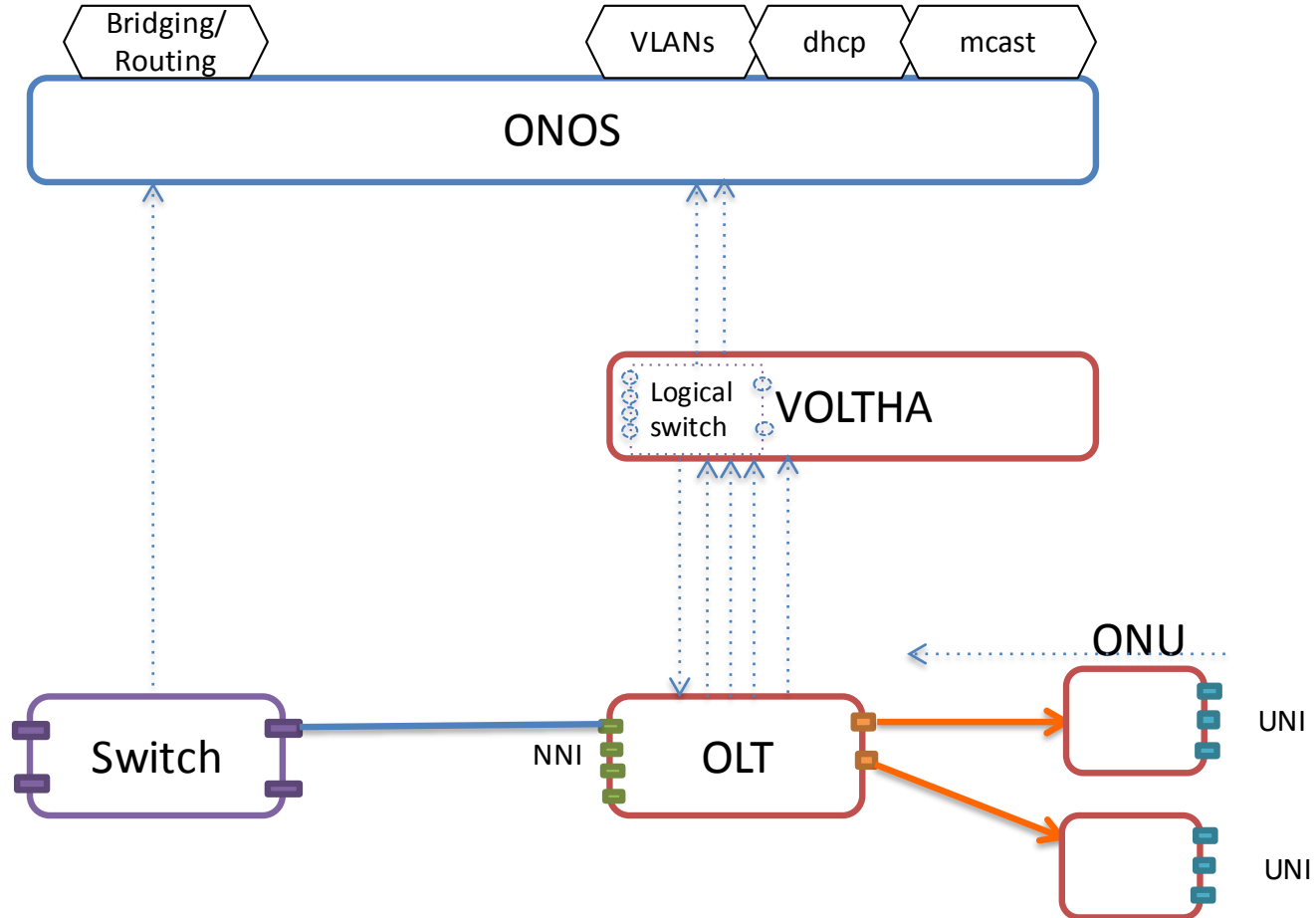
vBNG
- VLAN termination,
- Hierarchical QoS
- DHCP

Residence

Central Office

vBNG

VOLTH A

AAA

RG

ONU

OLT

OLT MAC

ETH

Leaf-Spine Fabric

BNG

Backbone Network

Fabric provides
- Eth aggregation
- Routing
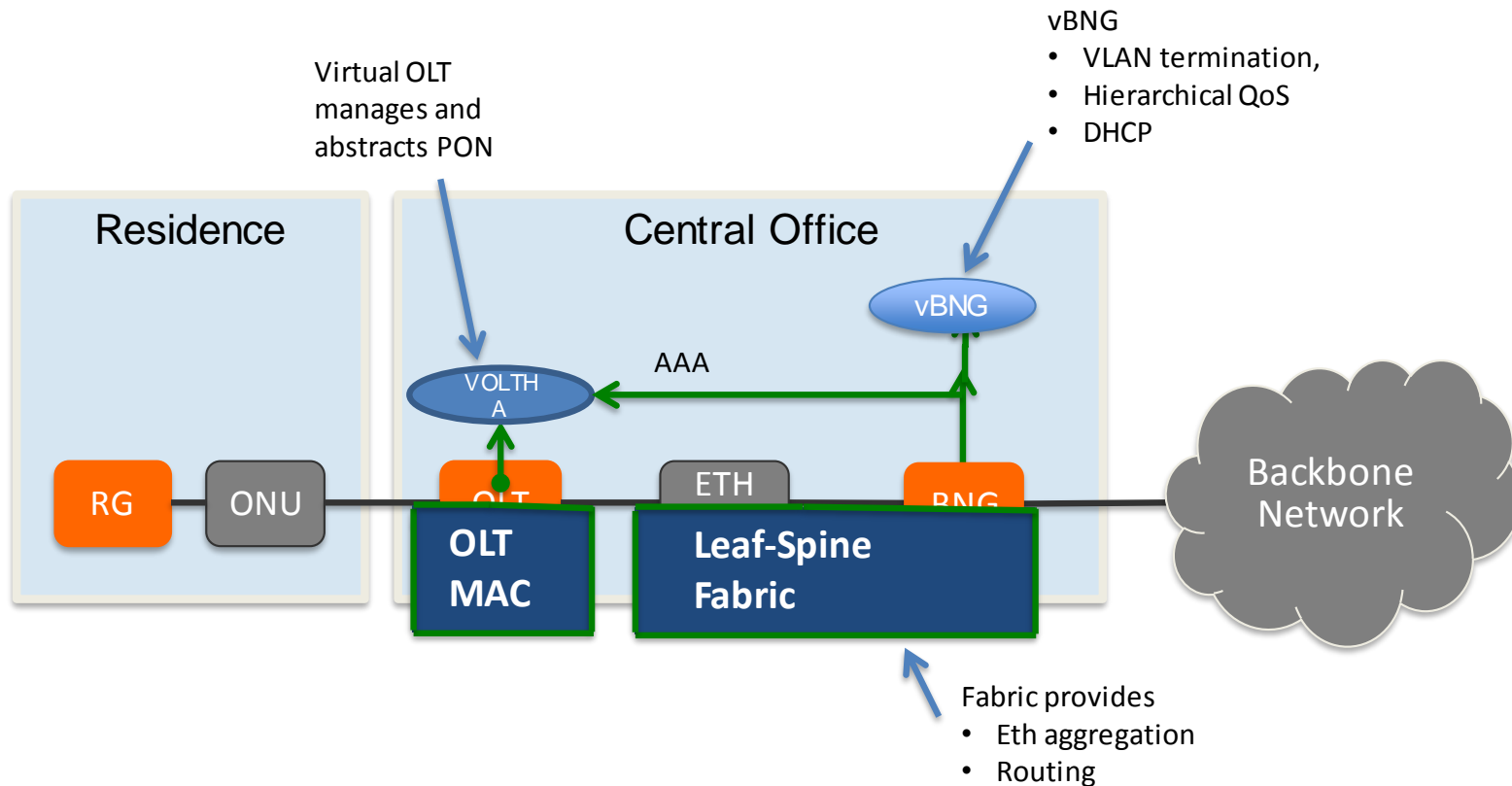
+ the ability to introduce other edge-compute services per subscriber

OLT Disaggregation → VOLTHA

VLANs, IGMP, 802.1x, Mcast …

Backplane

PON MAC blades

Compute blades

GPON OLT

VLANs | AAA | Mcast | …

ONOS
- OpenFlow
- NetConf

OpenFlow Agent | NetConf

OLT API | OMCI Stack

VOLTHA

GPON OLT MAC (Celestica)

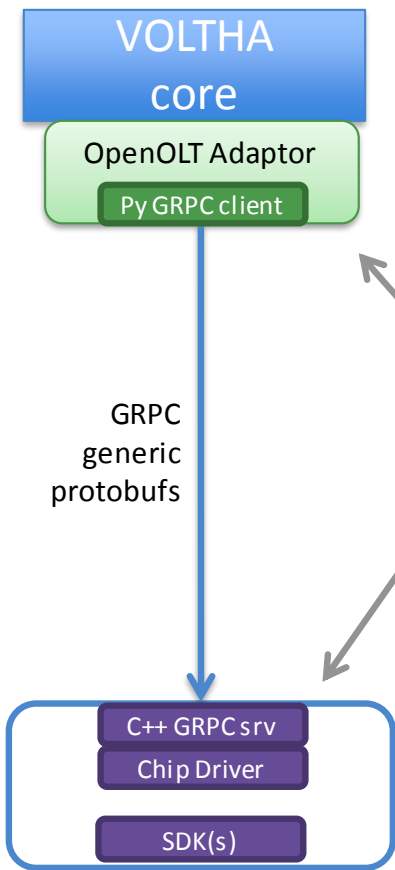**VOLTHA: Virtual OLT Hardware Abstraction**

ONF

VOLTHA Operation

VOLTHA Architecture

VOLTHA hides PON-level details (T-CONT, GEM ports, OMCI etc.) from the SDN controller, and abstracts each PON as a pseudo-Ethernet switch easily programmed by the SDN controller

VOLTHA northbound

Envoy (REST)	OpenFlow Agent	NetConf agent

VOLTHA core

global_handler	dispatcher	etcd	grpc_server	kafka_client
adapter_agent	fluentd	config_proxy	consul	openOMCI

Common control and management framework shared by all OLTs & ONUs

VOLTHA southbound adapters

Vendor-OLT adapters	OpenOLT adapter	Vendor ONU/ONT adapters

Vendor OLTs	Whitebox OLT (EdgeCore)	Vendor ONU/ONTs

Industry's First White-Box XGS-PON OLT

VOLTHA core

OpenOLT Adaptor

Py GRPC client

**White-Box = Open-Hardware Specs (OCP)
+ Open-source software (ONF+OCP)**

GRPC generic protobufs

OpenOLT

Software

C++ GRPC srv

Chip Driver

SDK(s)

Whitebox OLT
(including EdgeCore)

Edgecore

ASFvOLT16

Whitebox OLT

Available July 2017
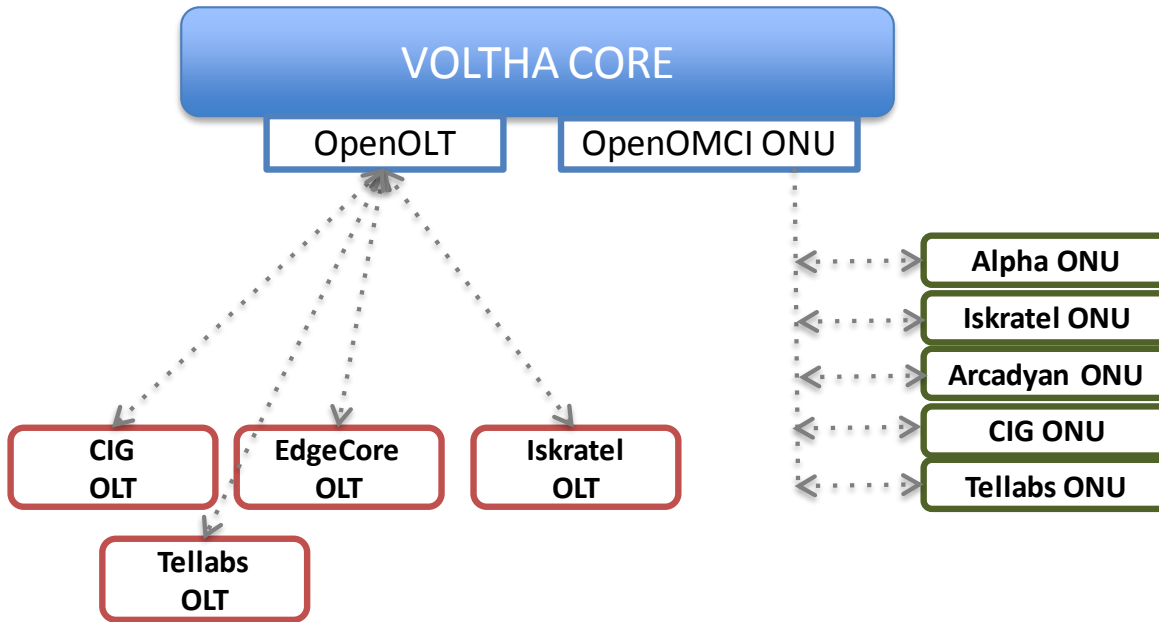
Trellis: Multi-purpose leaf-spine fabric

Trellis Overview

Multi-purpose leaf-spine fabric designed for NFV

Bare-metal hardware
Open-source software
**SDN-based (built on ONOS)**
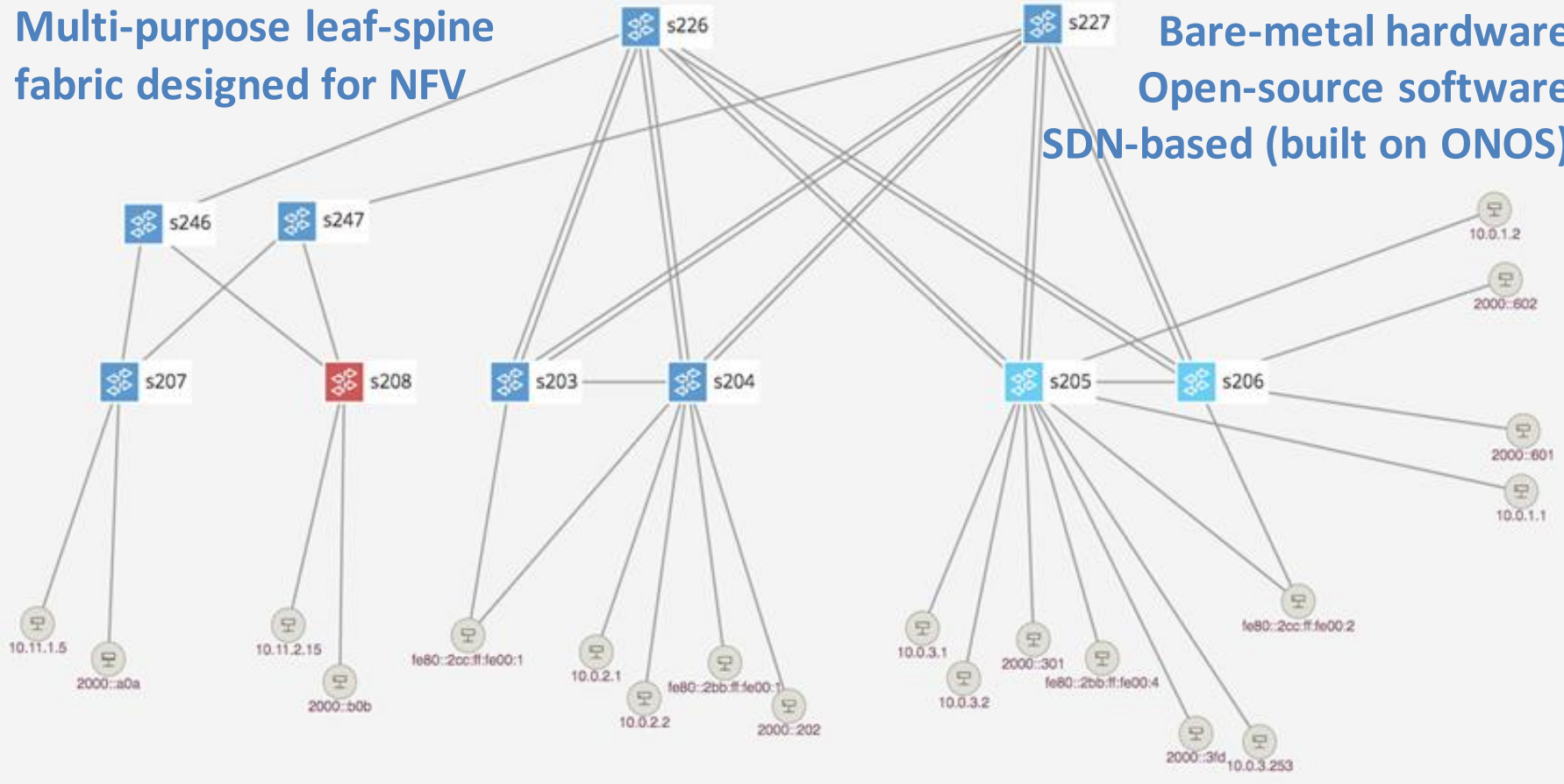
Trellis Features

- **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 (upstream) connectivity
  - Static routes, route blackholing
  - DHCP L3 relay (IPv4/v6)
- **MPLS Pseudowires**
- **QinQ termination**
- **T3** - Trellis Troubleshooting Tool
- **ASIC Support**
  - Broadcom Qumran, Tomahawk, Trident2 switches from EdgeCore & QCT
  - Preliminary support for Cavium Xpliant switches and P4-based Tofino switches

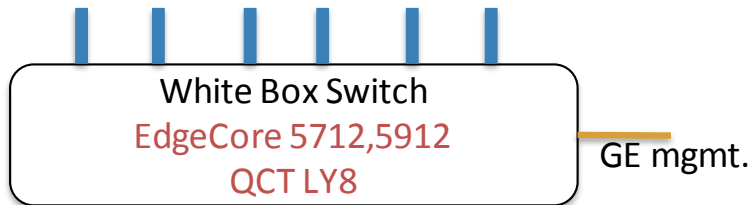# White-Box = Bare-metal hw + Open-Source sw

Spine Switch

White Box Switch
EdgeCore 6712,7712

GE mgmt.
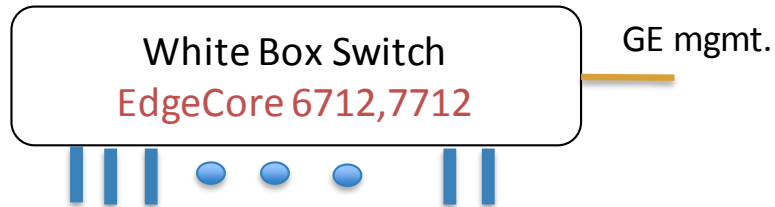
32 x 40G/100G ports downlink to leaf switches

Trident2, Tomahawk, Qumran

Leaf Switch

White Box Switch
EdgeCore 5712,5912
QCT LY8

GE mgmt.

48 x 10G, 6 x 40G/100G

Leaf/Spine Switch Software Stack

to controller

OpenFlow 1.3

OCP Software

(ONL,ONIE)

Indigo OF Agent

OF-DPA

BRCM ASIC

OCP Bare Metal Hardware
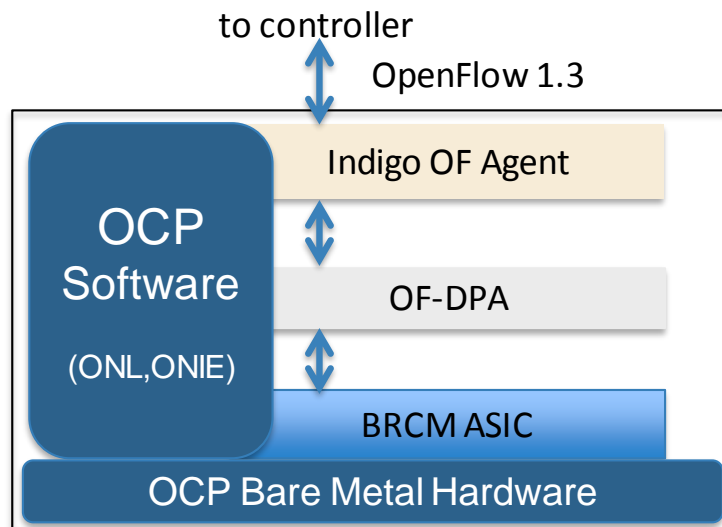
OCP: Open Compute Project
ONL: Open Network Linux
ONIE: Open Network Install Environment
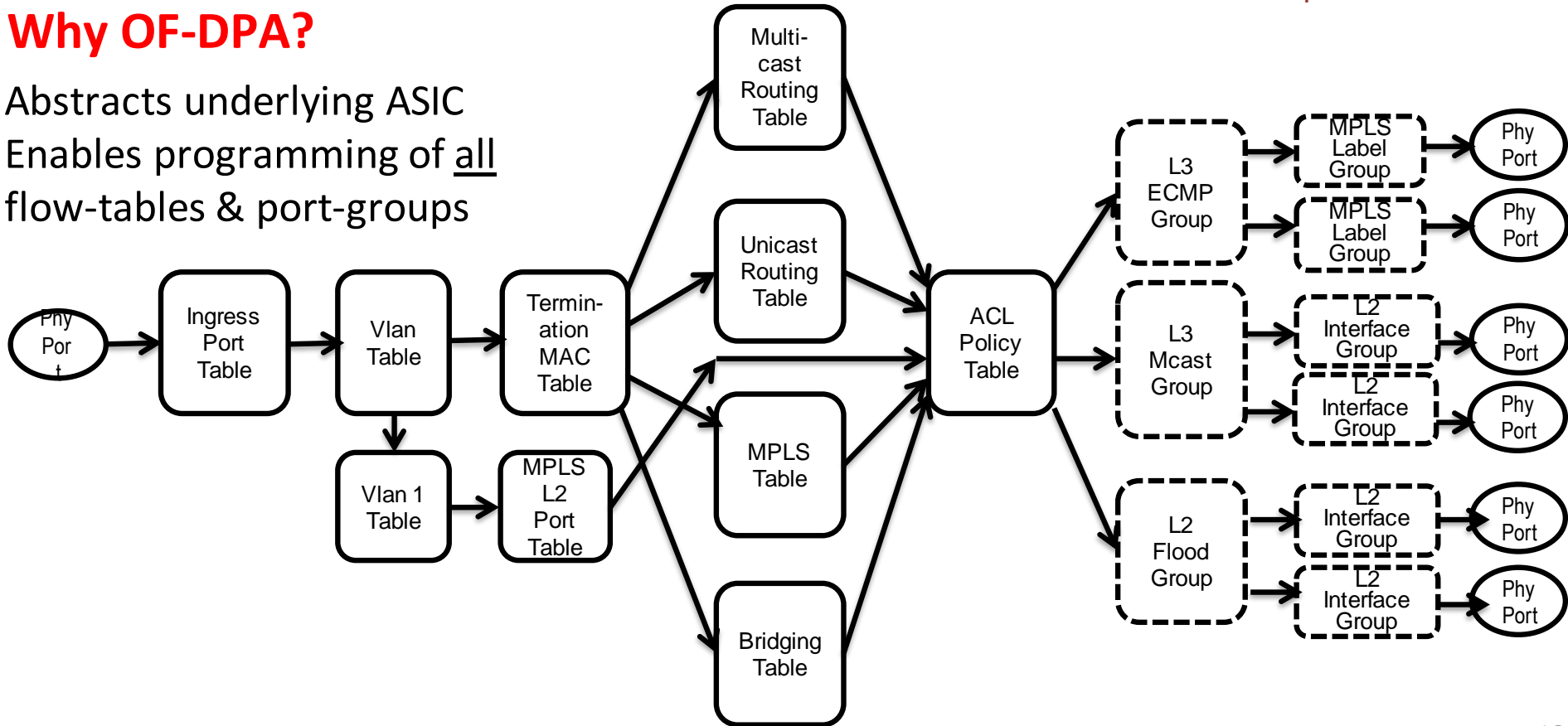BRCM: Broadcom Merchant Silicon ASICs
OF-DPA: OpenFlow Datapath Abstraction

Fabric ASIC Pipeline* (BRCM's OF-DPA)

* Simplified view

Why OF-DPA?

Abstracts underlying ASIC
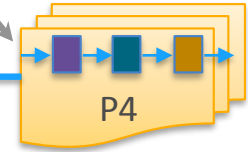Enables programming of all
flow-tables & port-groups
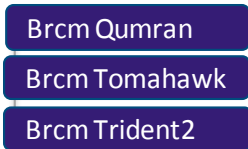
Trellis & P4

Same set of Trellis applications on ONOS

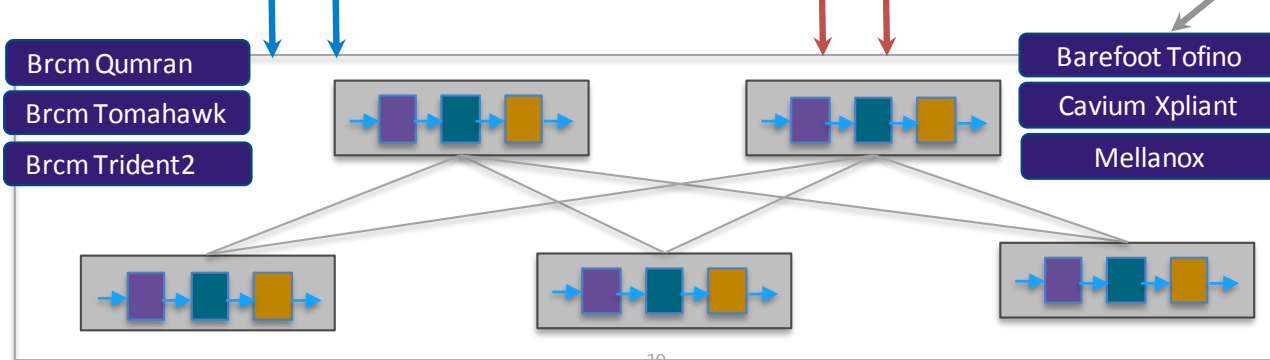Enhanced with P4 program deployment and pipeline configuration

Segment Routing | DHCP L3 Relay | vRouter | Multicast | SPGW-app

ONOS Cluster

P4

OF-DPA driver

fabric.p4 driver

Allowing new functionality on hardware (demo at MWC '18)

OpenFlow   NetConf   P4Runtime   gNMI

Brcm Qumran
Brcm Tomahawk
Brcm Trident 2

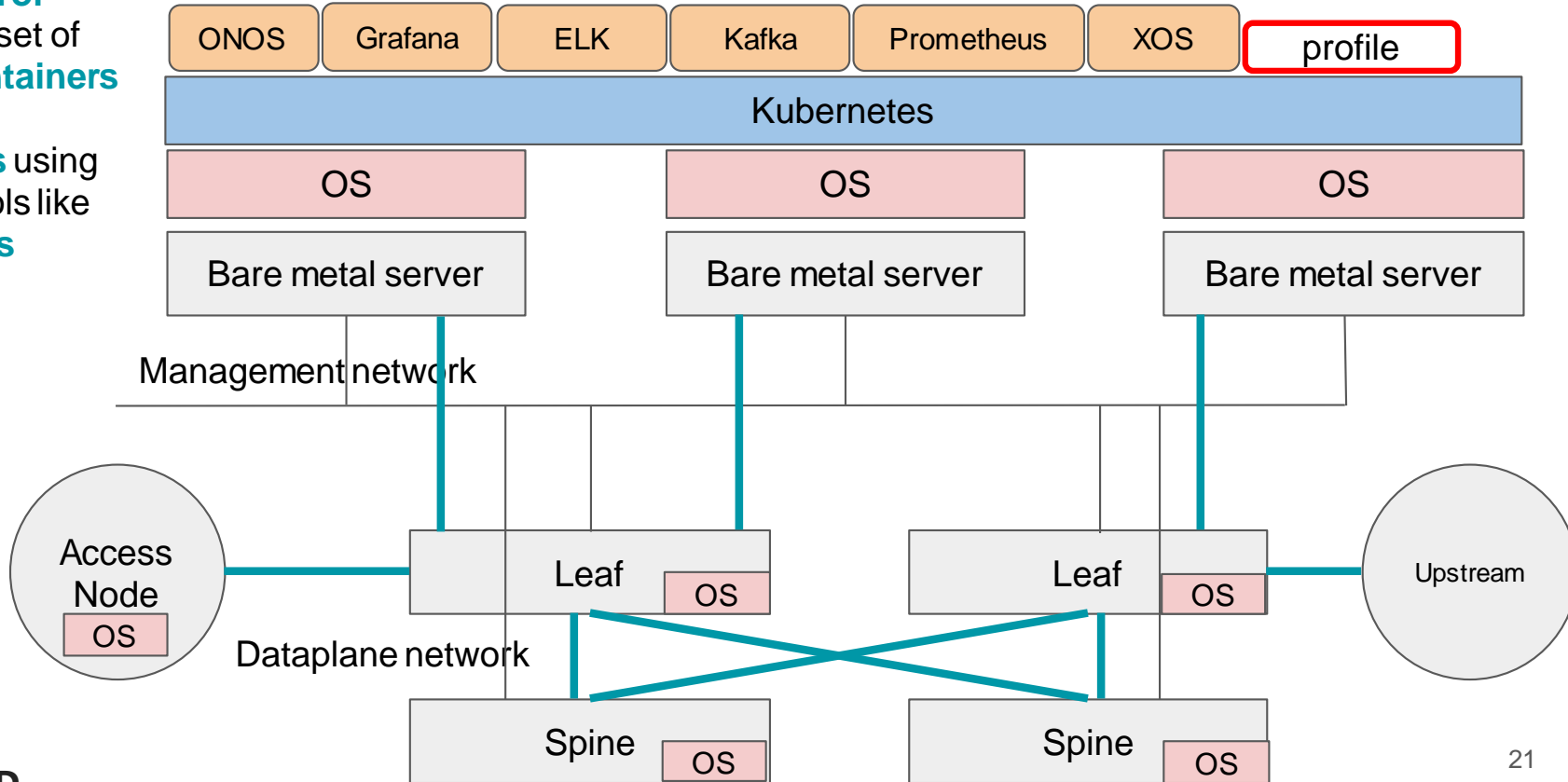Barefoot Tofino
Cavium Xpliant
Mellanox

P4 capable hardware

CORD Platform: service delivery @ the edge

New CORD 6.0 platform (July-2018)

CORD control software → set of **Docker containers** deployed on **Kubernetes** using standard tools like **Helm charts**

#OpenCORD

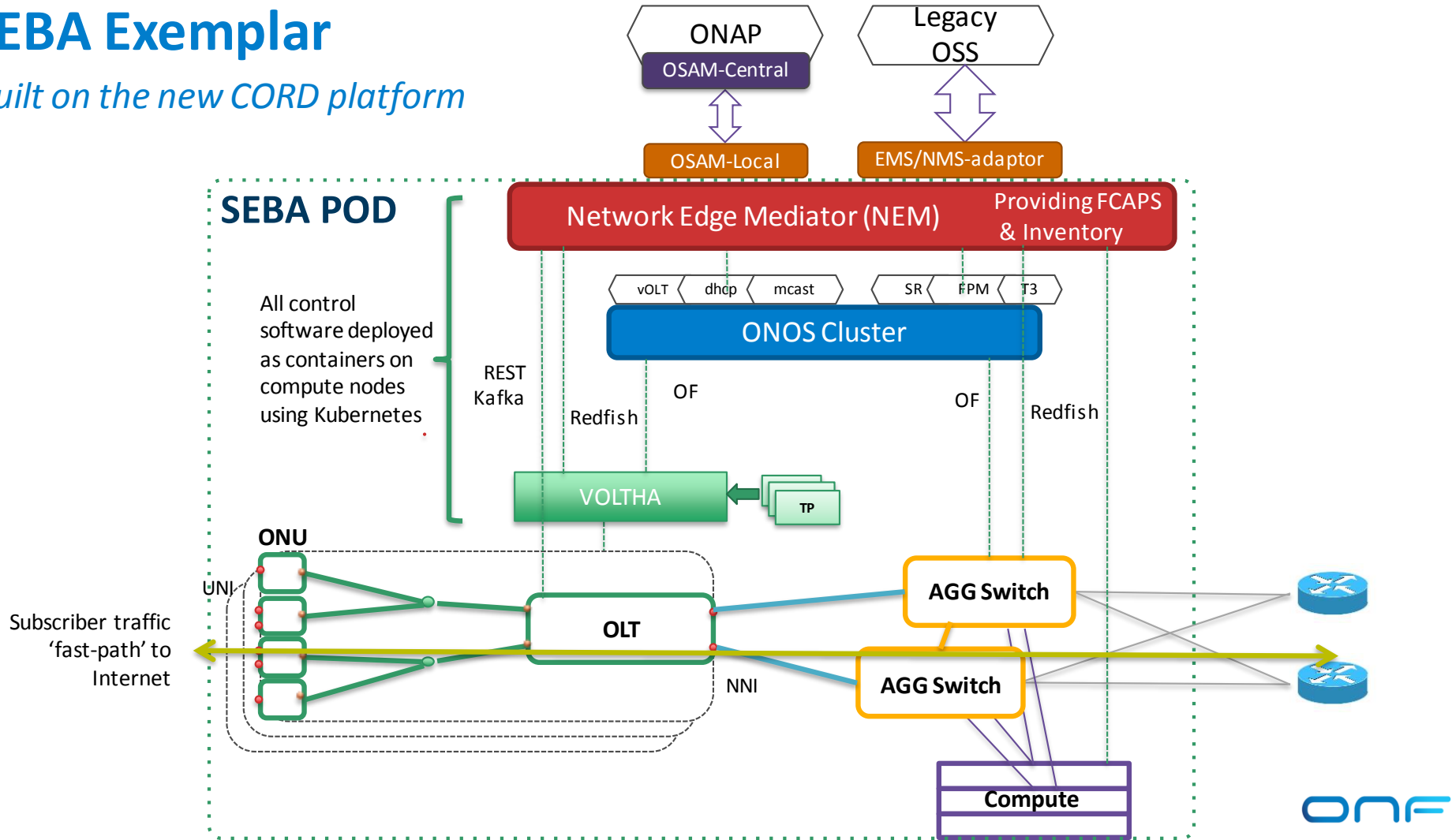**CORD control** software → set of **Docker containers** deployed on **Kubernetes** using standard tools like **Helm charts**

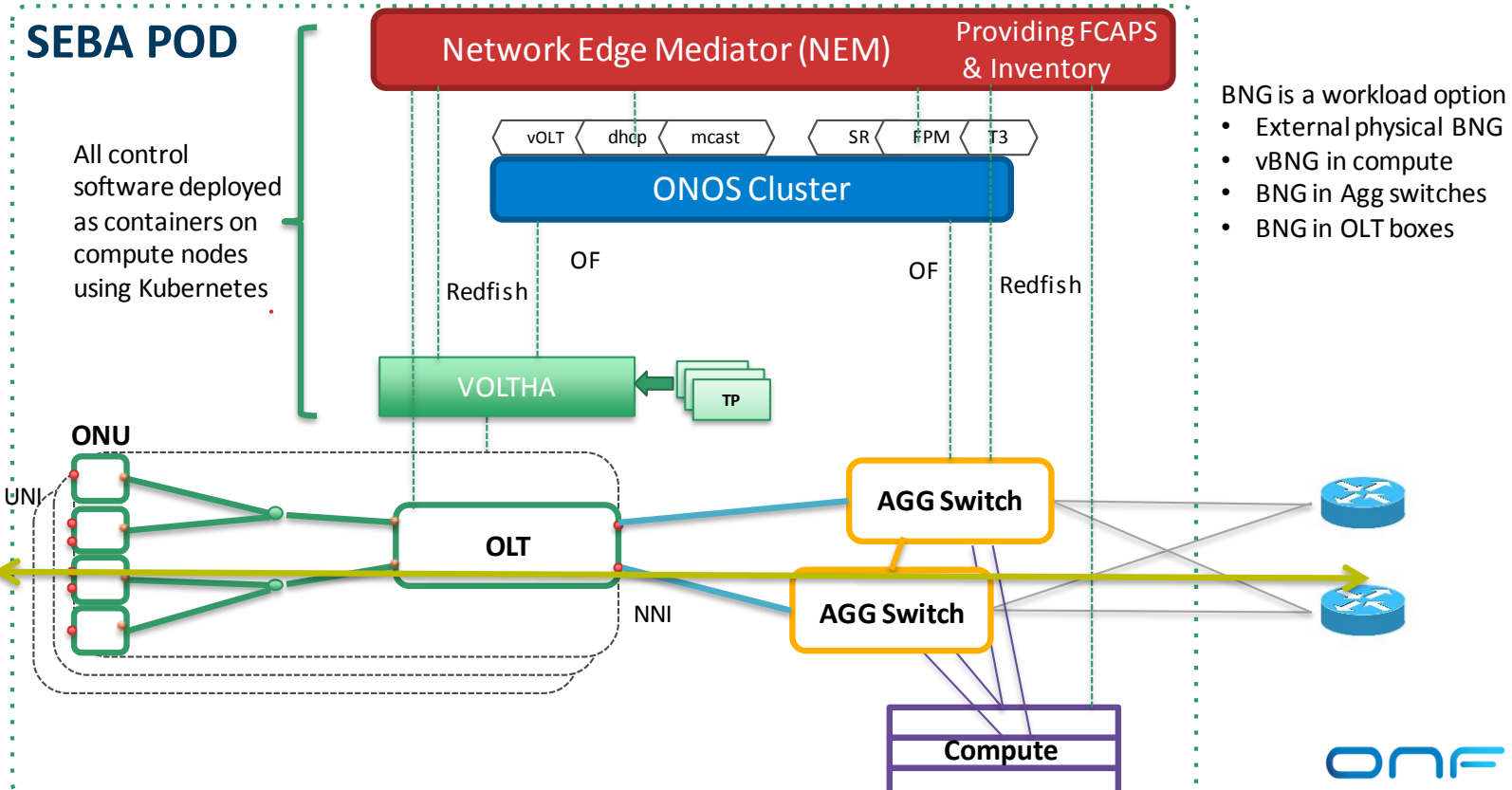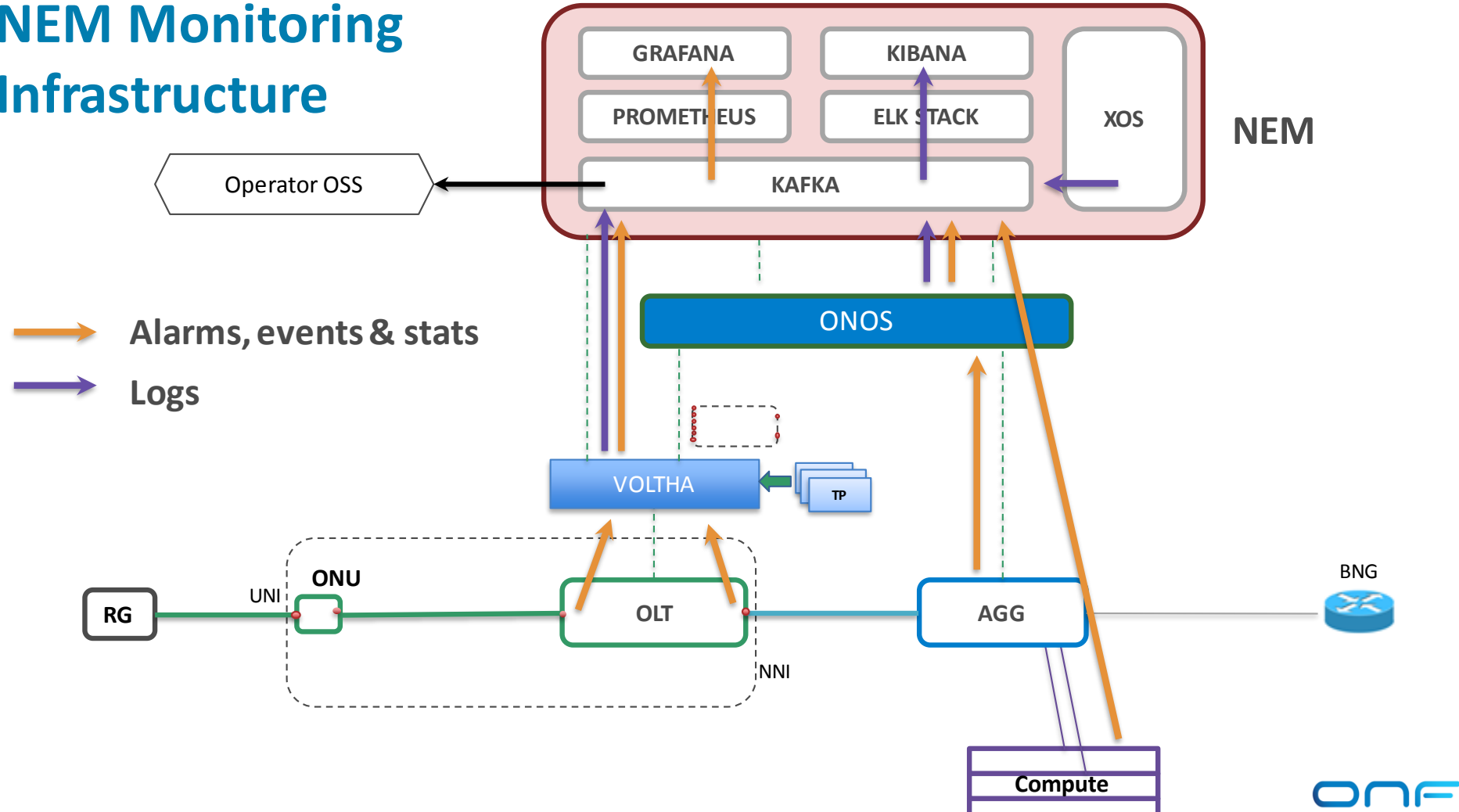| onos apps	workflow	VOLTHA	Runtime config & service instantiation

ONOS	Grafana	ELK	Kafka	Prometheus	XOS	profile

Kubernetes

OS | OS | OS

Bare metal server | Bare metal server | Bare metal server

Management network

Access Node — OS

Dataplane network

Leaf — OS

Leaf — OS

Upstream

Spine — OS

Spine — OS

#OpenCORD
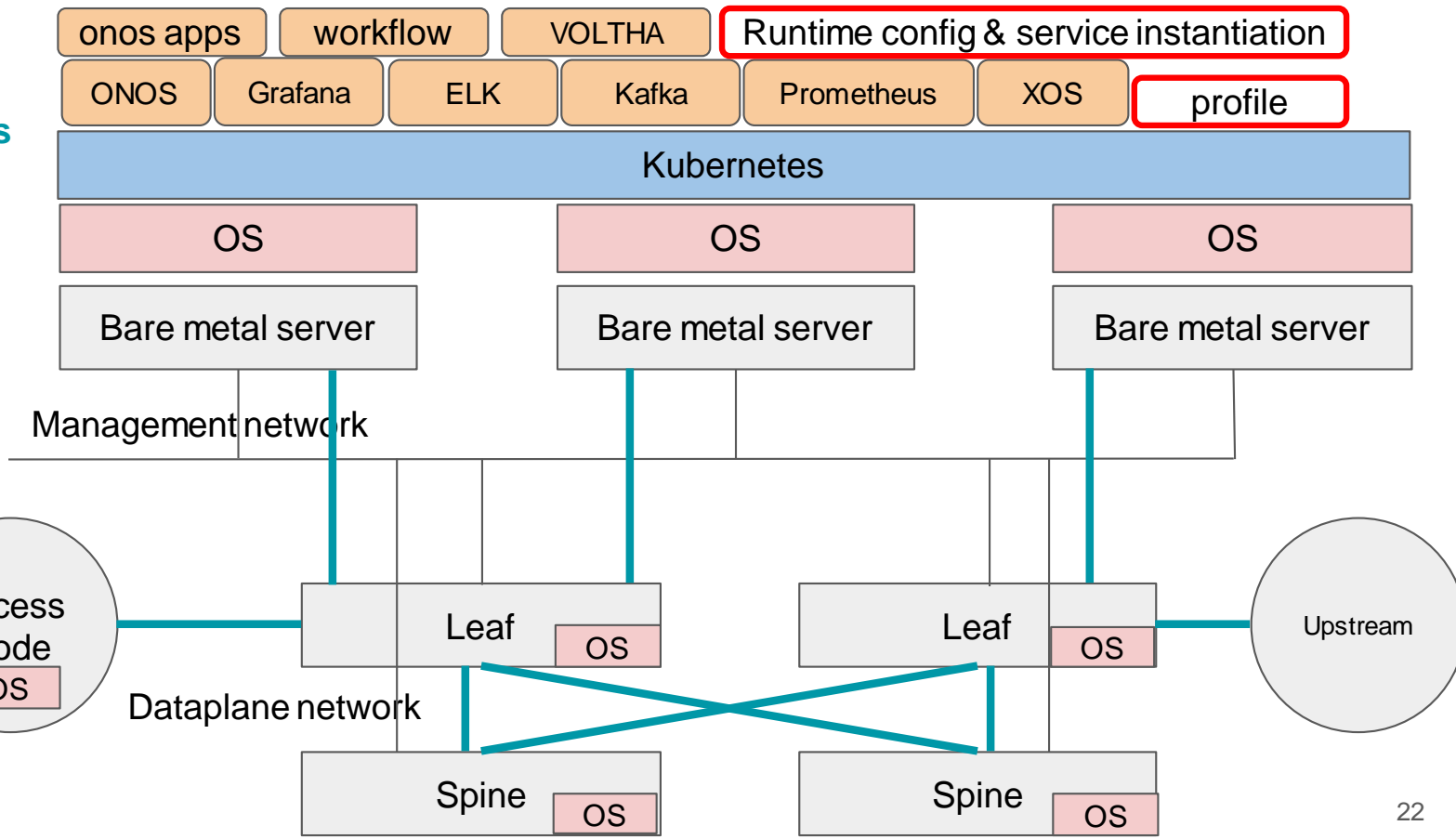
SEBA Exemplar Implementation

SEBA Exemplar

Built on the new CORD platform

NEM Workflows

SEBA POD

All control software deployed as containers on compute nodes using Kubernetes

Network Edge Mediator (NEM)

Providing FCAPS & Inventory

vOLT dhcp mcast   SR FPM T3

ONOS Cluster

OF

Redfish

OF

Redfish

VOLTHA

TP

BNG is a workload option
- External physical BNG
- vBNG in compute
- BNG in Agg switches
- BNG in OLT boxes

ONU

UNI

Subscriber traffic 'fast-path' to Internet

OLT

NNI

AGG Switch

AGG Switch

Compute

ONF

NEM Monitoring Infrastructure

Demo setup BBWF 2018

ONF Booth (Hall 22a, Booth B116)

NEM User Interface: runtime service instantiation, inventory, workflow status

NEM Monitoring Dashboard: stats, events, logs (FCAPS)

Demo setup BBWF 2018
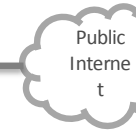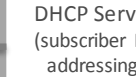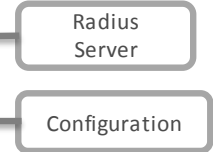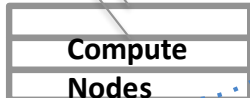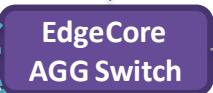
Demo setup BBWF 2018

ONF Booth (Hall 22a, Booth B116)
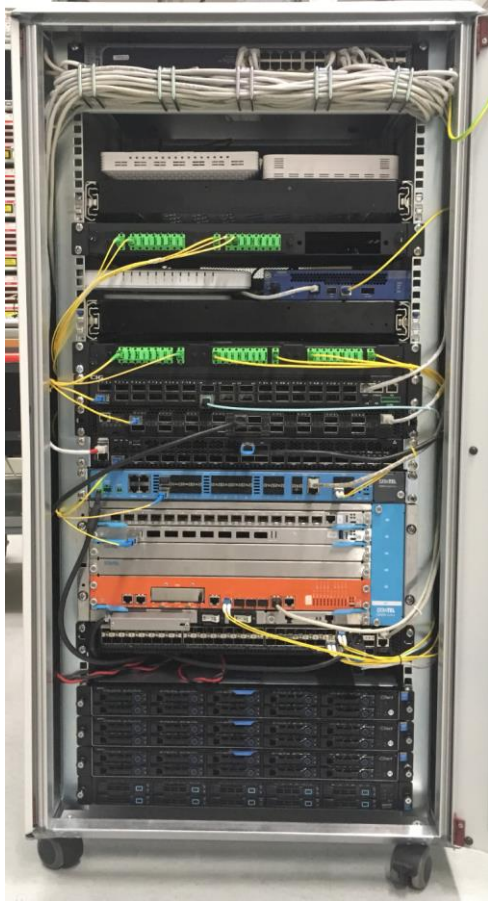
ONUs: Arcadyan, Alpha, Adtran, CIG, Iskratel

OLTs: Adtran, CIG, EdgeCore & Iskratel

AGG switch: EdgeCore

Servers: VOLTHA, ONOS, XOS, K8s, ELK, Docker, Prometheus, Grafana, Kibana

SEBA Development & Roadmap

Distributed DevOps - SEBA
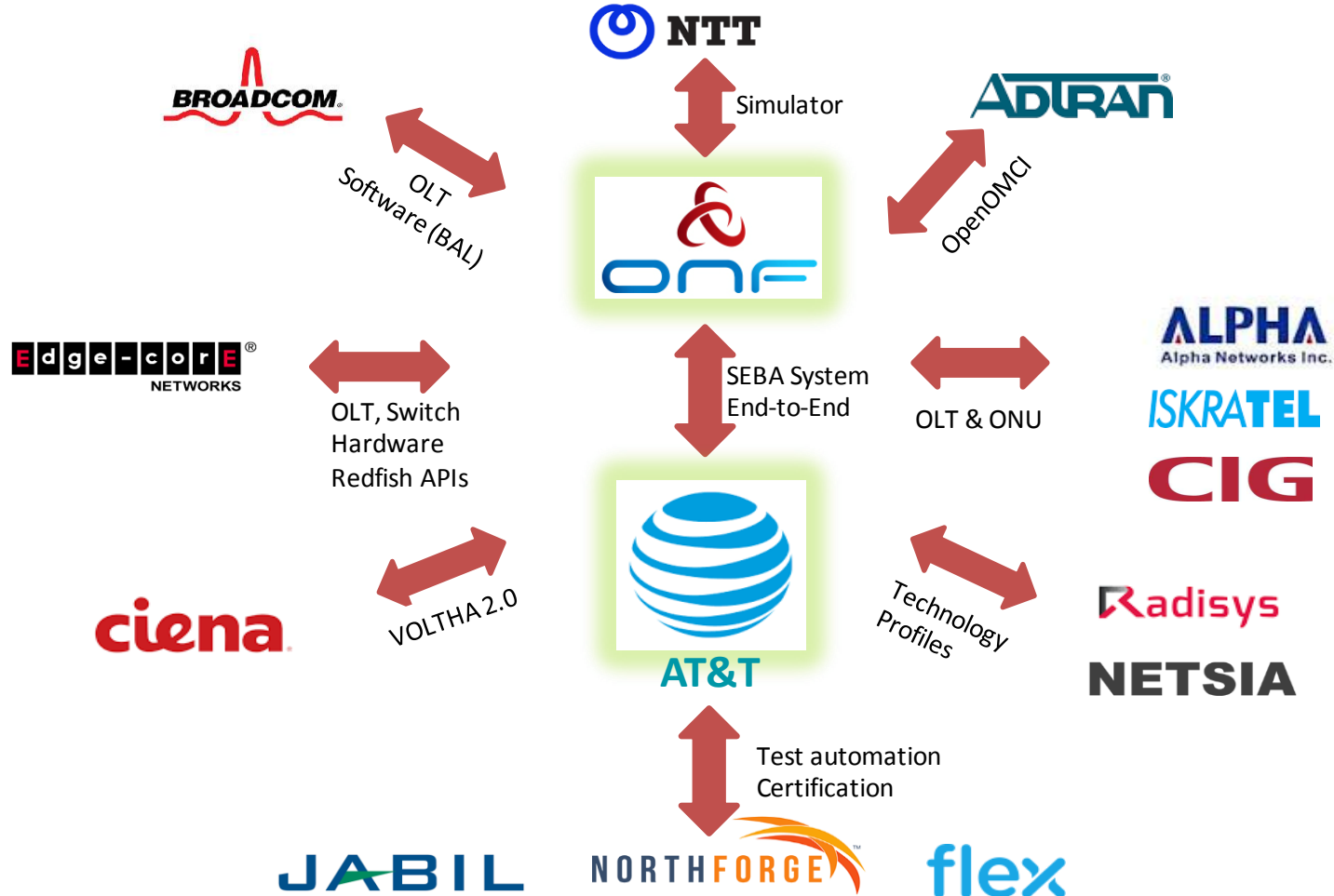
SEBA Distributed DevOps – ONF Responsibilities

Joint Development with AT&T Foundry
- **Daily scrum**
- **Bugs -** issue analysis; root-cause;
- **Design discussions** for new features
- Documentation
- **Recommend best-practices**/training

Support VOLTHA/SEBA Community
- **Weekly SEBA public meetings**
- **JIRA issues** – kanban methodology
- **Mailing lists, Slack community** support
- **VOLTHA meetings**, TST, architectural guidance

Deliver New Features
- ONF team resposible for all **ONOS and NEM feature** development
- **FCAPS features** – kpis, alarms & logs in SEBA monitoring infrastructure
- **AT&T workflow** development
- **Integrate** with new ONU and OLT vendors
- **AGG switch** features

SEBA/VOLTHA Stability & Scale
- Focus on **stability of VOLTHA –** robustness and repeatability
- Investigate **scalability and performance** of full SEBA system

Tooling
- **BBSim** – Guide NTT in the development of PON simulator
- **SEBA-in-a-BOX**: Complete end to end emulation of SEBA system with ponsim & mininet

QA
- Developing **automated feature tests**
- Extending framework for **hardware based end-to-end tests**
- Work with community to develop test automation and certification procedures

SEBA Deployment Goal @ AT&T

Up to 64 ONUs per PON port

ONU+RG

ONU+RG

ONU+RG

SEBA POD

Internal GE Management Switch

Up to 16 PON ports / OLT device

EdgeCore OLT

EdgeCore OLT

EdgeCore OLT

Up to 16 OLT devices

EdgeCore OLT

AGG Switch (Tomahawk 32 x 100G)

Compute Node

Compute Node

Compute Node

VOLTHA, ONOS, NEM, Kubernetes, Docker registry, **Gateway VM Abstract OLT**

AT&T External BNG

DHCP Server (subscriber RG addressing)

DHCP Server (POD addressing)

Radius Server

External OSS

Public Internet

ONF

Roadmap

- *BNG Disaggregation*

- *Using P4 in Aggregation switch*

- *Implementing more operator workflows*

- *Performance & scale improvements for Trials*

- *Redundancy*

- *Integrating VOLTHA 2.0 & Technology profiles*

- *ISSU*

- *Integrating M-CORD profile to use SEBA as mobile backhaul*

Summary

- ## ONF: Operator driven curated open source
  - *CORD is the flagship umbrella project*
  - *SEBA exemplar implementation is built on the CORD platform*

- ## Components:
  - *VOLTHA abstracts the PON as a quasi-Ethernet switch to the SDN controller*
  - *Trellis manages a multi-purpose leaf-spine fabric*
  - *VOLTHA and Trellis compatible white-box OCP hardware*
  - *CORD: service delivery platform - set of Docker containers managed by K8s*

- ## SEBA: SDN Enabled Broadband Access
  - *SEBA – a profile instantiated on CORD, jointly developed by ONF, AT&T & community*
  - *NEM – northbound interfaces for integration with operator backends*
  - *Significant focus on FCAPS infrastructure*
  - *Multiple operator workflows*
  - *Headed to trials at AT&T, significant interest from operators worldwide*