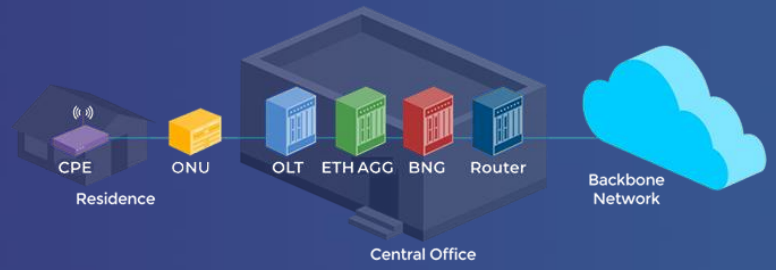
DENOG 14

GERMAN NETWORK OPERATORS GROUP

An Open Disaggregated Solution for PON FTTH



eps ipinfusion Radisys rtbrick Edge-corE NETWORKS

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Speakers

Barry McGinley
Senior Systems Engineer for EMEA at EPS Global

Prathap Thammanna
Senior Sales Engineer at Radisys

Lalit Kumar
Solutions Architect at IP Infusion

Christian Giese
Lead Developer & Professional Services Engineer at RtBrick

Agenda

14:30	Welcome and Introduction
14:40	History of Disaggregation
15:00	ONT, OLT, and management aspects of the PON network
15:40	Natural Break
15:50	vBNG and demo
16:30	Software enabling aggregation, routing, and backhaul
17:10	Questions & Answers / Wrap Up

History of Open Networking

Barry McGinley
Senior Systems Engineer for EMEA at
EPS Global

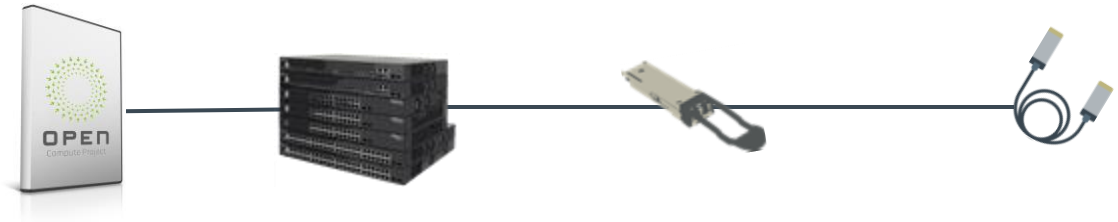
Open Networking Solutions

EPS Global has partnerships with all the leading hardware and software vendors in the open networking ecosystem, and our engineers can advise you on the best product set to suit your business needs, offering software configuration and bundling of hardware solutions for hassle-free, consolidated shipments.

Network Operating Systems

Pluribus Networks · SONiC · PICA8 White Box SDN · ip infusion · DriveNets Network Rising · kaloom · ARRCUS · The Linux Foundation · rtbrick · ONL · Open Networking Foundation · apstra · netris.ai · VOLTA Networks · exaware · netElastic systems

Turnkey Solutions from a Single Source



Software + Switch — Transceivers — Cables

Global Tech Support

Beginnings

- 2009 with Facebook
- Redesigned software, servers, racks, power supplies and cooling
- 38% more energy efficient and 24% less expensive to run
- Facebook, Intel, Rackspace and Goldman Sachs create the Open Compute Project

Open Compute Project

Hardware specifications lead to → Designs → which lead to Products

Sharing IP maximizes innovation

Server, storage, rack & power, data center, networking, security and firmware

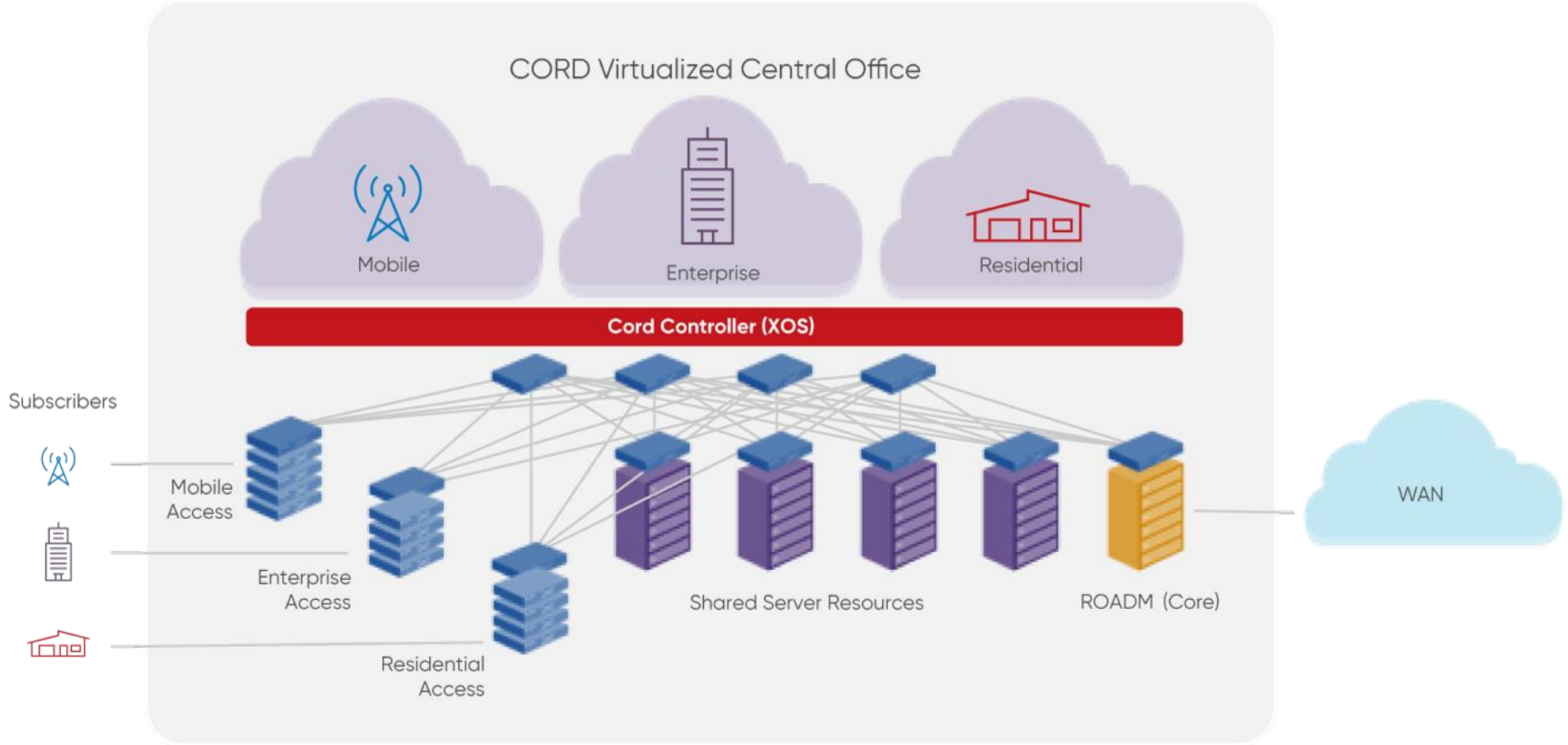
OCP Marketplace

Integrated Solutions

Close relationship with the ONF and TIP

Open Networking Ecosystem - ONF

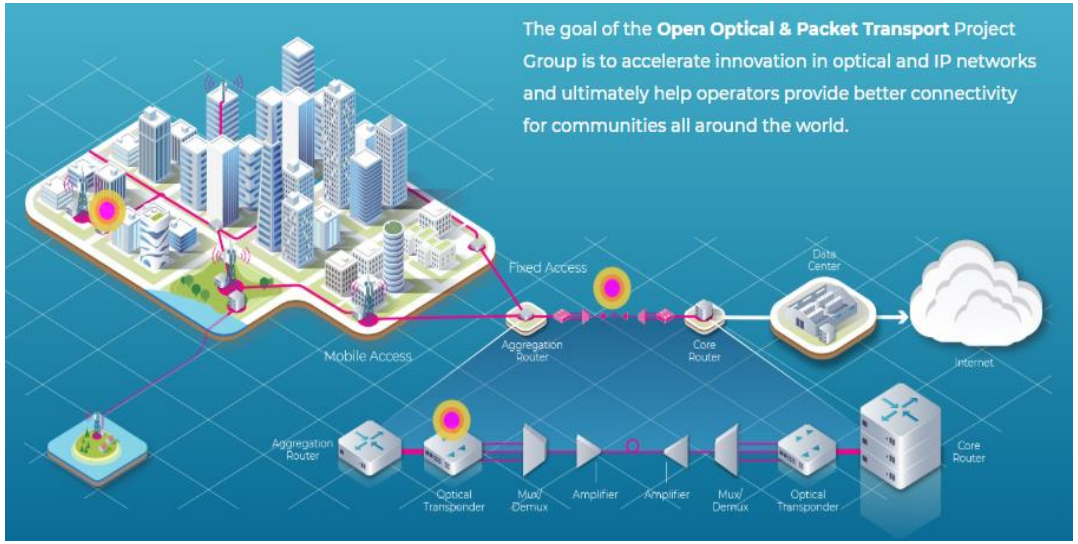
- **2011** – Decoupling data and control planes
- **2012** – Standardized the OpenFlow protocol
- **2014** – Released ONOS
- **2016** - Begins work on CORD
- **2019** – Released reference designs for SEBA, Trellis and ODTN.
- **2020** – T-Mobile rollout of OMEC, Comcast with Trellis and Turk Telecom with SEBA


CORD Virtualized Central Office
Mobile
Enterprise
Residential
Cord Controller (XOS)
Subscribers
Mobile Access
Enterprise Access
Residential Access
Shared Server Resources
ROADM (Core)
WAN

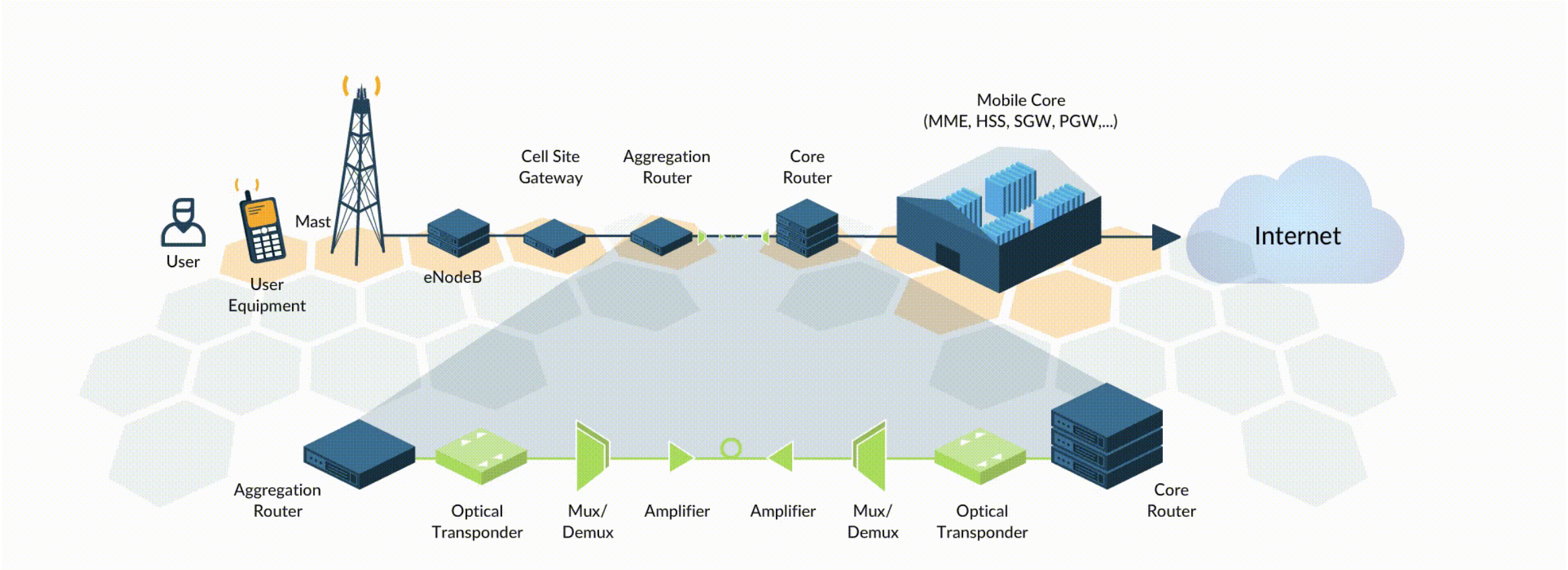
Telecom Infra Project

TELECOM INFRA PROJECT

- Founded 2016
- 3 distinct strategic areas: Access, Transport, Core and Services
- Access → OpenRAN, CrowdCell, vRAN
- Transport → OOPT, Wireless Backhaul
- Core and Services → Open Core Packet, End-2-End Network Slicing
- TIP Exchange



Open Optical & Packet Transport



Benefits of a Disaggregated Network

- Interoperability adhering to open standards, optics etc
- Customizability using open software
- Multiple suppliers of the bare metal
- Cost of hardware is cheaper
- Freedom of choice with no vendor lock in
- Software can evolve separately from hardware

Bare-metal, White-box & Brite-box

Bare-metal comes with ONIE

White-box comes with NOS installed e.g. IPI Pro

Brite-Box is white-box with a different label

Merchant silicon from Broadcom, Marvell & Barefoot

Edgecore Networks = Accton Technology

UfiSpace, Delta, Quanta and Celestica

Accton Technology and Edgecore Networks

Accton Technology

- The Leading Network ODM -Servicing Tier-1 Customers
- Founded 1988, IPO Taiwan 1995 (TWSE: 2345)
- $1.8B USD Revenue 2019, 5,145 Employees Worldwide
- 9 R&D Locations with more than 1,000 Engineers
- State-Of-The-Art High-Volume Manufacturing in Taiwan and China
- One Stop Shop!

Edgecore Networks

- Brand launched in 2004, wholly owned subsidiary of Accton
- Go-to-market business to network operators -DC, Telecom, and Enterprise
- Manages customer, partner and open community relationships
- Leading contributor of network designs to OCP, TIP participant, ONF –Charter Partner

Edgecore products

Cell Site Routers – CSR Series
For Mobile xHaul transport

Aggregation Routers - AGR Series
For Aggregation and Open
Broadband Network Gateway (BNG)

Core Routers - COR Series
For Distributed Disaggregated Chassis

GPON / XGS-PON OLT
For FTTx Broadband Access

Cassini Packet Transponder
For Metro and Long Haul Optical Transport

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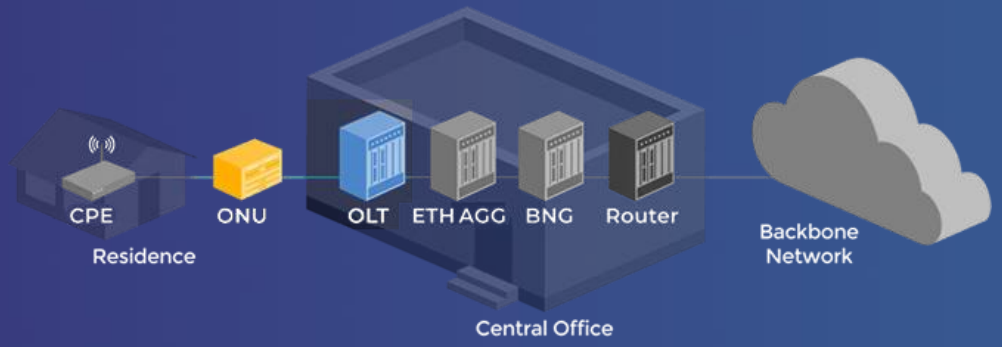
An Open Disaggregated Solution for PON FTTH



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Radisys

Openness, Disaggregation and Interoperability for Next-gen FTTx Networks

Prathap Thammanna
Senior Sales Engineer
at Radisys

Creating new digital experiences

Our Vision for the Networks of Tomorrow

Disaggregated

Software / Hardware
Network Functions
Control / Media

Intelligent

Software Defined
Programmable
AI/ML

Open

Software , Hardware, Interfaces

The Broadband Service Provider Dilemma

In a Digital Business Era

Networks Pushed to the Limit

Massive growth in connections and data usage

Eroding Margins & Dwindling ARPU

- Price compression
- Competitive markets
- Regulatory impacts

Capex and Opex must be optimized.

Lack of Agility and Vendor Lock-In

Proprietary solutions limit speed of innovation

Network Inflexibility

Introduction of a new vendor element can be a 6-month task due to OSS layer integration

Lack Of End-to-end Visibility & Common Management

This hampers troubleshooting and impairs upgrades

New Services on the Horizon

Edge applications like AR/VR, low-latency Enterprise apps

Driving the need for Broadband Access Transformation

What Do We Mean by Open Broadband?

Open Platforms
Reliance on Off-the-Shelf Platforms
Standards based interop with 3rd party

Open Software Defined Architecture
Separation of hardware and software;
Separation of Control and Media

Open Integration
Integration with OSS and vendor ecosystem through "Open" API

Open Standards
Leveraging Innovation from Key Open-Source Communities

Open Insights
Derived from best-in-class open network analytics

Leverages Multi-Vendor Solutions

Cost Efficient Network Growth

Accelerates Innovation

Scalable, Future-Proof Network

What is Disaggregation ?

Proprietary Management Tools

Vendor Software Stack

Integrated Hardware Platform

Custom ASICs

Legacy Solution

Programmable Merchant Silicon

Off the Shelf Server

Multi Vendor Software Stack

Open Management Tools

Disaggregated

- Evolution of solution from proprietary, closed hardware and software from single vendor to decoupled, open components from multiple vendors
- Concessions were made to based on the availability of the solution. With disaggregation, products could be tailored for the use cases by several mix and matches.
- No vendor lock-in, highly flexible and easily adaptable fitting into the SDN principles

The Evolution of Open, Disaggregated and Software Defined Networking

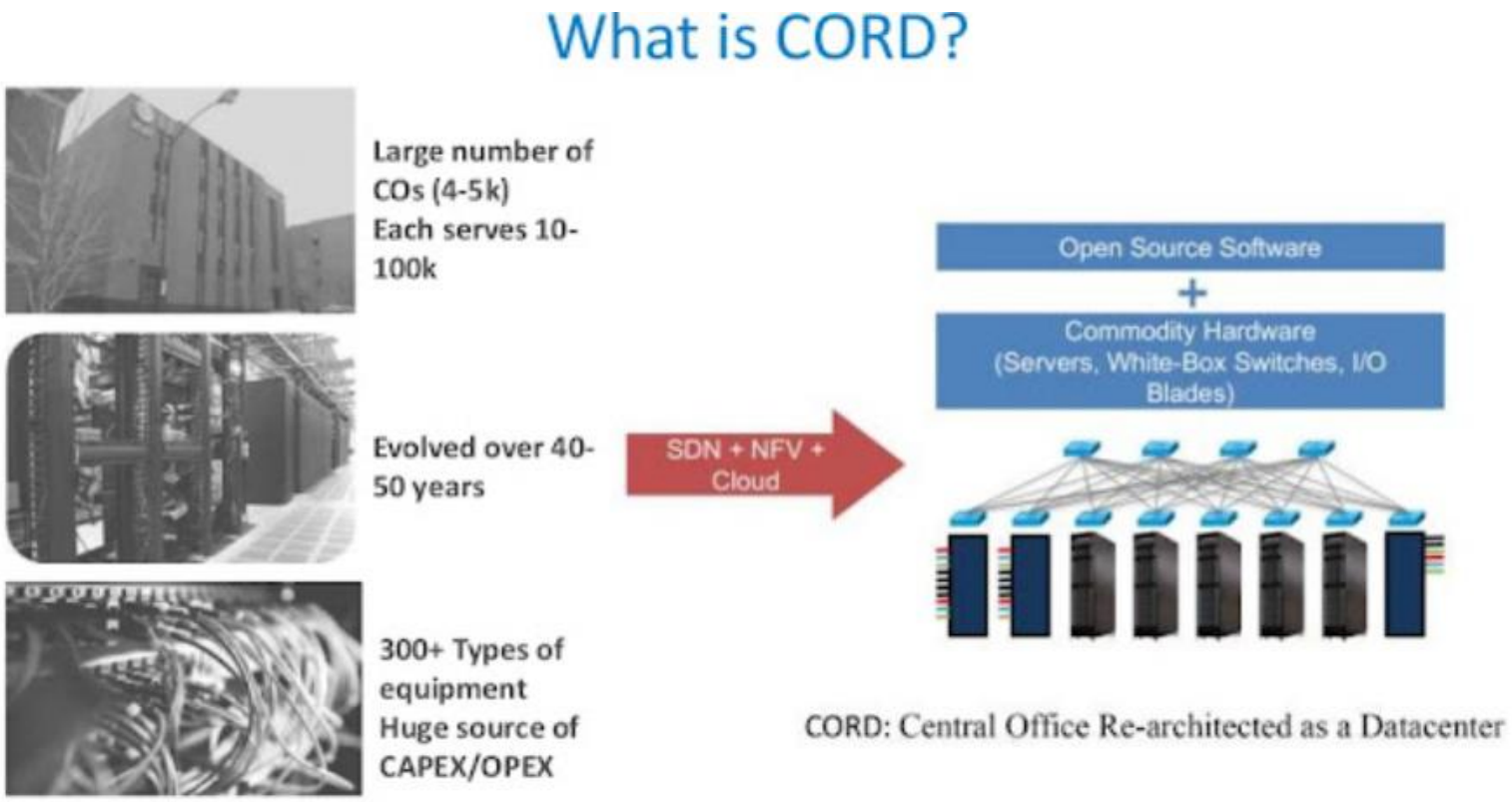
Open Networking Foundation

CORD

SEBA
VOLTHA

ONF projects are being used to build the next generation broadband infrastructure and services.

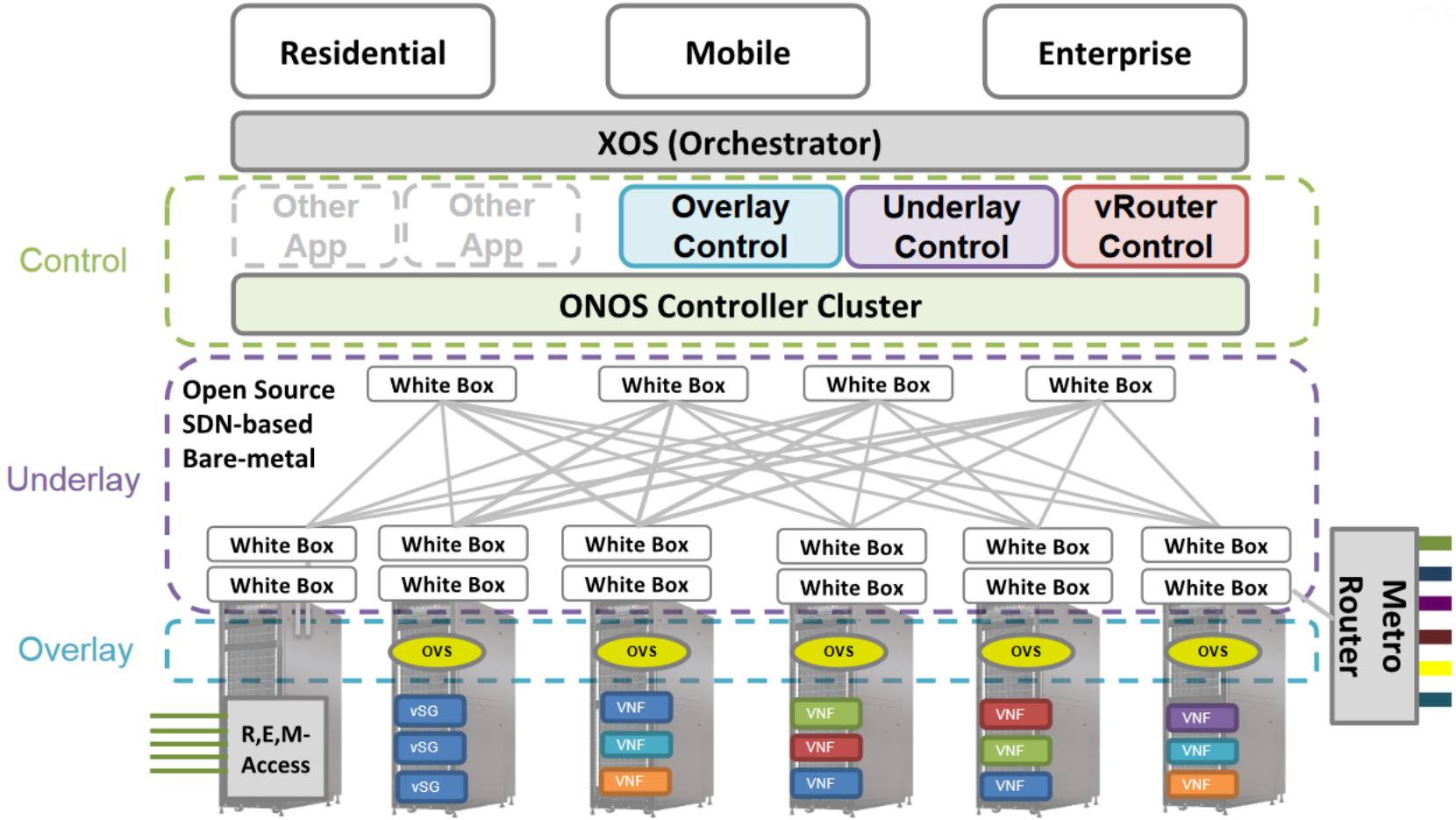
CORD – Central Office Rearchitected as Data Center



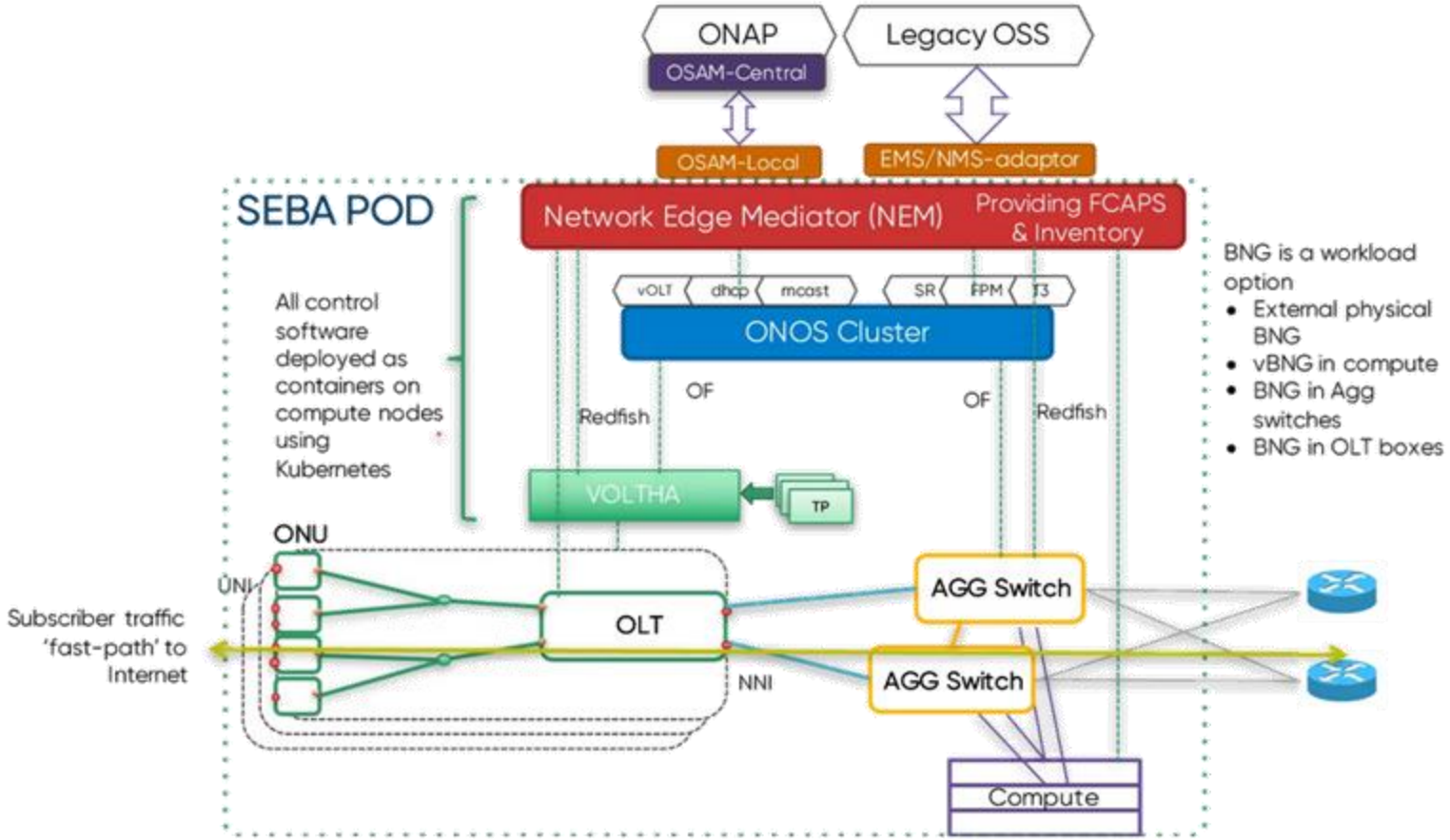
Legacy networks built using several discrete purpose-built hardware devices

Each of these devices is a source of complexity and considerable expense, for both Capex and Opex.

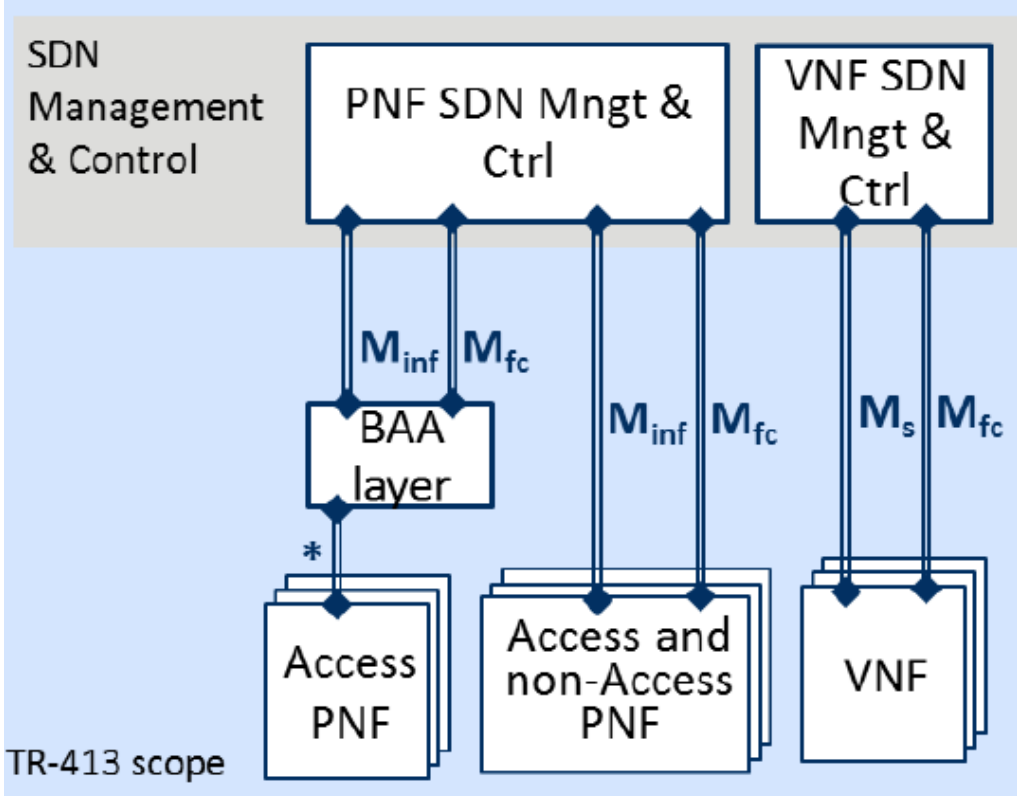
CORD Flavors – M, R, E



SEBA – SDN Enabled Broadband Access



BBF Defined Open Models



*Device-specific interface

CloudCO with Broadband Access Abstraction

Cloud CO Design principles:

- Software Defined Networking (SDN) and Network Functions
- Leverages commodity compute and networking platforms
- Virtualizes network functions that traditionally lived in monolithic devices
- Disaggregates physical network functions (L2/L3 data plane) using SDN
- Cloud-like APIs for Self-Service 3rd party service on-boardingand delivery

BAA:

- Provide abstraction that is vendor independent and also, technology independent
- Minf This is the reference point for FCAPS on infrastructure NEs in the MSBN.
- Mfc This is the reference point for Flow Control of NFs This is between SDN Manager & Controller and the Network Functions

connectopen BROADBAND

Connect Open Broadband is a comprehensive broadband access solution with a full spectrum of software and hardware components

Software Management (x86)

Radisys Management System

Network Management System

Software Control (x86)

Connect Broadband Access Controller

PON Control and Management Software

Hardware with Embedded Software

Connect OLTs

Whitebox Hardware with Broadcom Merchant Silicon and Intel Microprocessor

Connect ONTs

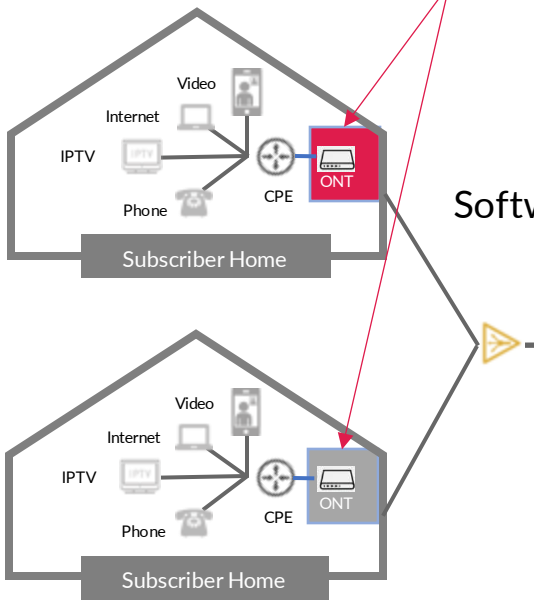
Supporting Open OMCI

Open and Disaggregated Architecture

connectopen BROADBAND

Disaggregated Access Solution Enabled by Open Interfaces and Open-Source Software

- INTERNET
- IPTV
- VOICE
- VIDEO



Software

OSS/BSS/MANO Platforms

Radisys Management System (RMS)

Rest API/Open Interface

broadband forum

Aggregating service orchestration at the management layer

Connect Open Broadband Controller

Microservices (Control & Mgmt.)

SDN Controller

VOLTHA*

OPEN OLT Adaptor*

ONF Open Networking Foundation

SEBA VOLTHA

Disaggregating the control plane from the OLT

Open OLT Interface

*Open Source (ONF)

Hardware

White box OLT

Radisys OLT

Hardware Access technology independent (GPON, XGS PON, Combo PON, 25GS, 50G etc.)

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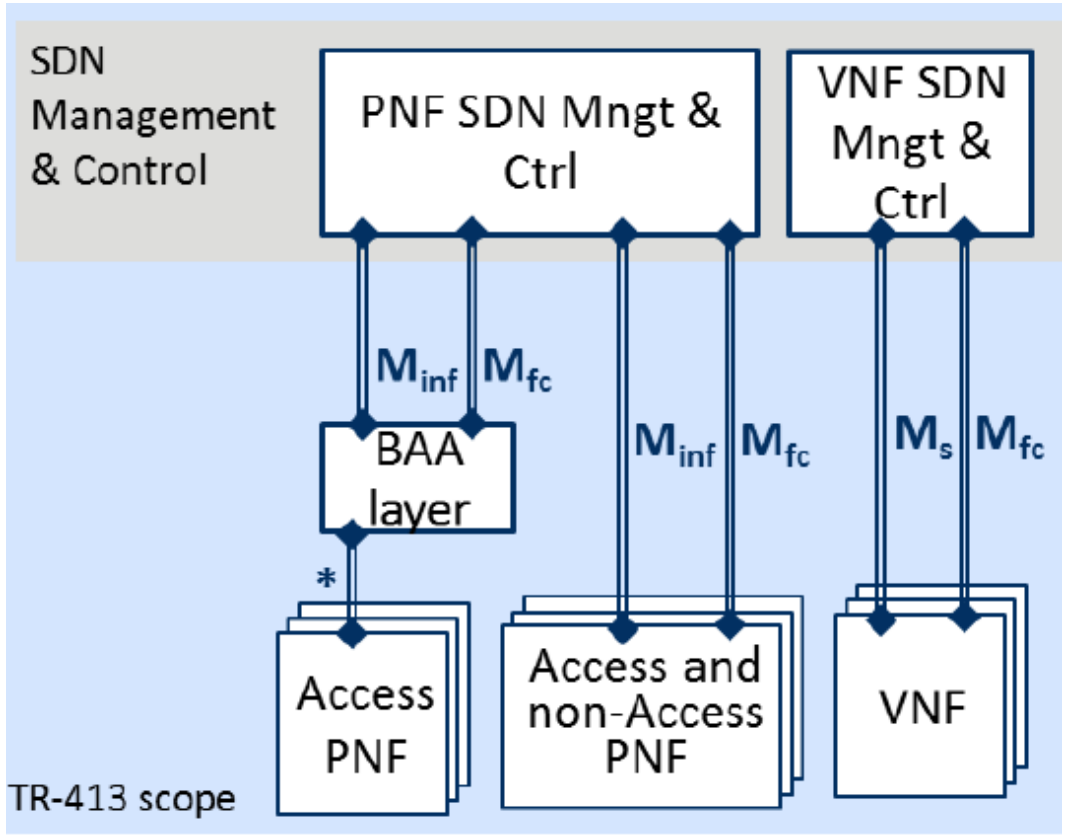
Where CBAC Fits within the TR-384 CloudCo Model

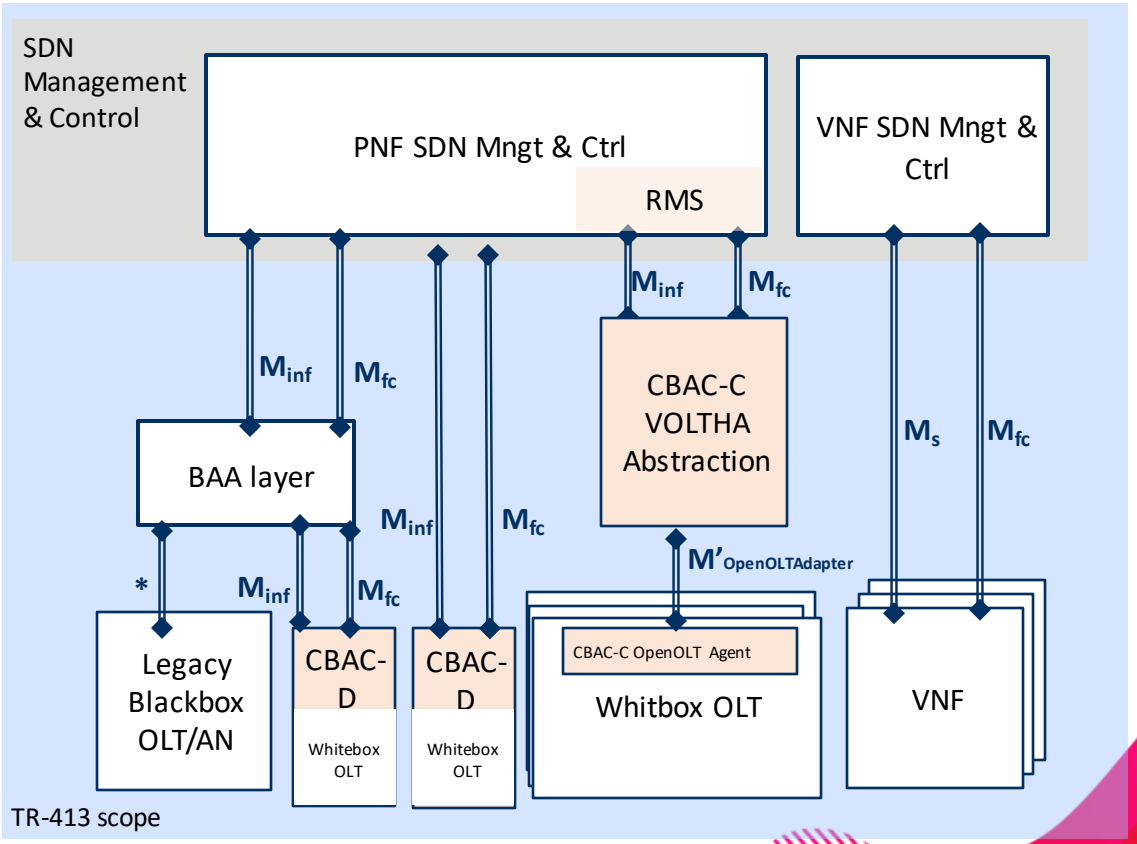
(BAA Management Abstraction for Legacy OLTs and the VOLTHA Abstraction and support for Whitebox OLTs)

TR-384/TR-413 Model



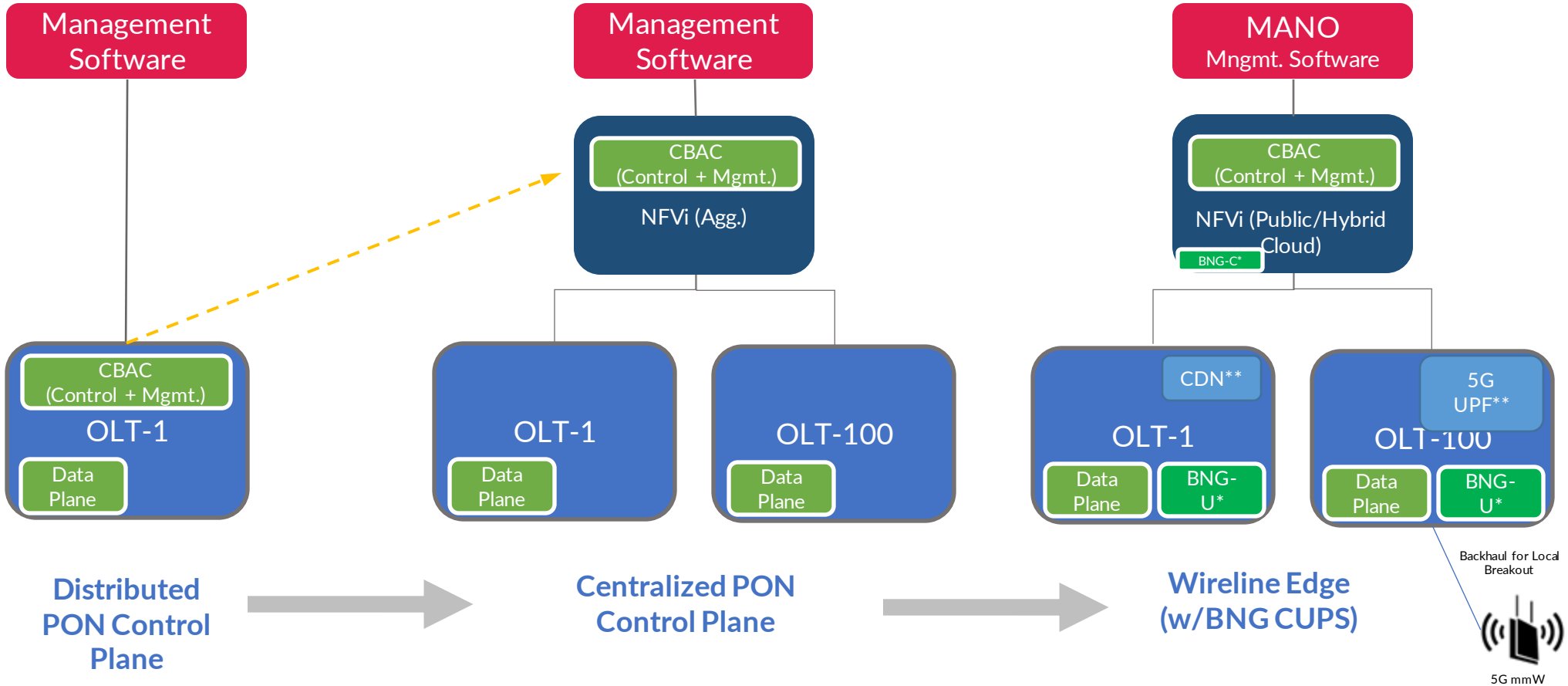
*Device-specific interface

CBAC-C and CBAC-D Alignment with CloudCo

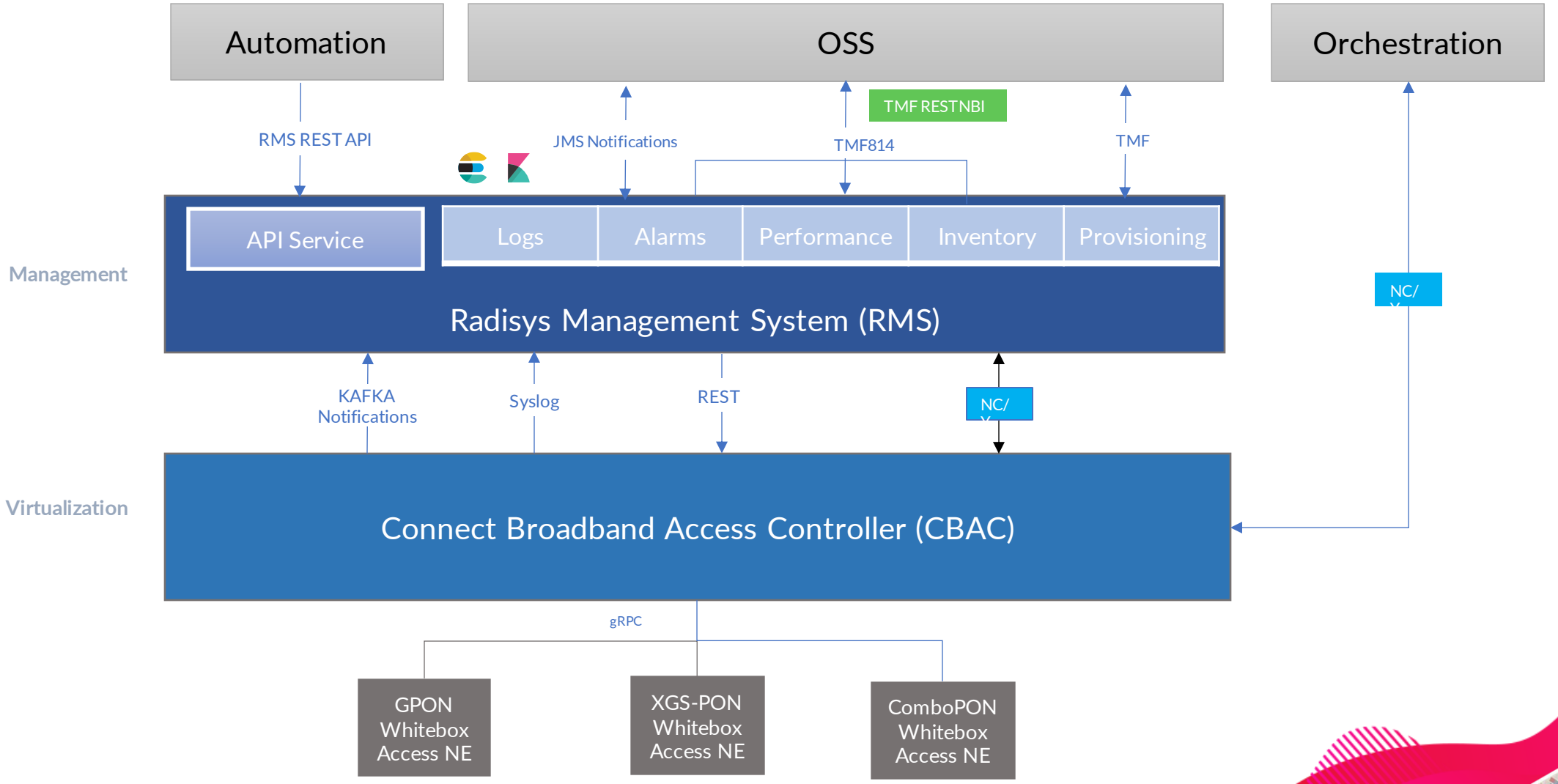


Example Architecture Evolution

Converged Disaggregated Edge



OSS and Orchestration Integration



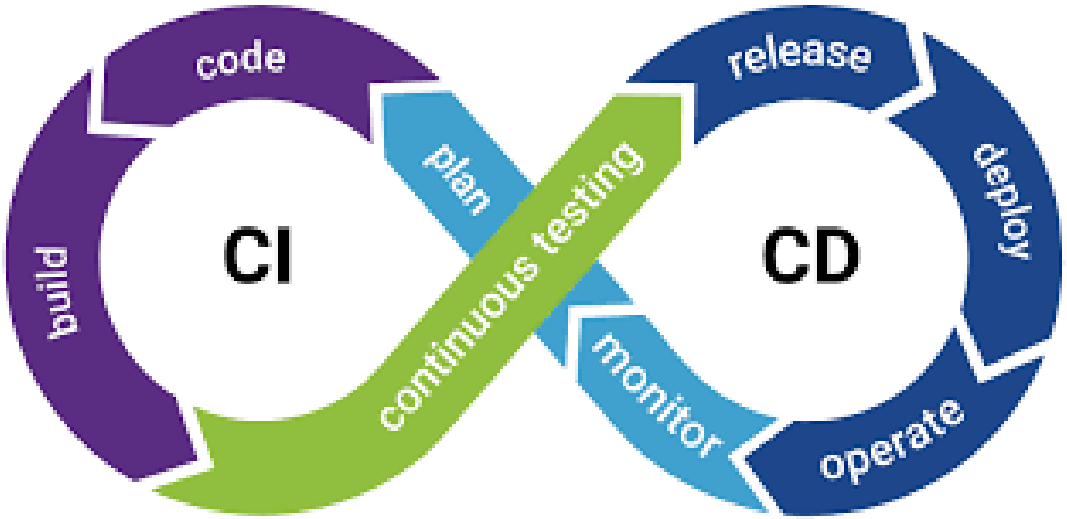
OLT Portfolio: G-PON, XGS-PON and C-PON

G-PON	Any-PON (G-PON **or** XGS-PON)	C-PON (G-PON **and** XGS-PON)
 RLT-3200G 32 Port GPON (GA)		 RLT 3200C 32 Port Combo PON (Q2, 2021)
 RLT 1600G 16 Port GPON (GA)	 RLT 1600X 16 Port GPON/XGSPON (GA)	 RLT 1600C 16 Port Combo PON(Q2, 2021)

How to effectively deliver the Open solutions based on modern frameworks: Continuous Integration, Continuous Delivery and Deployment (CICD)

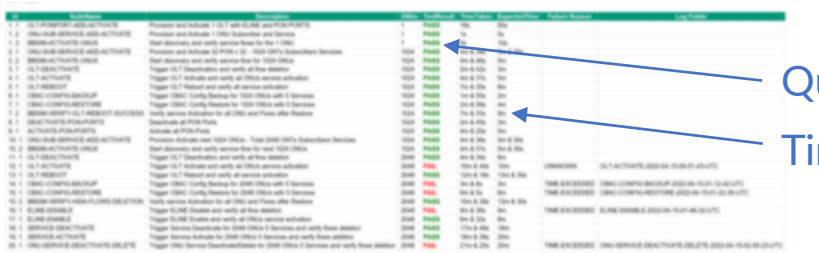
Quality & Speed

- “Nightly Build” (L4)
- Automated tests
- “Succeed or fail” fast



Speed & Non-stop Operation

- Deploy micro-updates
- Automate updates
- No disruptive updates

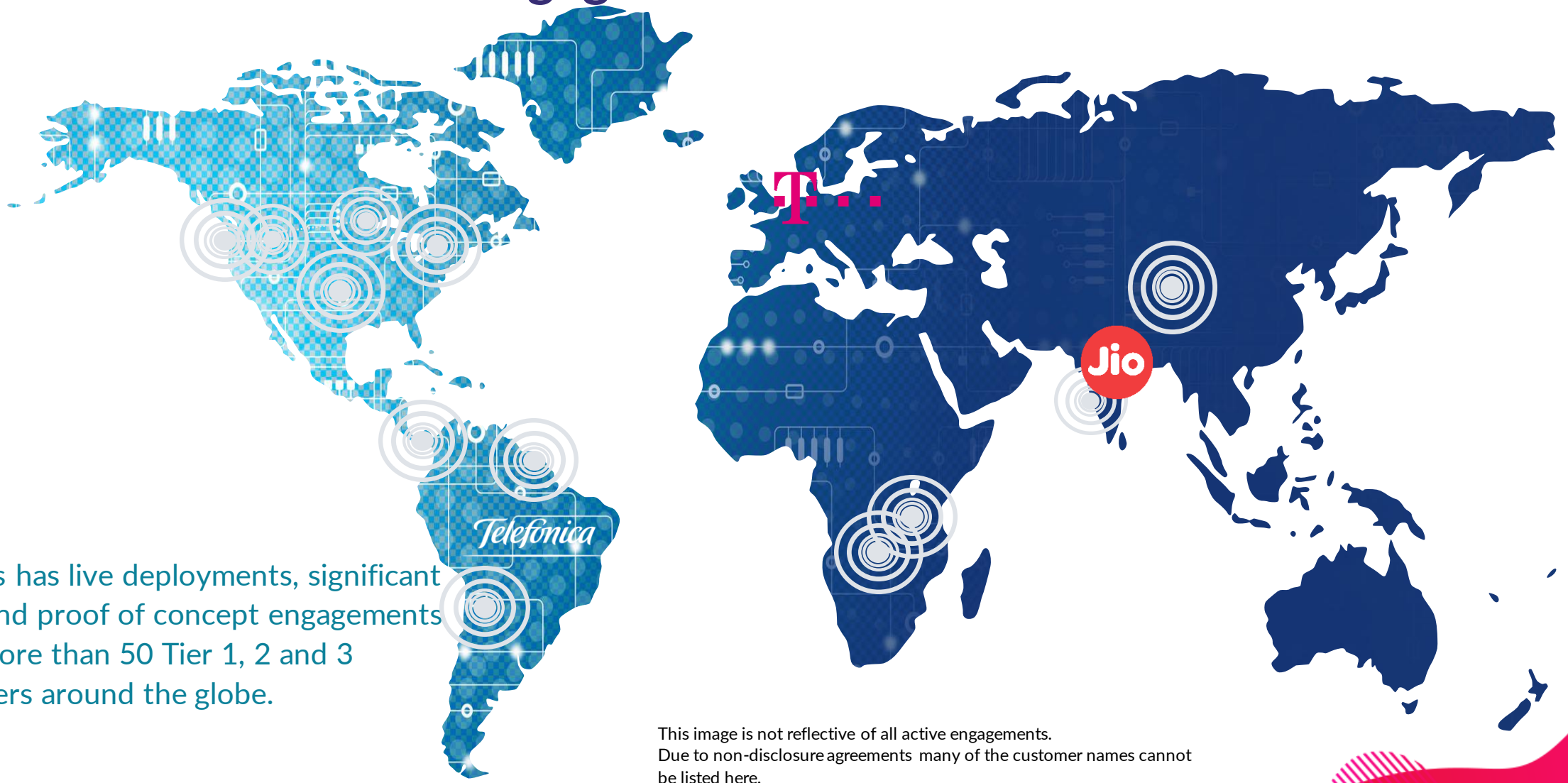


Quality Results

Time it took (performance)

- “Kubectl instead of night shifts”

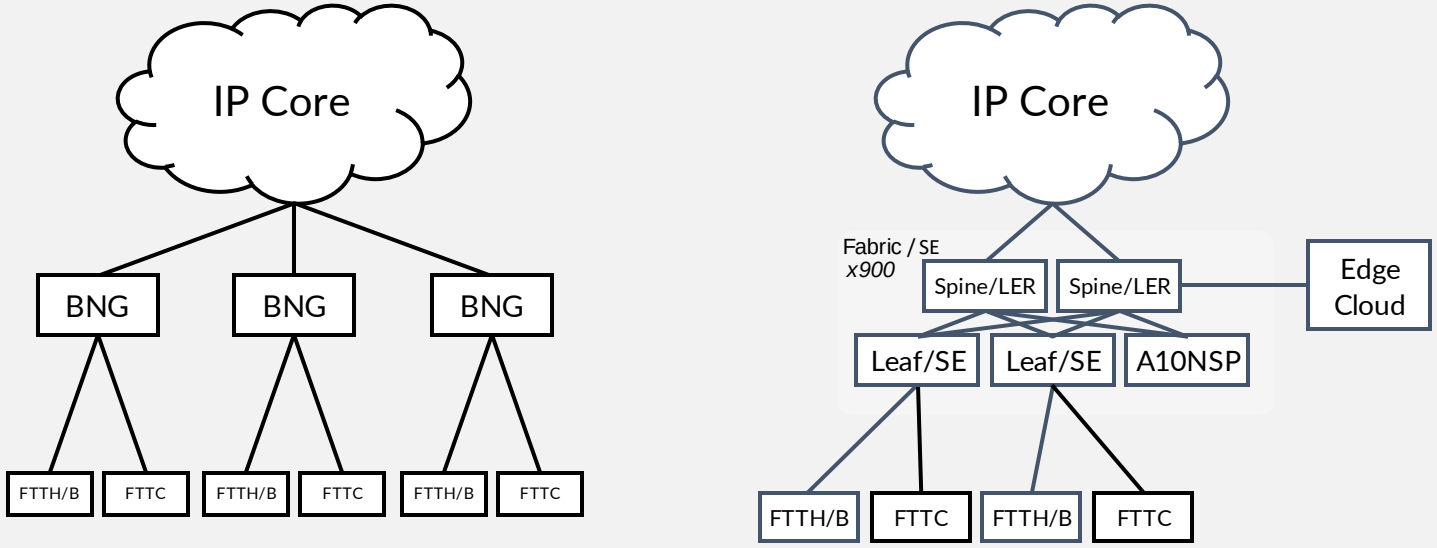
Active Customer Engagements



Radisys has live deployments, significant trials and proof of concept engagements with more than 50 Tier 1, 2 and 3 providers around the globe.

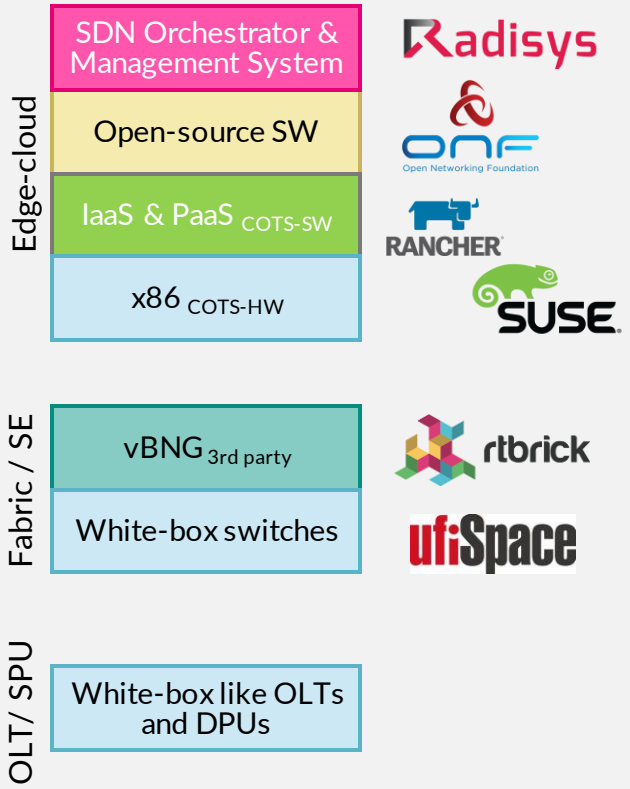
This image is not reflective of all active engagements.
Due to non-disclosure agreements many of the customer names cannot be listed here.

Radisys in DT A4.0



Transformation / MIGRATION

The A4 Ecosystem



Radisys Connect Open Broadband Solution Benefits

Open, Disaggregated Broadband Access

OPEN NETWORK DESIGN Enabling OLT Vendor Neutrality and Deployment Flexibility
- Best in class HW/SW sourcing
- Optimal CAPEX with merchant silicon

MICRO-SERVICES ARCHITECTURE Enabling On Demand Scaling and Deployment Agility
- Bring new services to market faster

ACCESS NETWORK AGNOSTIC – GPON/XGSPON/NG-PON2

CENTRALIZED MANAGEMENT Enabling Flexible Tiered Services and Network Slicing
- Sharpen fault detection and isolation

SERVICE AGILITY & OPEX SAVING with Highly Programmable SDN Control
- End-to-end orchestration
- Add new network functions on demand with economies of scale

NETWORK HARDENED SOLUTION aligned with Open Communities

FUTURE PROOF with Cloud Native Design
- Lower your cost and simplify management
- One-touch provisioning for faster upgrades

PATH TO AUTOMATED NETWORK OPS with AI based management
- One touch provisioning for faster upgrades

	Indoor	Outdoor
GPON	 ES4001 ES4101  PM4244  ES4002  PM4204 PM4244  PM4264 PM2264 PM5264	 ES4101H / ES4202H / ES4204H
XGS-PON	 ES6001 ES6101 ES6004  ES6005 ES6007  EL6264T EL3274 EL6274T	 ES6101H / ES6202H / ES6204H / ES6001H / ES6004H

SEGMENTS	Essential	Premium	Elite	Enterprise
				

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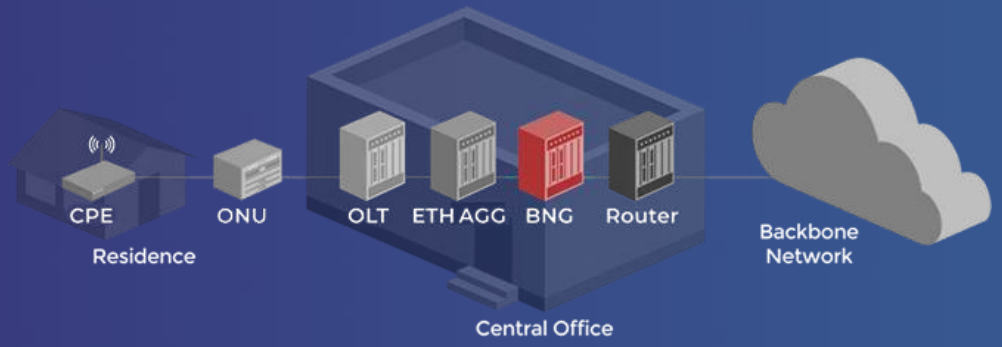

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The Open BNG

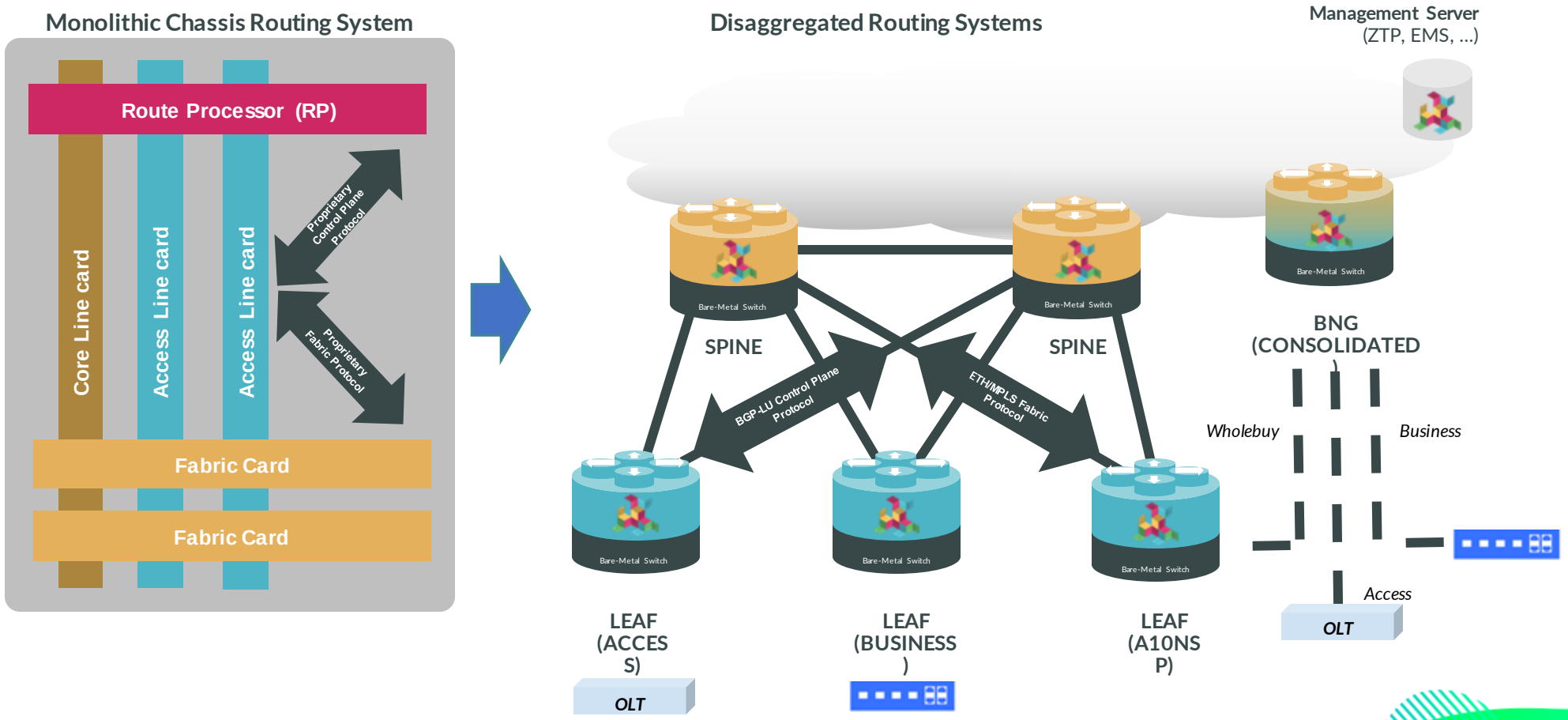
Christian Giese
Lead Developer & Professional Services Engineer at RtBrick

Legal Disclaimer

This presentation shows products or features that may not be finalized or released. All information is preliminary and may change before final product releases or in future releases. Unless otherwise indicated, this presentation has not completed all technical approval cycles.


rtbrick
Full Stack

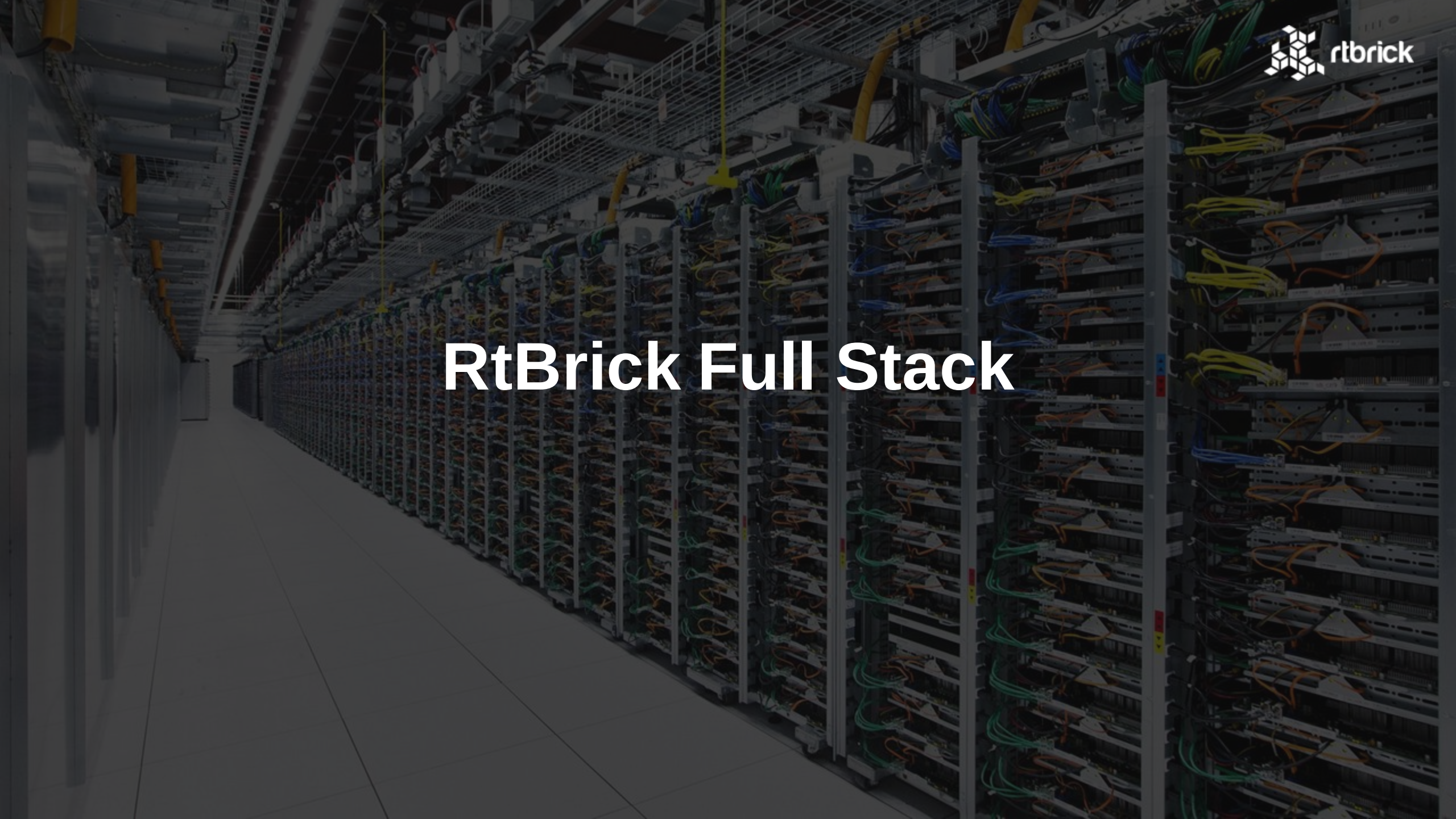
Disaggregation, the same but different …



There is no one-size-fits-all …

We provide roles for different use case, each with an optimized chipset configuration!

	Spine (Core)	Leaf (Access)	Wholesale (L2BSA/A10NSP)	BNG (Consolidated)
Optimized for …	Routing	Access	Wholesale	Routing & Access
Fabric (BGP/MPLS)	X	X	X	X
Routing (ISIS, OSPF, Segment Routing, LDP …)	X	-	-	X
QoS (H-QoS, Policer, …)	X	X	X	X
Access (PPPoE, L2TP, IPoE, …)	-	X	-	X
DHCP Relay	-	X	-	X
L2X	-	X	X	X



RtBrick Full Stack

RtBrick Full Stack

Routers today…

- Integrated systems
- Monolithic
- Software locked to hardware
- Inflexible and expensive

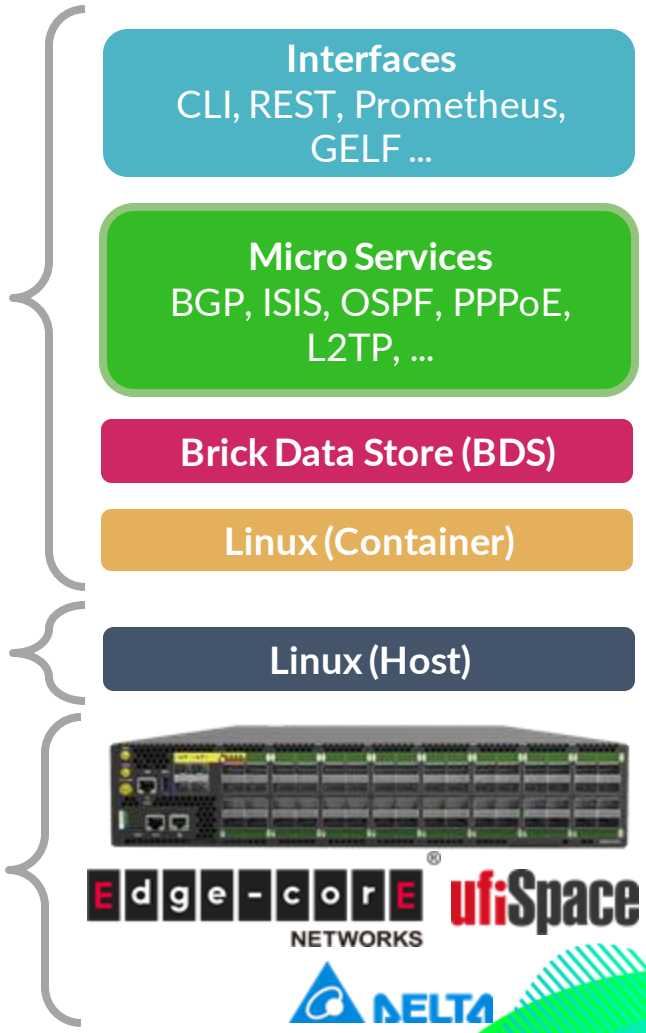
RBFS Container

- Programmable
- Scalable
- Carrier grade
- State of the art routing and access protocol stack

RBFS Helper

- Control Daemon
- API Gateway Daemon
- Zero Touch Provisioning

Off-the-shelf “bare-metal” switches



Supported Features and Hardware

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RBFS Feature Overview

Platform

- ✔ Ubuntu LTS, LXC Containerized, Qumran-2C/A, Qumran-AX, ONL Host
- ✔ Interfaces (1/10/25/100G/400G), DAC, Breakout Ports, Statistics, DPDK
- ✔ VPP, Host Path Protection, IPv4 Fragmentation

Access

- ✔ PPPoE with single, double and untagged VLAN, N:1 and 1:1, dual-stack IPv4/6, remote and local authentication, session and idle timeout
- ✔ L2TPv2 LAC with support for MPLS and RFC5515 (partly)
- ✔ IPoE with DHCPv4 and DHCPv6 Server
- ✔ RADIUS Authentication, Accounting (time/volume) and CoA
- ✔ RADIUS Control for services, QoS and IPTV
- ✔ RADIUS Filters (Ascend Data Filters)
- ✔ L2BSA / A10-NSP (L2 Wholesale)
- ✔ HQoS for physical/logical interfaces and subscribers, Classifiers (BA/MF), Policers (TrTCM, Multi-level), Remarking, Scheduling (Multi-level, SP, WFQ, FQ, Hybrid), Shaping, Queuing …
- ✔ Lawful Interception for PPPoE, L2TP and IPoE (UDP/BCOM SHIM Header)
- ✔ Traffic Mirroring
- ✔ Local/Remote Cross Connect (L2X) of tagged traffic with VLAN translation

…and many more!

Protocols

- ✔ BGP, MP-BGP, IPv4/6, IPv4/6 LU, VPNv4/6, 6PE, MVPN, Communities (Extended, Large), Multi-Hop, Route Refresh, VRF, Route Reflection, 4-Byte AS, Segment Routing, Add Path, ECMP, Auth. MD5/AO, Route Policy, PE-CE as Static, eBGP, ISIS, Carrier-of-Carriers Option A, B and C
- ✔ ISIS, IPv4/6, VRF, Segment Routing, Anycast, ECMP, Flood Filtering, PoI TLV, Crypto. Auth.
- ✔ OSPFv2, IPv4, P2P, LAN, Segment Routing, Crypto. Auth.
- ✔ Static, IPv4/6, MPLS, Multicast, Community, VRF, ECMP, Conditional Routes
- ✔ ACLs (L2, MPLS, IPv4/6, MPLS, L2) action permit/deny/redirect
- ✔ DHCP Relay, NTP, LLDP

IPTV/Multicast

- ✔ IGMPv2/3 ASM/SSM Mapping, IGMP Policy, Static Joins, Group Filter/Limit, Immediate Leave
- ✔ PIMv2, Static Joins, Filter

Manageability

- ✔ CLI/Config, REST API, RESTCONF/YANG Models, Inband/OOB, ZTP, OAM Support (IPTrace, MPLS Ping)
- ✔ Syslog, GELF, Prometheus, Alarm Management, Resource Monitoring
- ✔ RBMS (Open Source EMS), Web UI
- ✔ Security, Local Users, TACACS+, RBAC

Hardware Compatible 2RU Systems

	 ufiSpace S9600-72XC	 ufiSpace S9600-32X	 Edgecore Networks AGR420 *AS7946-74XKSB*	 Edgecore Networks AGR400 *AS7946-30XB*	 Delta AGCV_A48S
Switching Capacity	2.4 Tbps	2.4 Tbps	2.4 Tbps	2.4 Tbps	2.4 Tbps
Rack Space	2RU	2RU	2RU	2RU	2RU
1G Interfaces	-	-	-	-	-
10G Interfaces	-	4*	-	-	4
25G Interfaces	64	-	64	4	48
100G Interfaces	8	32	10	22	10
400G Interfaces	-	-	-	4	-
Switch ASIC	BCM88820 (Q2C)	BCM88820 (Q2C)	BCM88820 (Q2C)	BCM88823 (Q2C)	BCM88820 (Q2C)
Co-Processor	BCM16K	-	BCM16K	-	BCM16K
Roles	Consolidated BNG Access Leaf	Spine	Consolidated BNG Access Leaf	Spine	Access Leaf
Routing Table (IPv4/IPv6)	1.2M/250K	1.2M/250K	1.2M/250K	1.2M/250K	1.2M/250K
Buffers	4 GB (Deep Buffers)	4 GB (Deep Buffers)	4 GB (Deep Buffers)	4 GB (Deep Buffers)	4 GB (Deep Buffers)
CPU	Intel Skylake (8-Core)	Intel Skylake (8-Core)	Intel Broadwell (8-Core)	Intel Broadwell (8-Core)	Intel Broadwell (8-Core)
Memory	2 x 16 GB	1 x 32 GB	2 x 16 GB	2 x 16 GB	2 x 16 GB
Storage (SSD)	128 GB	128 GB	128 GB	128 GB	128 GB
Temperature Hardened	-	-	-	-	

**4 x 1GE/10GE/25GE SFP28 ports (break out from first 100G port)*

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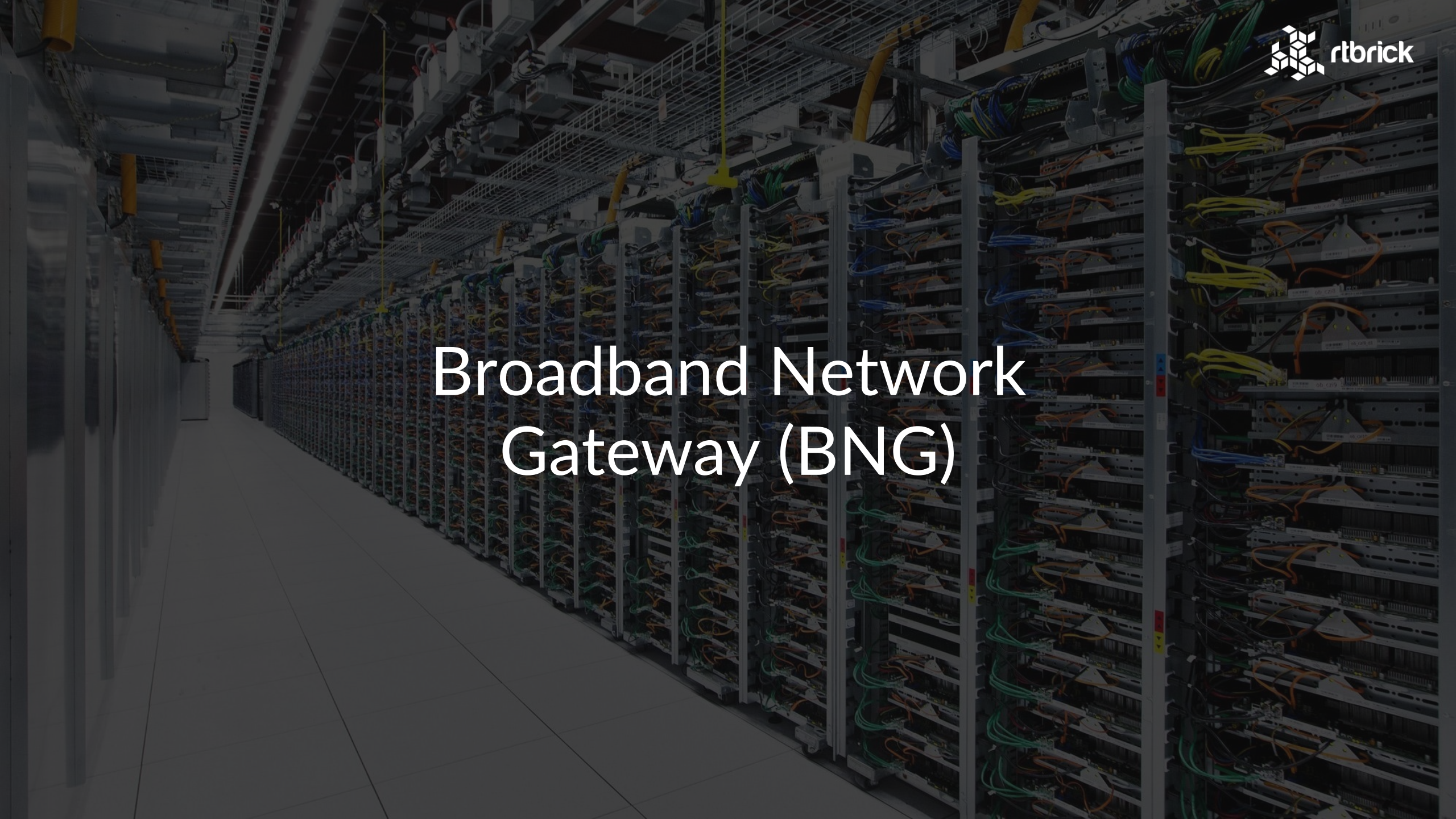
Hardware Compatible 1RU Systems

	 ufiSpace S9510-28DC *Premium*	 ufiSpace S9500-22XST	 Edgecore Networks CSR320 *AS7316-26XB*	 Edgecore Networks CSR440 *AS7535-28XB*	 BNGaaS *Roadmap*
Switching Capacity	800 Gbps	300 Gbps	300 Gbps	800 Gbps	-
Rack Space	1RU	1RU	1RU	1RU	-
1G Interfaces	-	4	-	-	-
10G Interfaces	-	8	16	-	-
25G Interfaces	24	8	8	24	-
100G Interfaces	2	2	2	2	-
400G Interfaces	2	-	-	2	-
Switch ASIC	BCM88483 (Q2A)	BCM88470 (QAX)	BCM88470 (QAX)	BCM88483 (Q2A)	DPDK (x86)
Co-Processor	-	-	-	-	-
Roles	Consolidated BNG	Wholesale Leaf	Wholesale Leaf	Consolidated BNG	BNGaaS
Routing Table (IPv4/IPv6)	500K/200K	64K+	64K+	500K/200K	1.2M/250K
Buffers	4 GB (Deep Buffers)	2 GB (Deep Buffers)	3 GB (Deep Buffers)	4 GB (Deep Buffers)	-
CPU	Intel Denverton (8-Core)	Intel Broadwell (4-Core)	Intel Broadwell (4-Core)	Intel Broadwell (8-Core)	-
Memory	2 x 8 GB	1 x 8 GB	2 x 8 GB	2 x 8 GB	-
Storage (SSD)	128 GB	32 GB	128 GB	128 GB	-
Temperature Hardened	Yes	Yes	Yes	Yes	-

RBFS Demo



Broadband Network Gateway (BNG)

What is a Broadband Network Gateway (BNG) …. ?

RADIUS Authentication, Accounting and Control…

NOKIA HUAWEI cisco JUNIPER NETWORKS ERICSSON

PyRAD

FreeRADIUS The world's most popular RADIUS Server

Management Protocols

RESTful API

Logstash

Prometheus

Routing Protocols

BGP, ISIS, OSPF, MPLS, LDP PIM, Segment Routing, …

broadband forum

TR101, TR-177 …

OpenSSH

SSH, TACACS+, SSL, JWT, …

LACP, EOAM, …

Access Protocols

IPoE, DHCP, DHCPv6 …
PPPoE, PPP, LCP, PAP, CHAP, IPCP, IP6CP, L2TPv2 …
IGMP, …

Legal Interception, TKG §, …

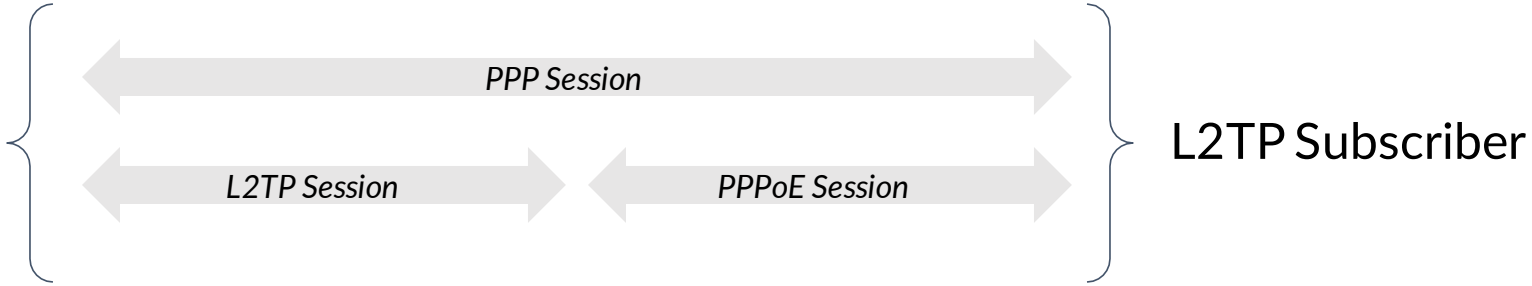
MikroTik OpenWrt WIRELESS FREEDOM LANCOM Systems

LINKSYS AVM ASUS tp-link UBIQUITI NETWORKS D-Link arcadyan ZYXEL NETGEAR

Subscriber Management

The term subscriber describes the representation of a customer in a Broadband Network Gateway (BNG) which is formed out of multiple protocols and sessions:

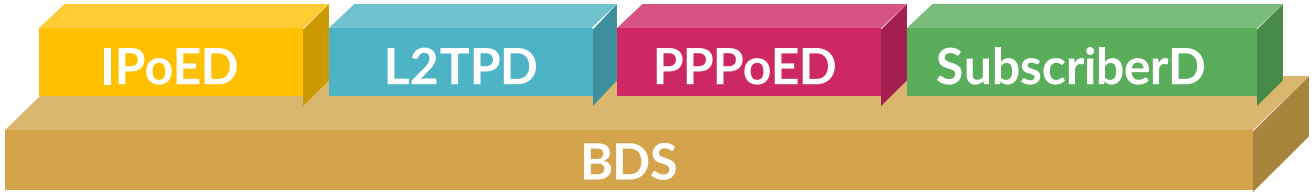
- *PPPoE Subscriber:* *PPPoE/PPP Session + DHCPv6*
- *L2TP Subscriber:* *PPPoE/PPP Session + L2TP Session*
- *IPoE Subscriber:* *DHCPv4 + DHCPv6*



Therefore Subscriber Management can be understand as the management of customer connections in a BNG.

Subscriber Management Architecture

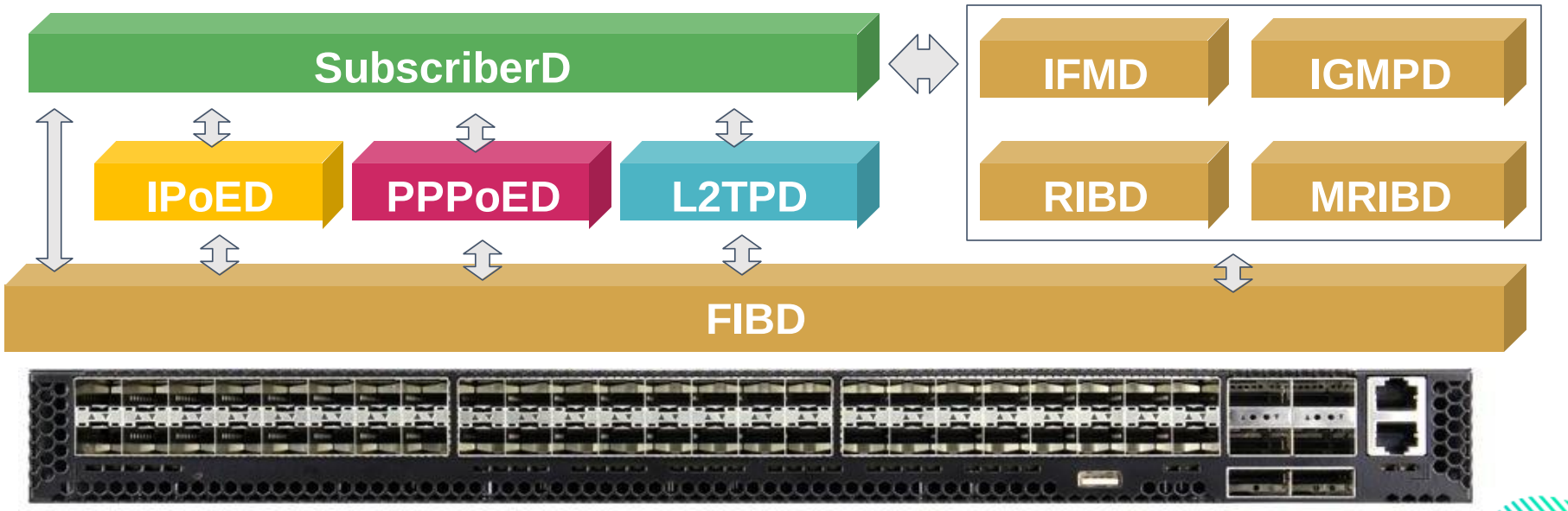
Brick Daemons form the RBFS Subscriber Management Architecture



1. **SubscriberD**
   Subscriber Management, Service Control and AAA (RADIUS)
2. **PPPoED**
   PPPoE Session Management (PPPoE, PPP LCP, IPCP, IP6CP, ICMPv6 (RS/RA), DHCPv6)
3. **L2TPD**
   L2TP Tunnel and Session Management (L2TPv2)
4. **IPoED**
   IPoE Session Management (DHCP, DHCPv6)

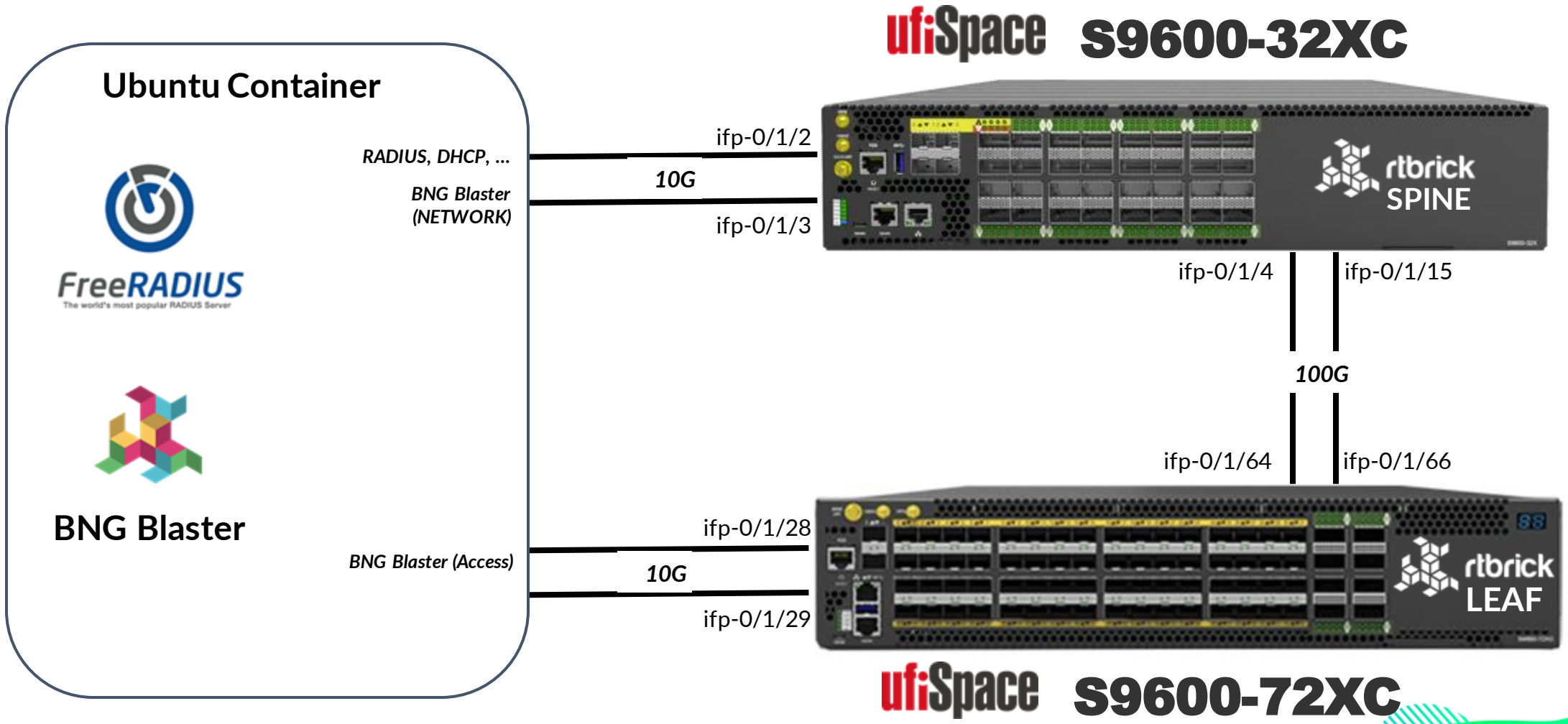
Subscriber Management Architecture

- All traffic is sent and received through FIBD
- The PPPoED, IPoED and L2TPD don't talk to each other
- The subscriber daemon provides the interfaces to the forwarding infrastructure
- Restart or crash of each access daemon is properly handled
- Fast troubleshooting through shared terminate code infrastructure
- …



BNG Demo

RBFS Demo


Ubuntu Container
FreeRADIUS
The world's most popular RADIUS Server
BNG Blaster
RADIUS, DHCP, ...
BNG Blaster (NETWORK)
BNG Blaster (Access)
ufiSpace S9600-32XC
rtbrick SPINE
ifp-0/1/2
10G
ifp-0/1/3
ifp-0/1/4
ifp-0/1/15
100G
ifp-0/1/64
ifp-0/1/66
ifp-0/1/28
10G
ifp-0/1/29
rtbrick LEAF
ufiSpace S9600-72XC

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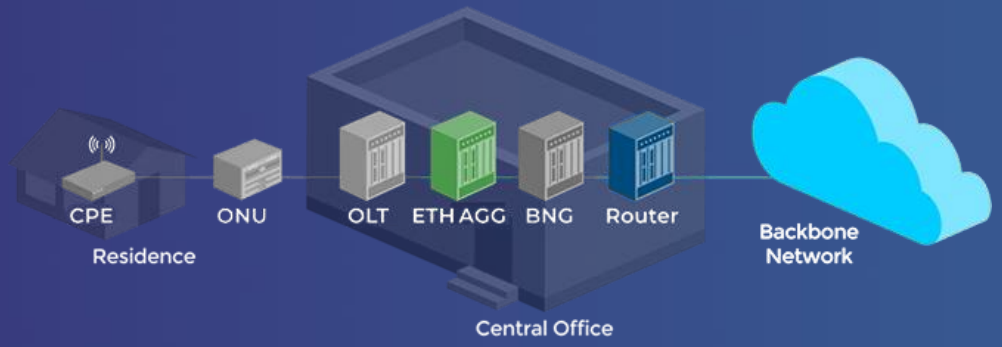
An Open Disaggregated Solution for PON FTTH



eps

ipinfusion

Radisys

rtbrick

Edge-corE NETWORKS

www.epsglobal.com

ipinfusion™

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Broadband Aggregation using OcNOS

Lalit Kumar
Solutions Architect
at IP Infusion

IP Infusion Corporate Overview: Think Networking

20 Years Of Network Software Solutions

- Carrier-Grade Open Networking
- Unparalleled Control Plane
- 500+ customers
- 10,000's of carrier grade deployments

IP Infusion is the Networking Software Leader

Product and Technology Leadership

Network OS

OcNOS

Control Plane Software

Validated on market-leading switching or customer-specific platforms

Total Network Disaggregation

Service Provider

Data Center

OEM

IP Infusion Customer Momentum

Service Providers /Network Operators

Network Equipment Providers

Strategic Ecosystem Partners

SILICON PARTNERS

BROADCOM

MARVELL

HARDWARE PARTNERS

ufiSpace

Edge-corE

Celestica

PEGATRON

ZYXEL

DELL

DELTA Smarter. Greener. Together.

OPTICS PARTNERS

Hisense

LUMENTUM

E.C.I.NETWORKS

smartoptics

FINISAR

II-VI

TiBiT communications inc

Amphenol

SKYLANE OPTICS®

JABIL

SYSTEMS INTEGRATORS

FUJITSU

amdocs

wipro

Radisys

CHANNEL PARTNERS

eps

ASBIS

KGPCo

Tech Data

World Wide Technology

VALUE-ADDED RESALE PARTNERS

AIRCOM

ANIXTER

Aviat NETWORKS

OKI

COMSYS.HD

giku

NERA

ipt

FONEX

AS

MACNICA

BARQ SYSTEMS

Upstream ICT Alliance

E.C.I.NETWORKS

infin&africa.

STORDIS The Open Networking Expert

ROCNET

GGI

sekom

Fhnet 富鴻網

LARCH NETWORKS

FS

open globe

R.COMM

VAYU GROUP

AWAT

nomios

dacoso

ITOS Information Technology Consultants

GIOFAT

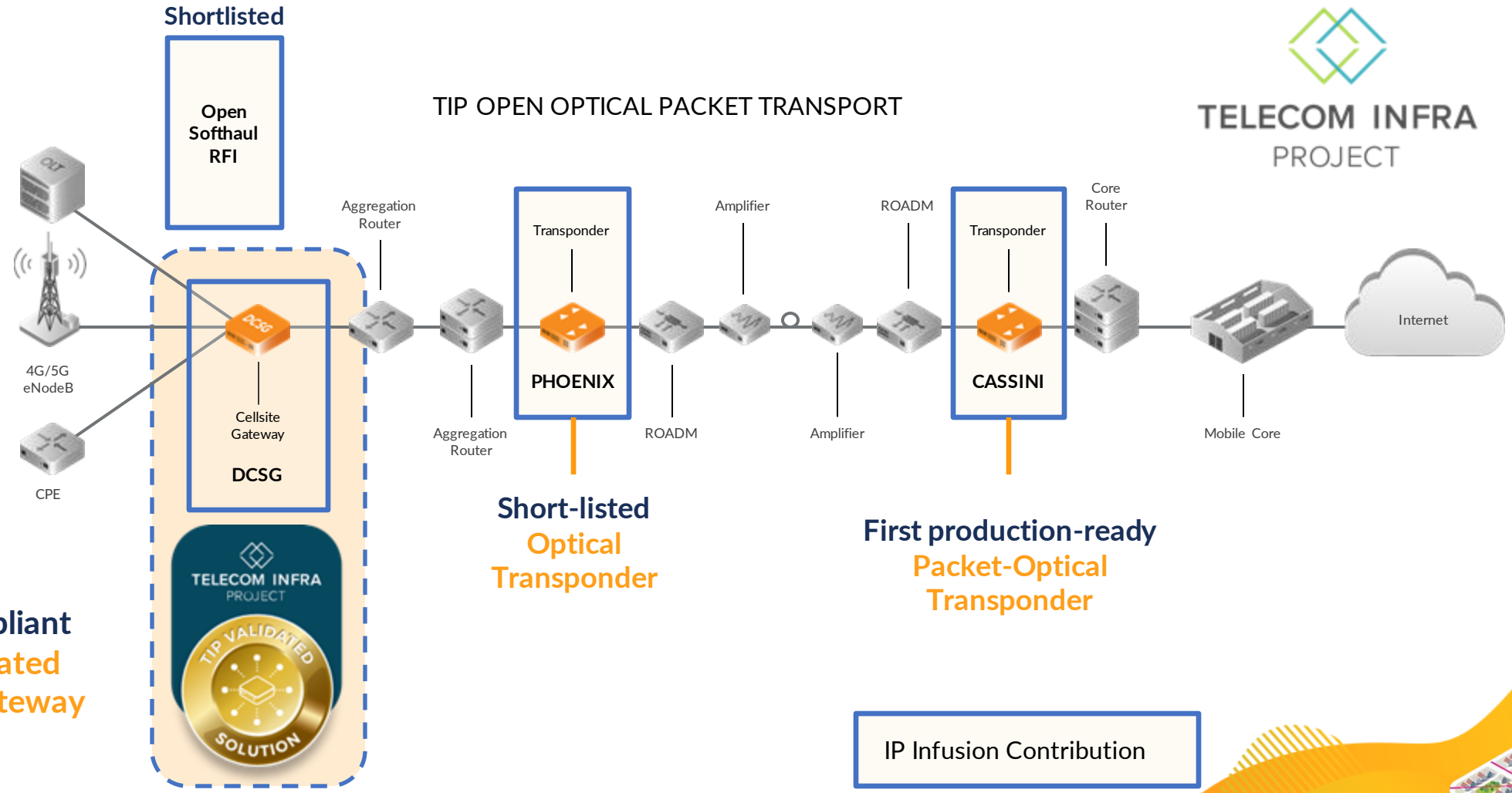
Lead Com

Infradata

whitestack

STARVIEW International

OcNOS Awarded TIP Validated Solution Gold Badge

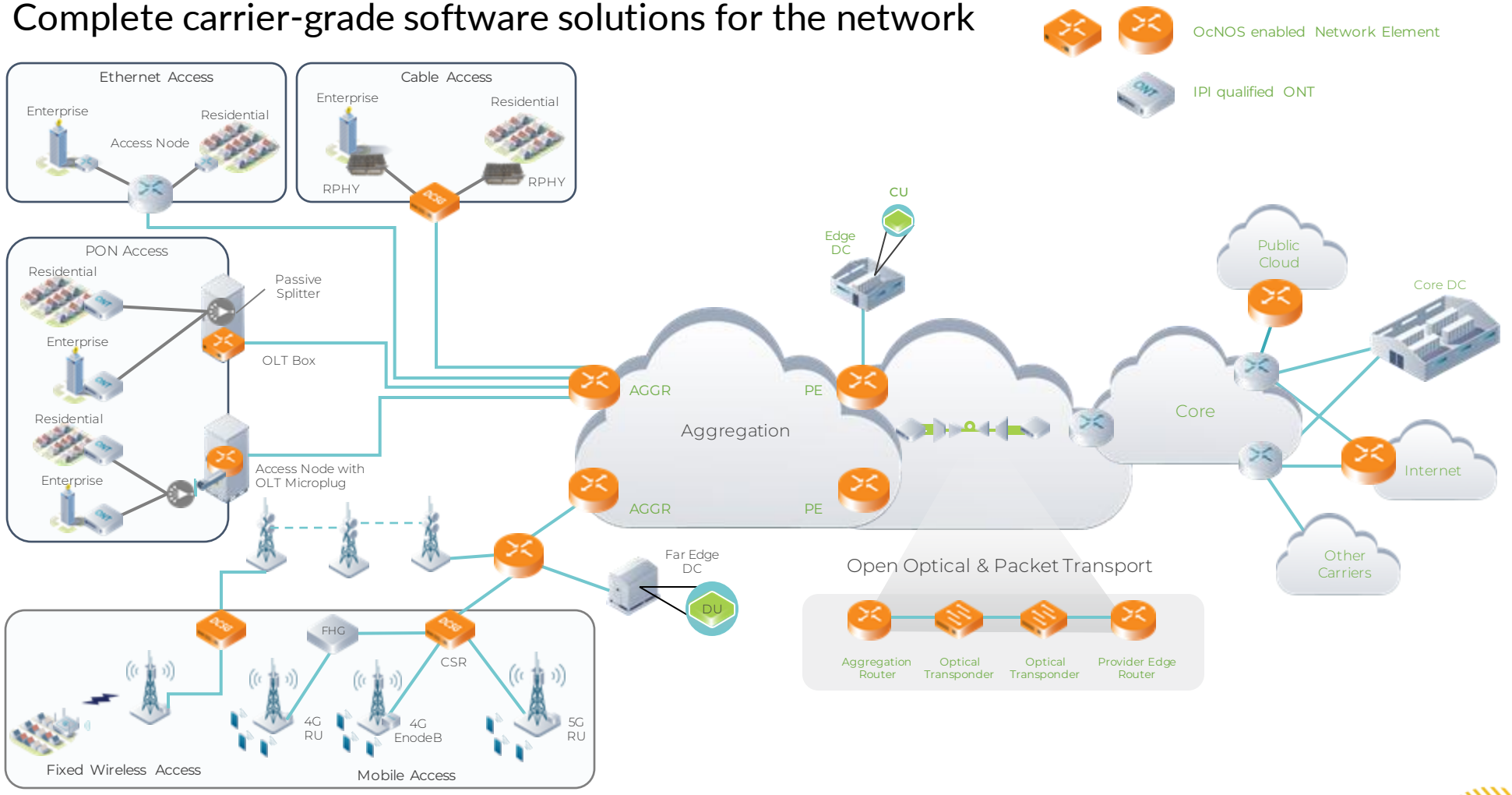


Fully Compliant
Disaggregated
Cell Site Gateway

IP Infusion Contribution

OcNOS Solutions

Complete carrier-grade software solutions for the network



Customer Success: OcNOS Solutions In Production

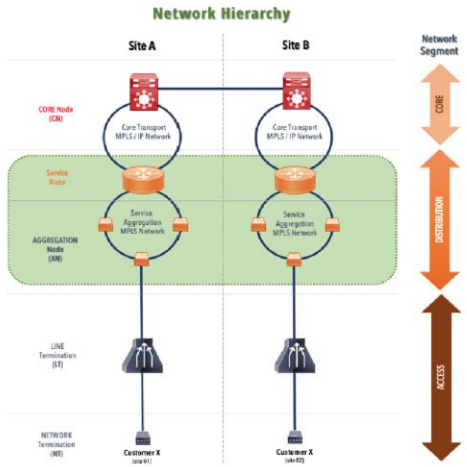
netomnia

Broadband Aggregation in the UK

- Working to cover 1 million premises across England, Wales, Scotland and Northern Ireland with gigabit-capable full fiber broadband network by 2023
- IP Infusion OcNOS Turnkey Solution

lintasarta

Aggregation Router and Data Center Solutions across Indonesia



- Upgrade legacy network with high capacity and low cost solution
- Future-proof with Terabit scale
- Next generation services with Ethernet VPN (EVPN) and Segment Routing

CERAGON

Wireless Transport & Cell Site Router

- Industry's first Radio-Aware Disaggregated Cell Site Router
- Significantly reduced time-to-market (6 months)
- Full featured, DCSG compliant NOS with routing and timing features

IP Infusion Partners with Marvell

ipinfusion™

MARVELL™

Industry choice for merchant silicon

Use cases for radio access and carrier edge networks

Industry leading features including SRv6 and Timing & Synchronization

Lower Total Cost of Ownership

OcNOS for Multi-Service Broadband Networks

Broadband Aggregation& Multi-Service Core

Broadband Network Reference Architecture

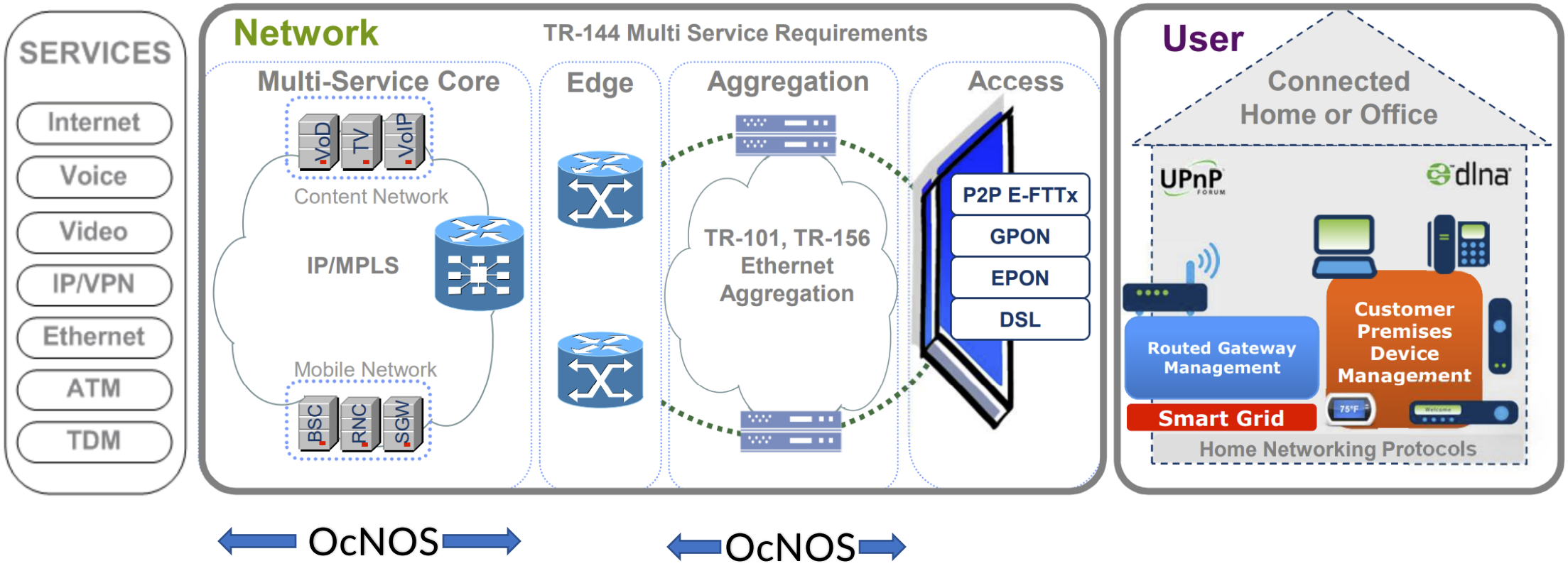


Image source: https://grouper.ieee.org/groups/1904/

Ethernet Based Broadband Aggregation

- Support for wider range of access technologies (xDSL, xPON, Point to Point Ethernet etc.)
- Provides higher user bit rates
- Better support for services requiring QoS and Multicast
- Improved availability
- Interworking with Mobile Networks
- Support for business class services like L2 and L3 VPNs

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OCNOS: A Converged Network OS

Features	Specification
Layer-2	VLAN, Spanning Tree, LLDP, LACP, MC-LAG
Layer-3	BGP, OSPF, ISIS, RIP, VRRP, BFD
Multicast	PIM-SM, PIM-DM, IGMP, IGMP/MLD Snooping
MPLS	LDP, RSVP-TE, VPLS, VPWS, L3VPN, MPLS OAM,, BGP-LU
QoS	DiffServ, 1/2/3 level queuing hierarchy, policing, marking, shaping, multiple hardware queues per port, WRR/WFQ/SP scheduling per queue, WRED, 802.1p remarking, Classification based on interface, ACL, DSCP, IP Precedence, RTP, 802.1p and VLAN, Trust IEEE 802.1p/DSCP, Remarking of bridged packets, SRTCM/TRTCM, minimum and maximum bandwidth per queue
Carrier Ethernet	EVPN-MPLS E-LINE, E-LAN and E-Tree, CFM, Y.1731
Segment Routing	OSPF and ISIS extensions for SR, SR with MPLS data plane, Segment Routing Policy, TI-LFA, BGP-LS, PCEP, SRv6
Timing and Synchronization	1588v2, T-BC, T-GM, G.8275.1, G8275.2, G.8273.2, SyncE- G..8262, ESMC – G.8264

Features	Specification
Security	SSH v1/v2, Storm Control, Flow Control, DHCP Snooping, IP Source Guard
Access Control List	ACL based on source IP address, destination IP address, TCP/UDP source port, IP protocol type, Source MAC, destination MAC, Ethertype, TCP Flags, Protocol type, IP Fragment flags, DSCP, CoS, IP Precedence, VLAN Rule prioritization and sequence, on fly modification
HW Specific Features	SPAN/RSPAN, Dynamic load balancing, Port breakout, TCAM space monitoring
Chassis Monitoring	Temperature monitor, FAN control, Power monitoring, CPU load monitoring, Board Information, FAN and PSU information, Hardware MIB and Traps
DDM	Temperature Monitor, Power monitor, Hardware MIB and Traps
Management	Role based management, CLI access via console, telnet and SSH, Authentication using TACACS/RADIUS, SNMP v1, v2c, sFlow, DHCP Client, NTP, Syslog, NetConf, OpenConfig

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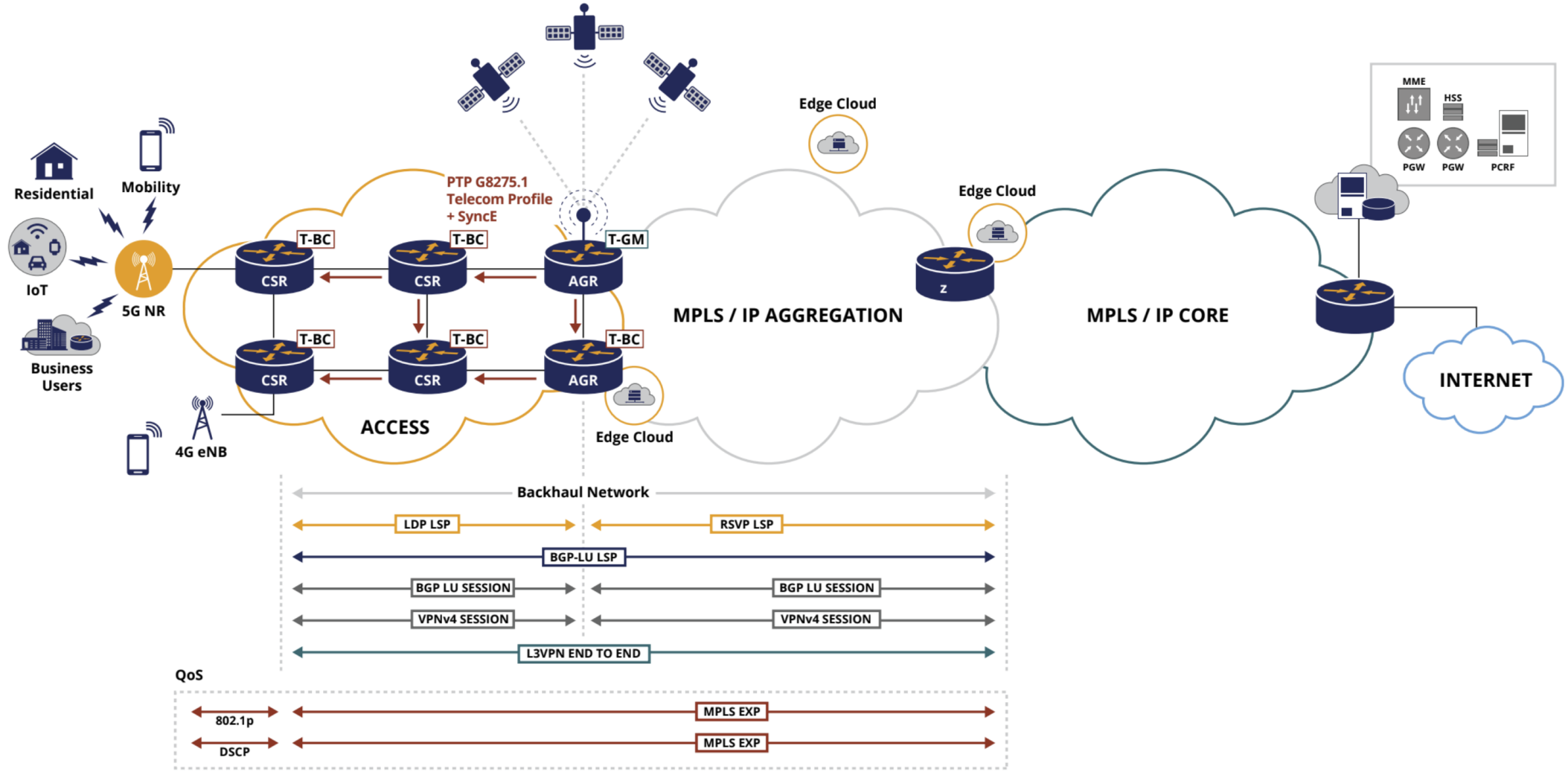
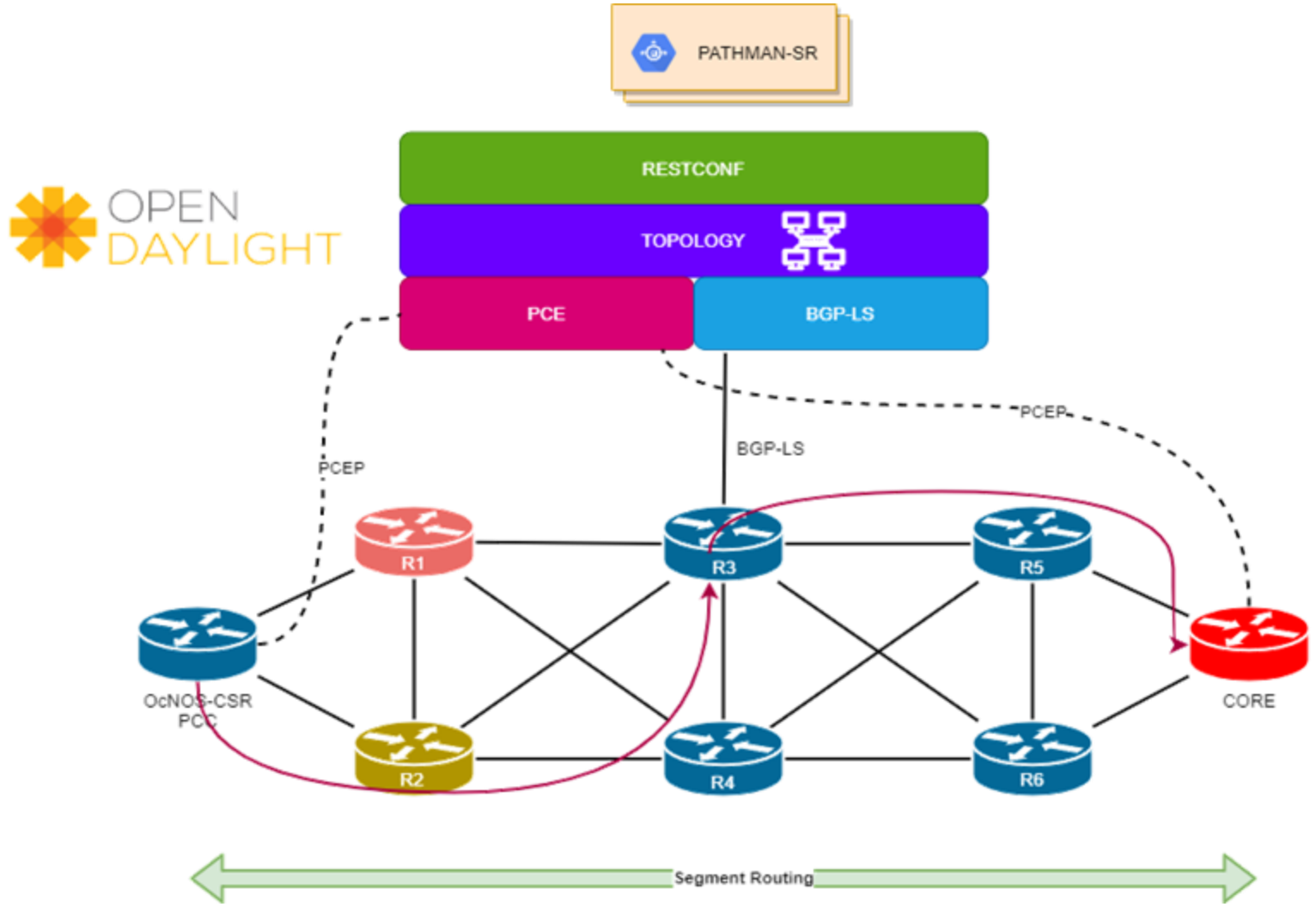
Seamless MPLS



Segment Routing with MPLS Data Plane



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Best of breed Hardware Choices for Transport

Access Router	Pre-Aggregation Router	Aggregation Router/Provider Edge
32 Gbps (Qumran-UX)	**300 Gbps (Qumran-AX)**	**800 Gbps (Qumran-MX)**
UfiSpace S9502-16SMT 	Edgecore AS7315-27X  Edgecore AS7315-30X  Edgecore AS7316-26XB  UfiSpace S9500-22XST  UfiSpace S9500-30XS 	Edgecore AS5912-54X  Edgecore AS5916-54XM  Edgecore AS5916-54XKS 
64 Gbps (Qumran-UX)		
Edgecore AS5915-18X  UfiSpace S9501-18SMT 		
120 Gbps (Qumran-UX)	**800 Gbps (Qumran-2A)**	**2.4 Tbps (Qumran-2C)**
UfiSpace S9501-28SMT 	UfiSpace S9510-28DC 	UfiSpace S9600-32X  UfiSpace S9600-72XC 
300 Gbps (Qumran-AX)		**4.8 Tbps (Qumran-2C)**
Edgecore AS7315-27X  Edgecore AS7315-30X  Edgecore AS7316-26XB  UfiSpace S9500-22XST  UfiSpace S9500-30XS 		UfiSpace S9600-64X 

Best of Breed HW Choices for Data Center

AS4610-54T

Top of Rack switch
48x1 GbE connection to servers
4x10 GbE and 2x40G uplink
Broadcom Helix4 switching silicon

AS5835-54X

Top of Rack switch
48x10G SFP+, 6x40G QSFP
Broadcom TR3 switching silicon
Support VxLAN tunneling for network Virtualization
Supports MPLS L2/L3 VPN

AS7712-32X/7716-32X

Spine Switch
32x100G QSFP28
Broadcom Tomahawk switching silicon
Support VxLAN tunneling for network Virtualization
Supports MPLS L2/L3VPN

AS7326-56X

ToR switch for high performance DC
48x25G SFP28 & 8x100G QSFP28
Broadcom TR3 switching silicon
Supports VxLAN tunneling for network Virtualization
Supports MPLS L2/L3 VPNs

AS7726-32X

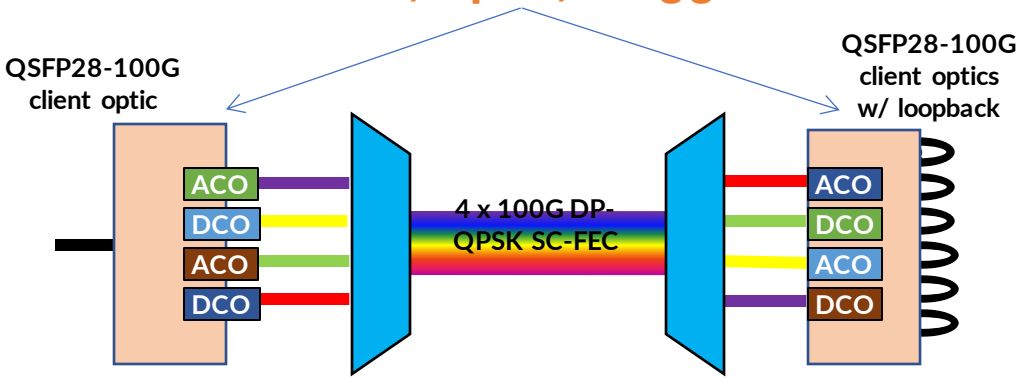
Spine switch for high performance DC
32x100G QSFP28
Broadcom TR3 switching silicon
Supports VxLAN Tunneling for NVO
Supports MPLS L2/L3 VPNs

AS7816-64X

Spine switch for high performance DC
64x100G QSFP28
Broadcom TH2 switching silicon
Supports VxLAN for NVO
Supports MPLS L2/L3 VPNs

OcNOS Packet Optical Solution

Flexible, Open, Pluggable



Solution Ecosystem

Design and Validation: TELECOM INFRA PROJECT

Network Operating System: ipinfusion

Cassini Hardware: Edge-corE NETWORKS

ACO / DCO Modules: LUMENTUM

FUJITSU FUJITSU OPTICAL COMPONENTS

Supported HW

EdgeCore Cassini

- 16x100GbE QSFP28 each port supports 1x40/100GbE
- 8 Line card slot for DCO/ACO module each supporting 100/200GbE

Wistron Galileo

- 12x100GbE QSFP28, full flexibility in configuring as 10/25/40/50/100 GbE
- 4 Line card slot for DCO/ACO module each supporting 100/200GbE

Supported CFP-2 Optics

CFP-2 ACO/DCO 100/200Gbps DP-QPSK/DP-8QAM/DP-16QAM modulated data link

LUMENTUM

ACACIA COMMUNICATIONS, INC.

FUJITSU

SKYLANE OPTICS®

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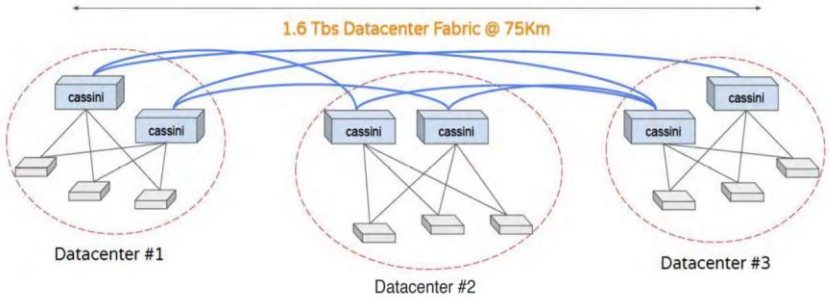
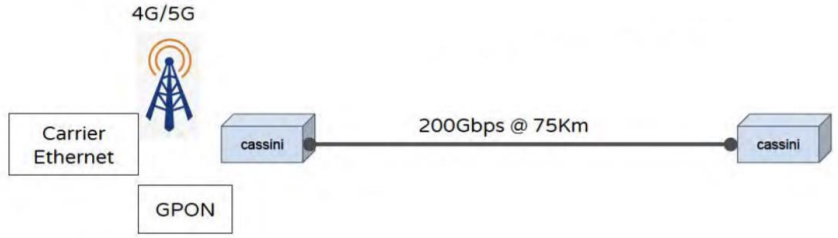
Optical Transport Use Cases

A Simple Transport Network

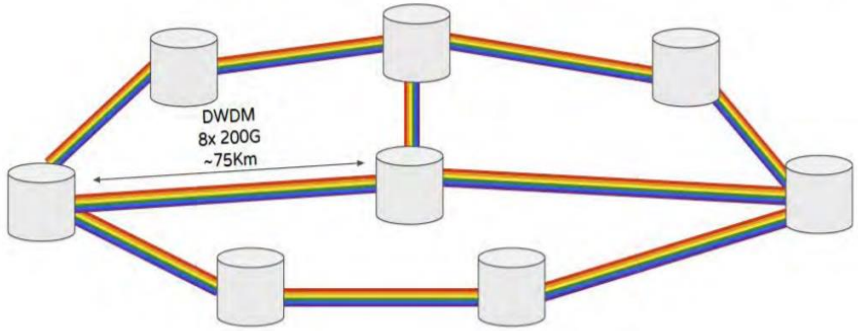
Data Center Interconnect



Backhaul for converged access



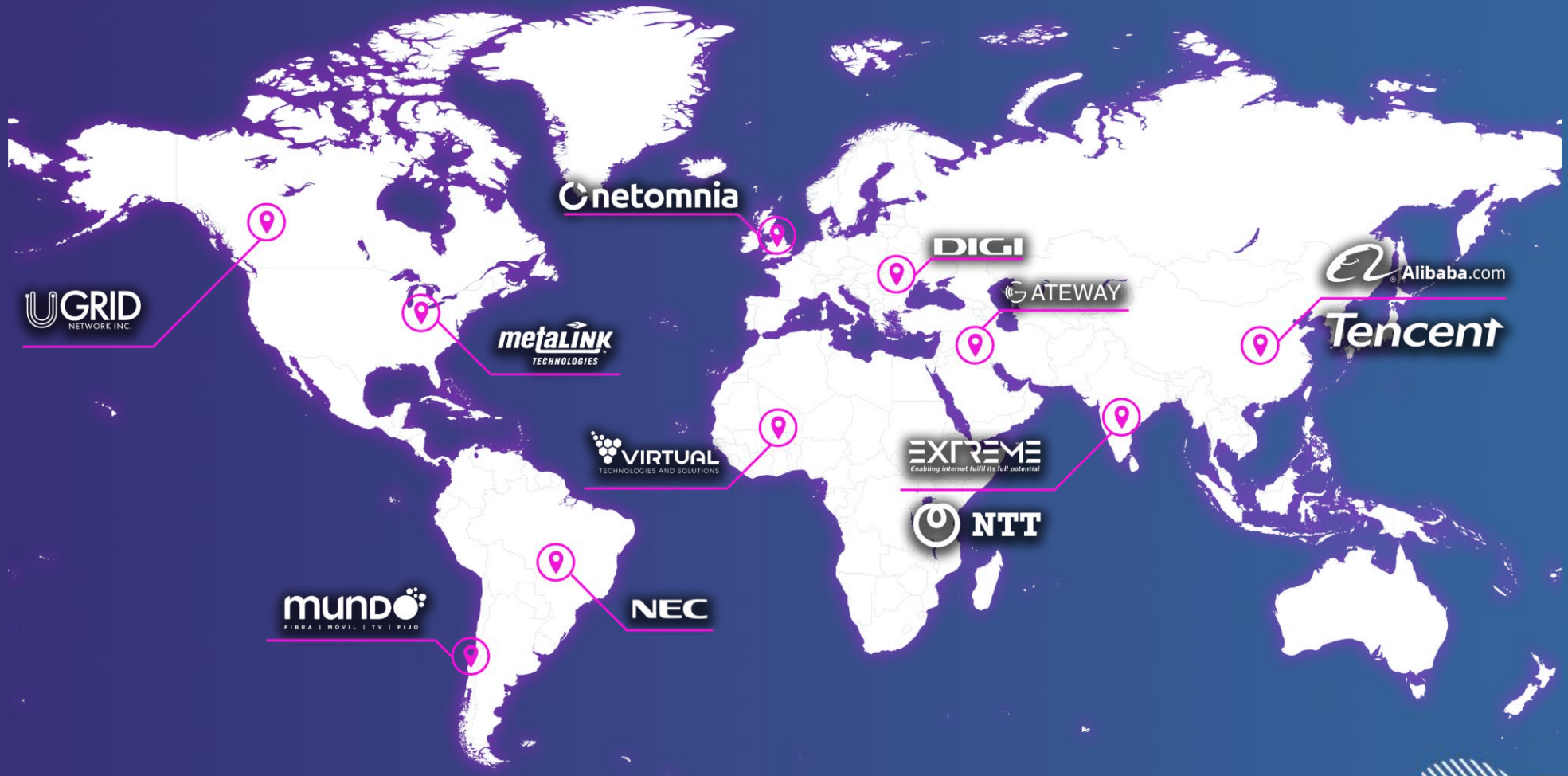
Regional IP Backbone using Dark Fiber



Danke Sehr

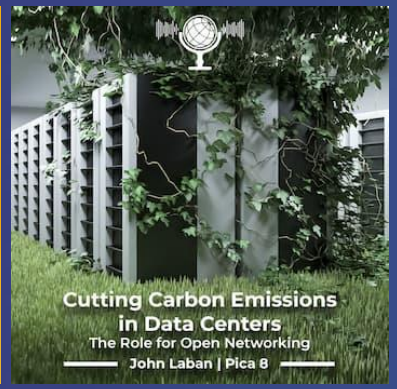
Apply for your solution here

Apply for your solution here

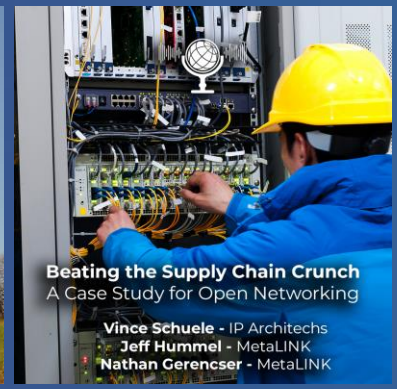


Podcasts

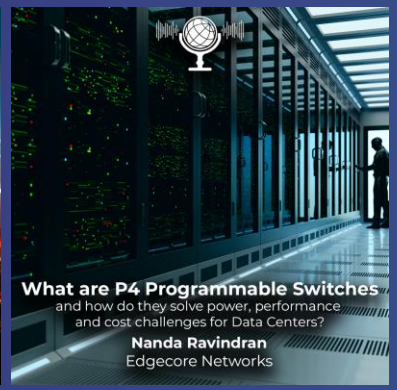

Open Networking &
the Global Chip Shortage
Kelly LeBlanc | Pica 8


Cutting Carbon Emissions
in Data Centers
The Role for Open Networking
John Laban | Pica 8


Harnessing the Power of
Open Disaggregated Networking
to Speed up Broadband Rollout
Feka Samakuva | Netomnia


Beating the Supply Chain Crunch
A Case Study for Open Networking
Vince Schuele - IP Architechs
Jeff Hummel - MetaLINK
Nathan Gerencser - MetaLINK


5G Crosshaul
Meeting Network Demands
with Open Networking
Nanda Ravindran - Edgecore Networks


What are P4 Programmable Switches
and how do they solve power, performance
and cost challenges for Data Centers?
Nanda Ravindran
Edgecore Networks


Driving Sustainable
Network Innovation with
Open Telecom Technology
Bhartendu Chaurasia
Head of TIP Technologies – EMEA - META


The Future of In-Home WiFi
Turning Service Providers
into Experience Providers
Gunter Reiss
Chief Marketing Officer - DZS

Unboxing Videos

Get in Touch

Barry McGinley
Senior Systems Engineer for EMEA
at EPS Global

bmcginley@epsglobal.com

Frank Krämer
Head of Sales DACH
at EPS Global

fkraemer@epsglobal.com