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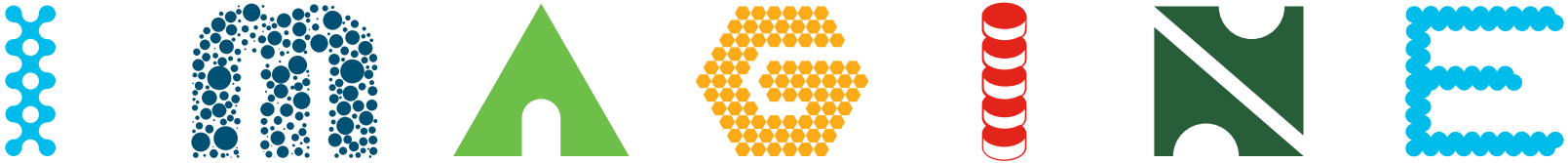
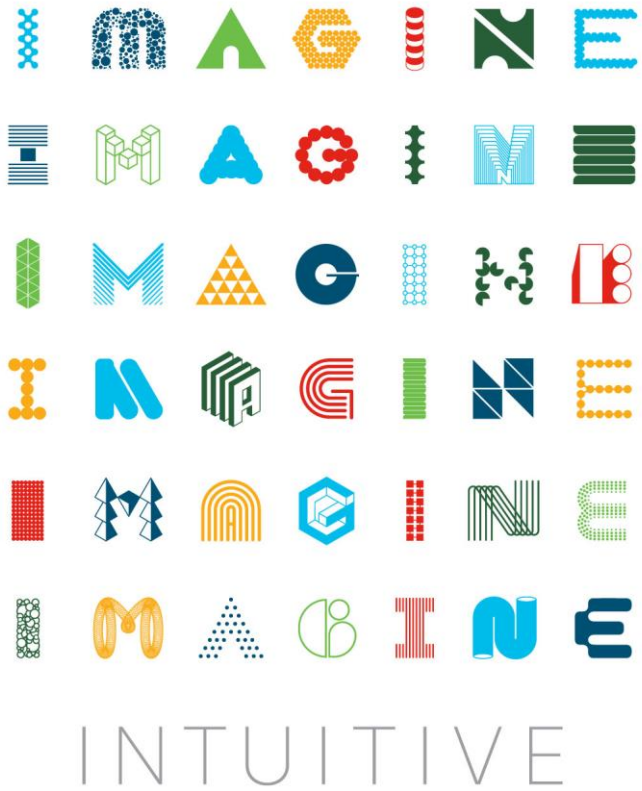


INTUITIVE

BRKSPG-2159

Deploying Next Generation SP Access Networks with the NCS540/NCS560 Platforms

Osman Hashmi, Product Manager, SP Access



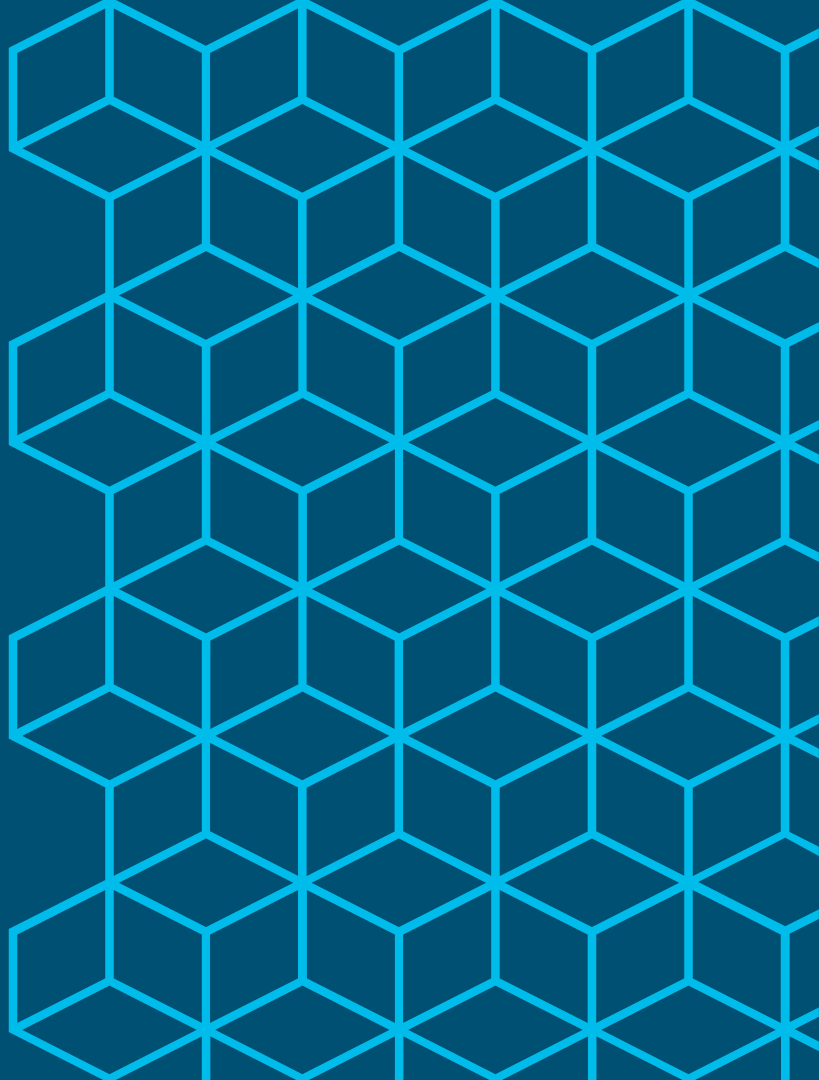
Session Abstract

The NCS540 and NCS560 platforms are the next generation Access routers that extend the IOS XR programmable network to the SP Access. This session will focus on the architectures, deployment use-cases and positioning of these XR enabled routers in the access (Access/Aggregation/5G x-Haul/R-Phy) and provide an overview of the end to end solutions and differentiators for SP access.

Agenda

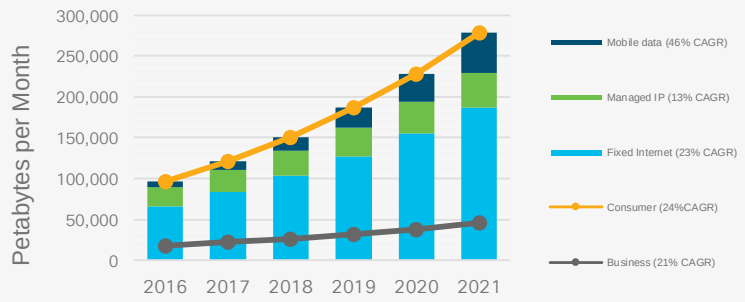
- Introduction
- Cisco's SP Access solutions
- Vortex Pricing Model
- NCS 540
- NCS 560
- Deployment Use-Case Review
- Software Roadmap (Reference)

Introduction

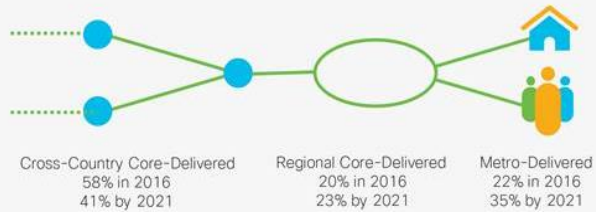


Growing Traffic Creates Growing Opportunity

IP Data Growth: Increasingly More Mobile*

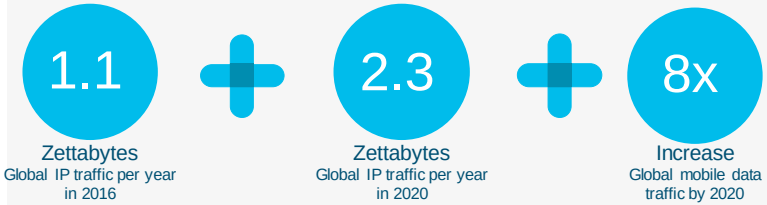


Traffic is Moving Closer to the End User*

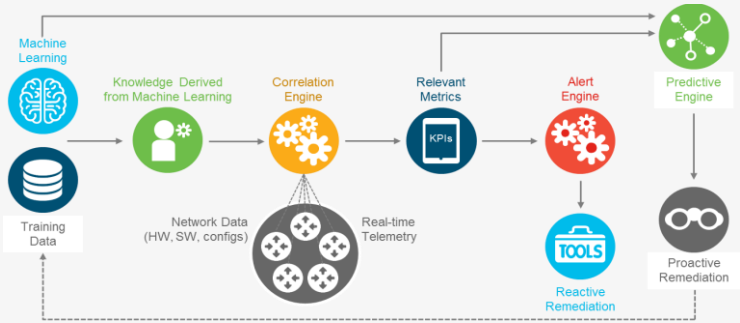


Source: Cisco VNI Global IP Traffic Forecast, 2016–2021

Opportunity for Growth*

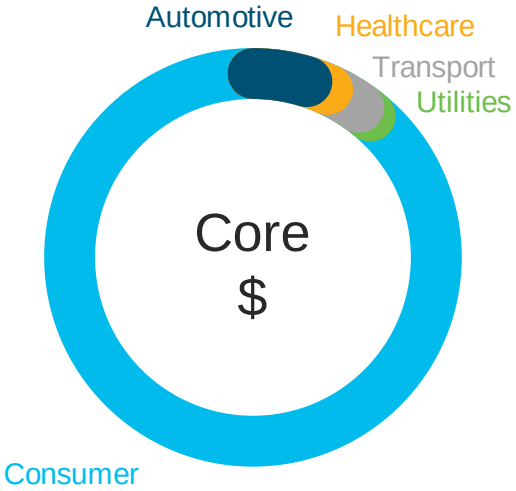


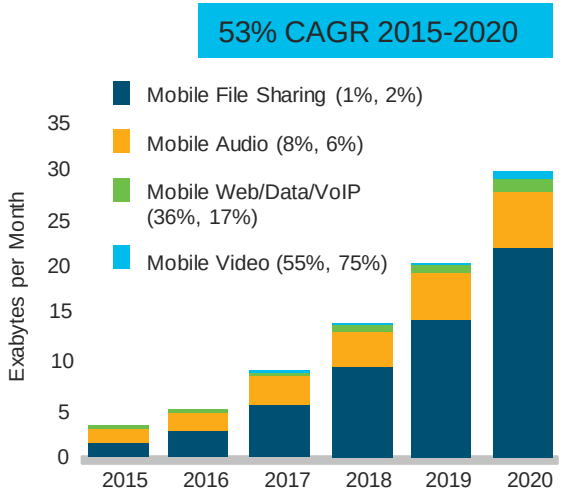
Automation is the Key to New Operational Models

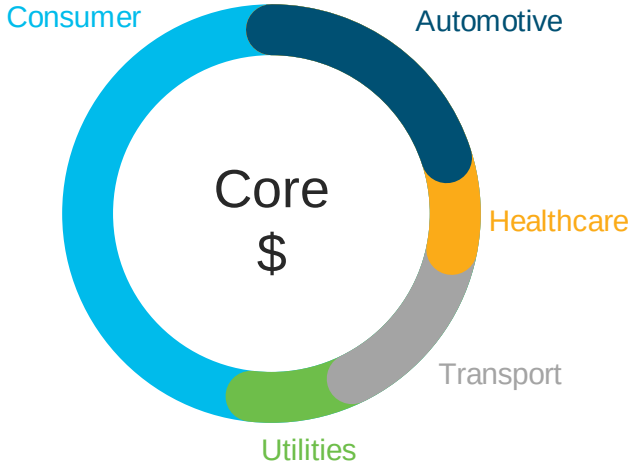


*Cisco Visual Networking Index™ Forecast and Methodology, 2015–2020

Mobile Operator Revenue Growth Opportunities







Today
Operator business mostly focused on the saturated consumer market

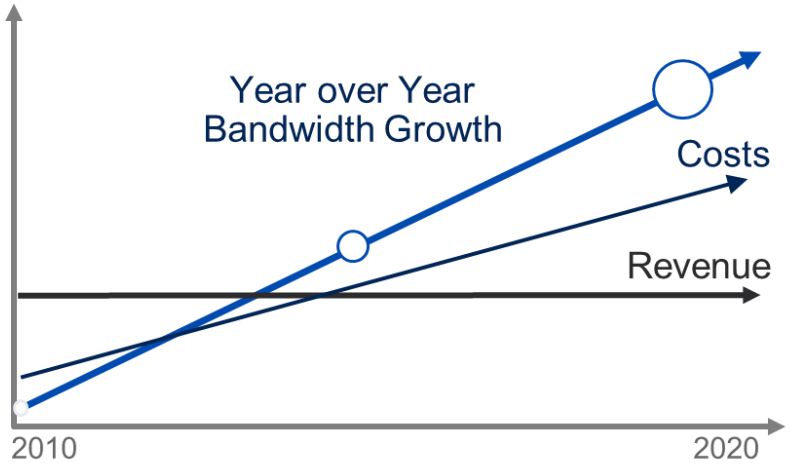
Video drives traffic… but not revenue

2025
Vertically targeted services will accelerate operator business growth

Source: European Commission Report, 2016

Service Provider Business Challenge

Bandwidth Growth vs. Revenue Growth



Telco offers Capacity

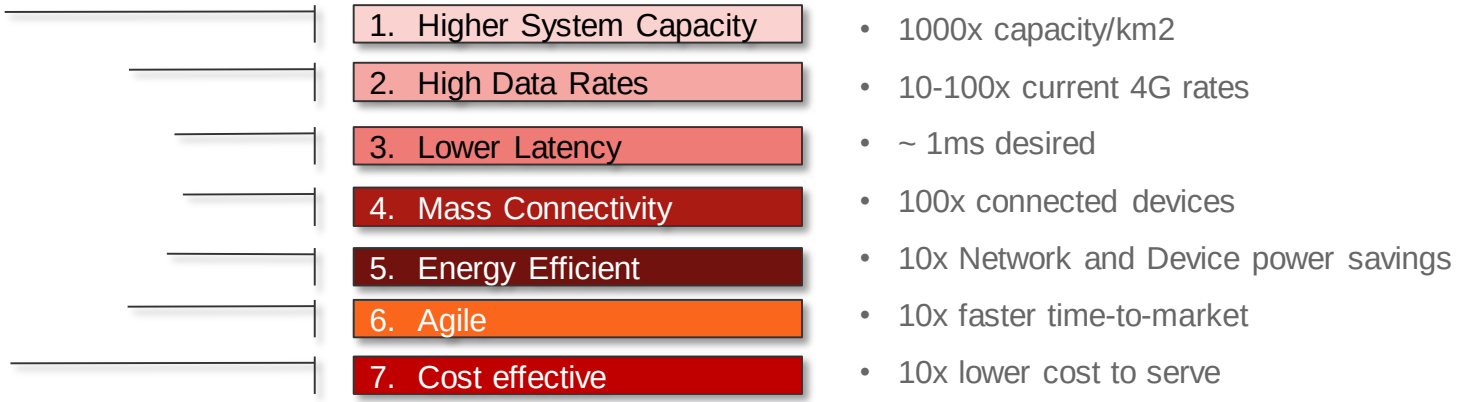
- Network complexities contributing to OPEX growth:
  - More bandwidth, RAN, Access, DC etc.
  - Monolithic Systems on Purpose-built
  - Multiple OS
- Lacks Elasticity: Increase in provisioning and management costs
- Rigid Architecture: No Service/Network Views
- Slow to introduce: Innovation, New capacity and services

Need to reduce overall expenditure, especially OPEX
Simplification and speed “is” innovation

Access Network Expectations

Benefits	Barriers
• Super-efficient, cost optimized • Dynamic resource allocation - Agile • Scale, High bandwidth and ultra-low latency • Service Monetization - IoT Capable • Power efficient	• Monetization potential Recouping 4G investments • Device availability • Regulatory issues : Spectrum allocation • Use case / test data development

Functional Requirements



Simple, Scalable, Automated – Evolution Architecture

Access Architecture Evolution Principles

Layers

Metro

Mobile Access

Wireline Access

Trends

- ✓ MPLS-TP / L2 to L3/SR EVPN Access
- ✓ IPoDWDM / 80Km 100G
- ✓ Content Caching distribution

- ✓ 10G densification Massive MIMO
- ✓ TDM2IP for 2G sites
- ✓ IP'fication of Cell Site

- ✓ NID access from 100M to 1G/10G
- ✓ Security and OAM functions

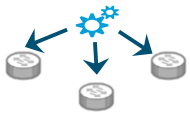
Glue

E2E Automation / Protocol Simplification / Security

Building Blocks

SR/EVPN

Automation

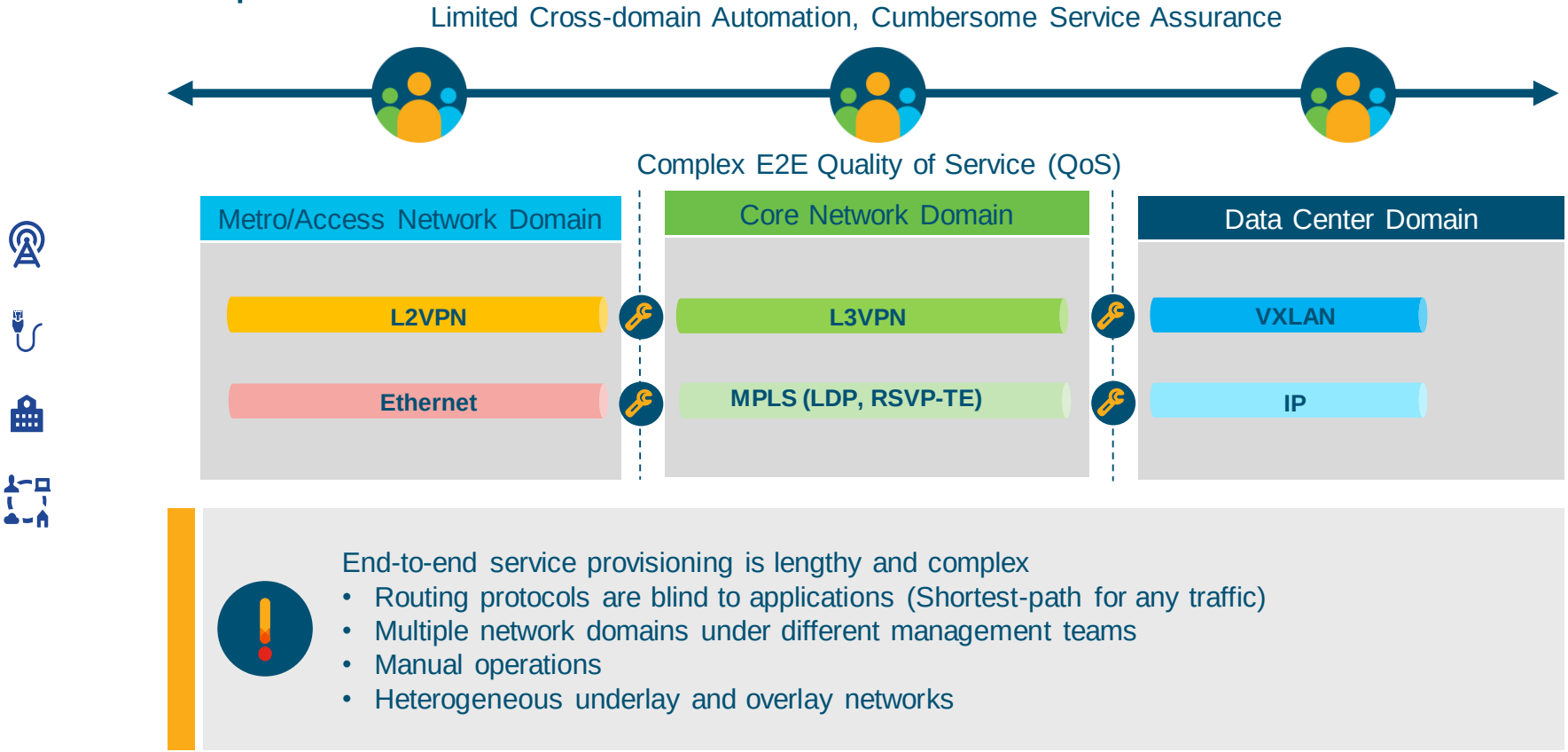


Telemetry and Analytics

YANG data models

Device Security

Traditional service creation process is a major challenge with explosion of access elements



End-to-end service provisioning is lengthy and complex

- Routing protocols are blind to applications (Shortest-path for any traffic)
- Multiple network domains under different management teams
- Manual operations
- Heterogeneous underlay and overlay networks

Access equipment are often installed at places where environmental conditions are not ideal

Extreme temperature

- Device must operate in very hot or very cold temperature

Lack of protection

- Increase security risks
- Exposed to elements which could impact device operation

Size and power constraints

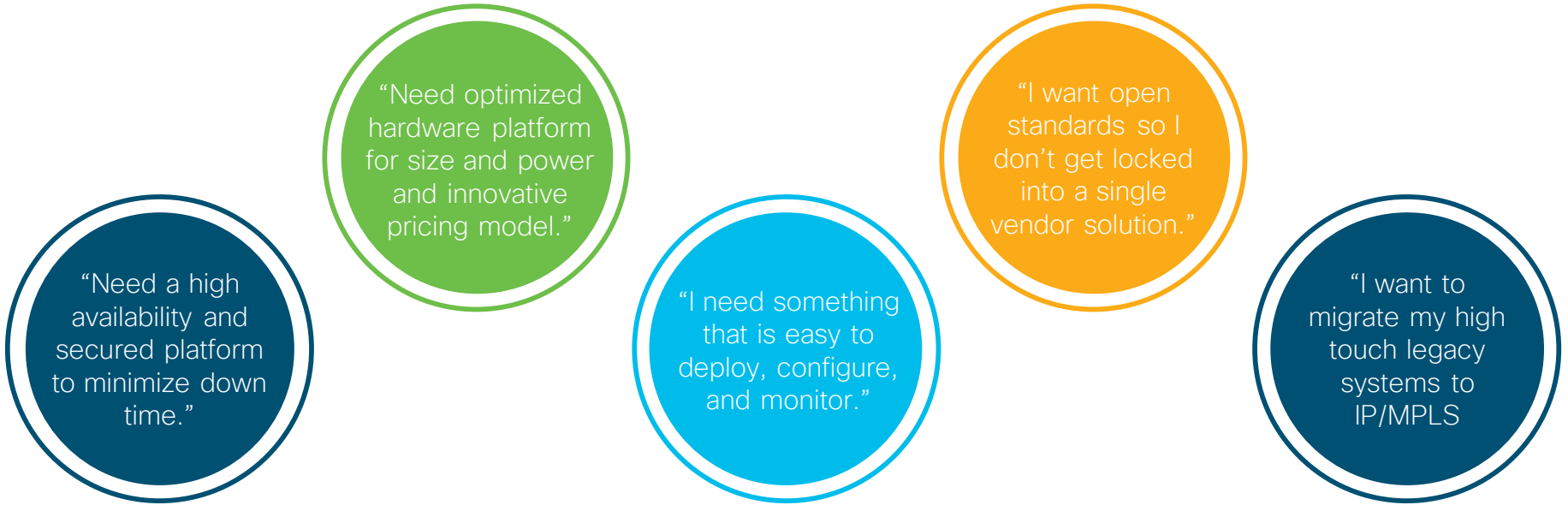
- Very tight spaces at remote locations
- Power feed is expensive

All these factors make access network more costly to deploy and slow down service turn up

Legacy equipment are going to end of life and operators are challenged to keep the TDM network going

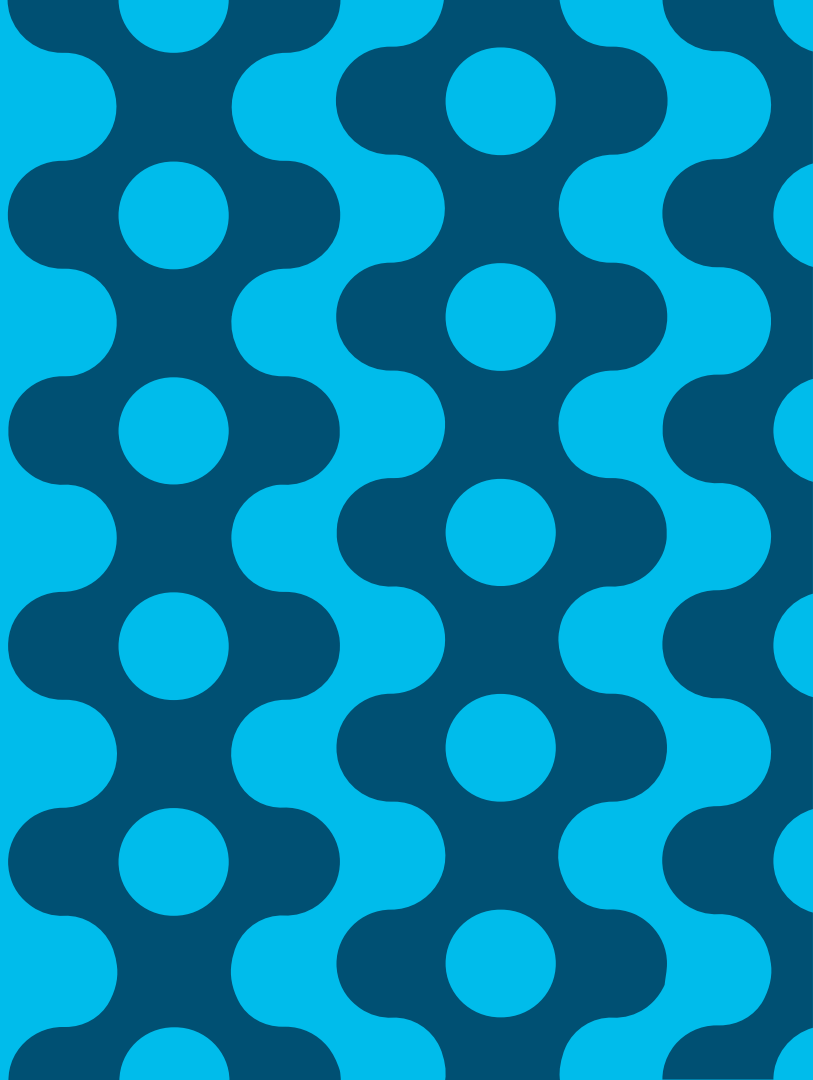
How do I migrate my legacy equipment to the 21st century

Service Providers' Biggest Access Challenges



Need to Grow Revenue, Reduce Costs, De-Risk with Security/Compliance and Improve Customer Experience – *Faster*

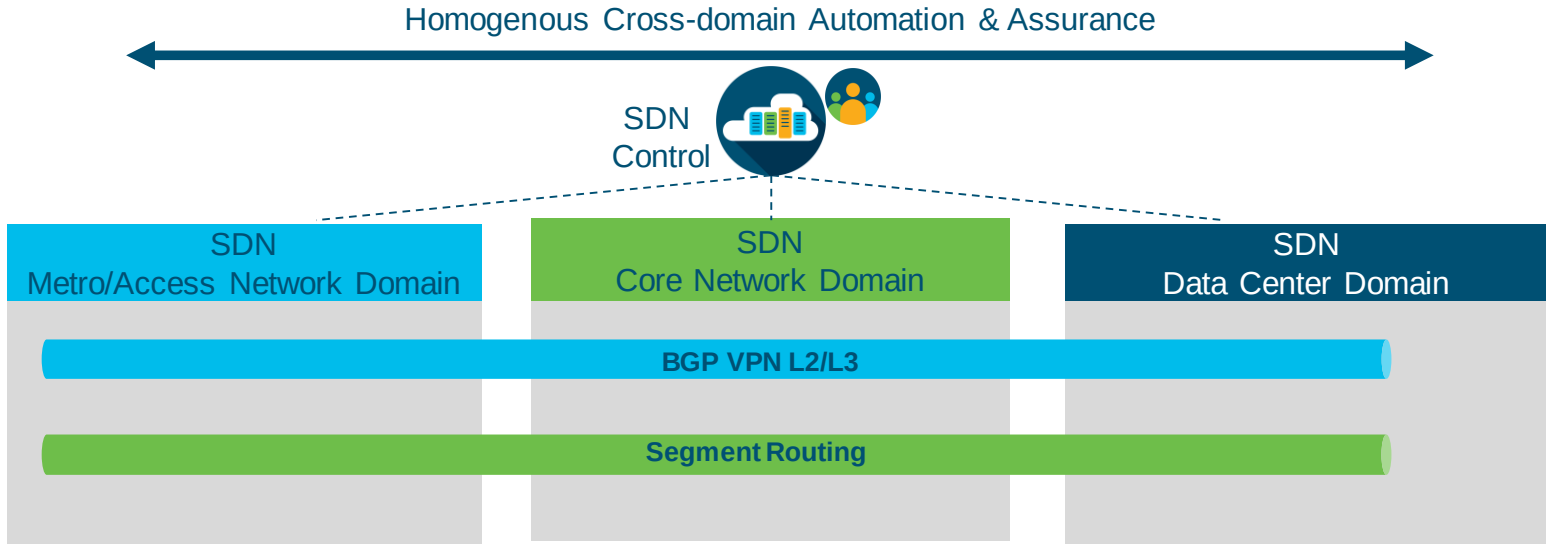
Cisco's SP Access Solutions



Next Generation Access

Guiding Principles	Simple, scalable design to support legacy migration and future growth	Ready for 5G, smart city, M2M communications & IoT	Increased reliability and security
	Services agility with guaranteed SLAs	Ready for uncontrolled environment	Modern network automation and orchestration for lower TCO
Elements	IP/MPLS platforms option ranging from 6 Gbps to 800 Gbps with Vortex Pricing	Advanced timing capabilities, and application aware routing	ISSU, Trustworthy System, <50ms convergence protection with TI-LFA
	Full Netcong/YANG programmability with Segment Routing	Conformal coating, extended temperature	Network Visibility and analytics with Telemetry

Segment Routing for automated service creation

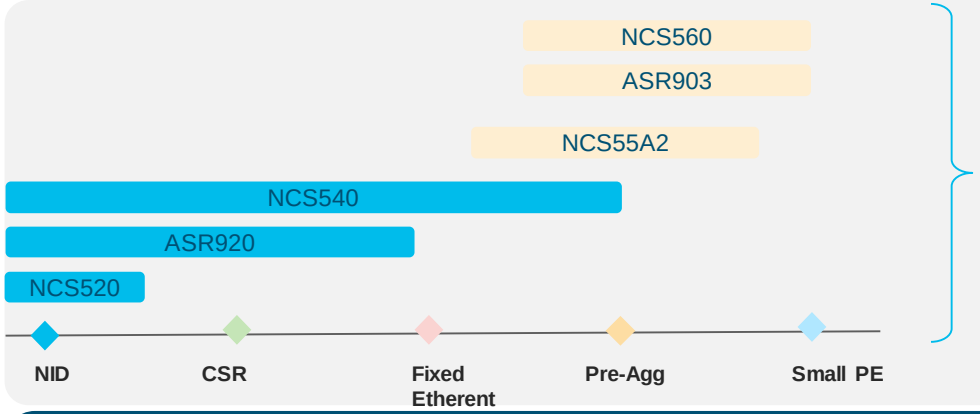


End-to-end service provisioning is simple and scalable

- Multiple network domains under same management teams
- Automated operations
- Homogenous underlay and overlay networks

Cisco Access/Aggregation platform at a glance

Enabling a new era in simplification of Access/Aggregation network



Platform benefits

Secure

- IPSec
- MACsec
- Trustworthy systems
- Imaging signing

Availability

- 50 msec in service software upgrade (ISSU)
- Software pack patching
- Industry leading MTBF

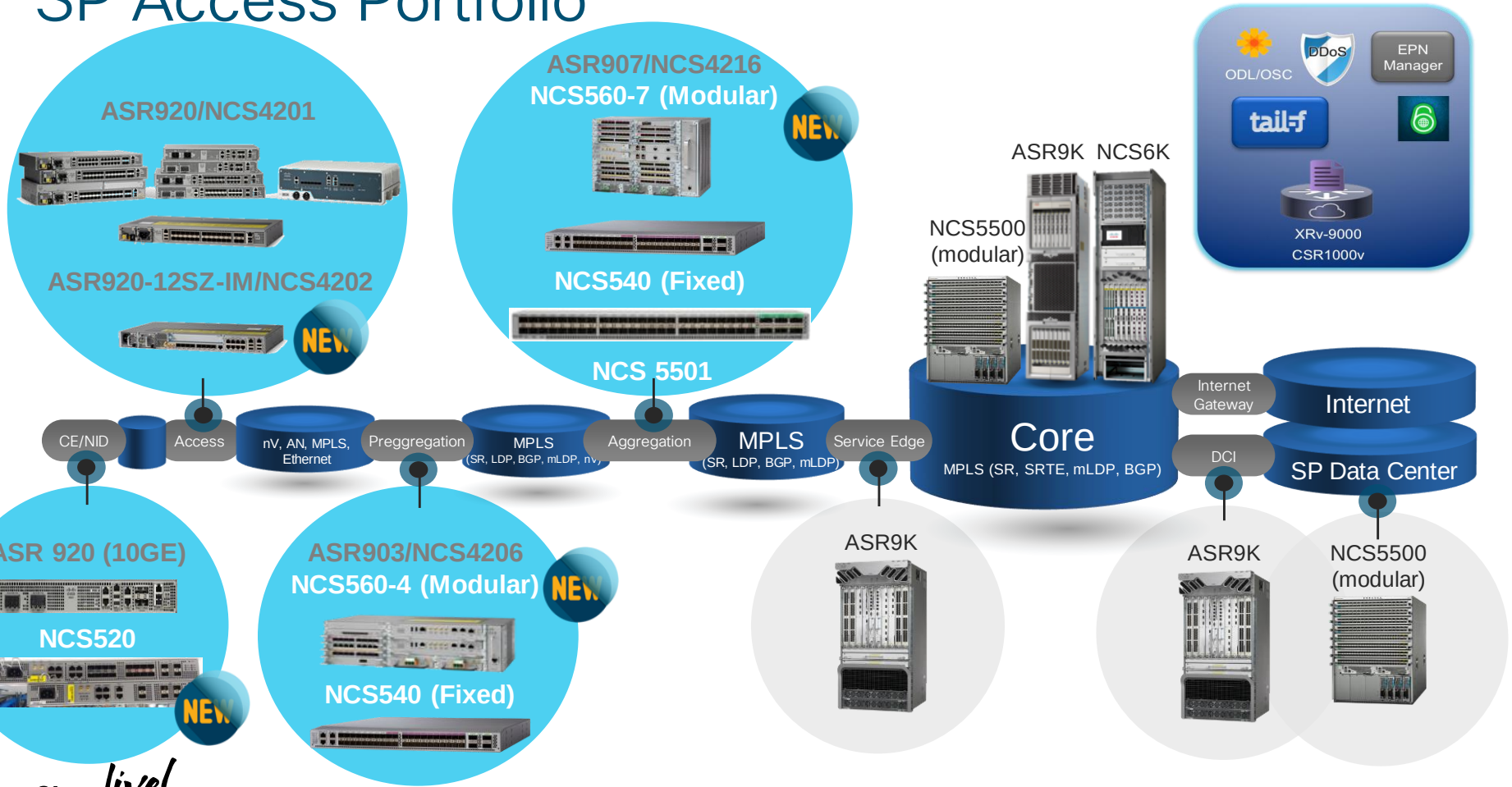
Flexibility

- L2/L3/MPLS/Segment Routing/5G/TDM support
- Optimized power and form factor that scale from 40G to 800G
- Investment protection and PAYG pricing model

Automation

- DevOps toolkit
- Standard based NETCONF/YANG models
- Streaming telemetry
- Zero touch provisioning
- Application hosting

SP Access Portfolio



NCS 500 Series

Access Switch/NID

NCS 520

Access Router

NCS 540

Pre-Agg Router

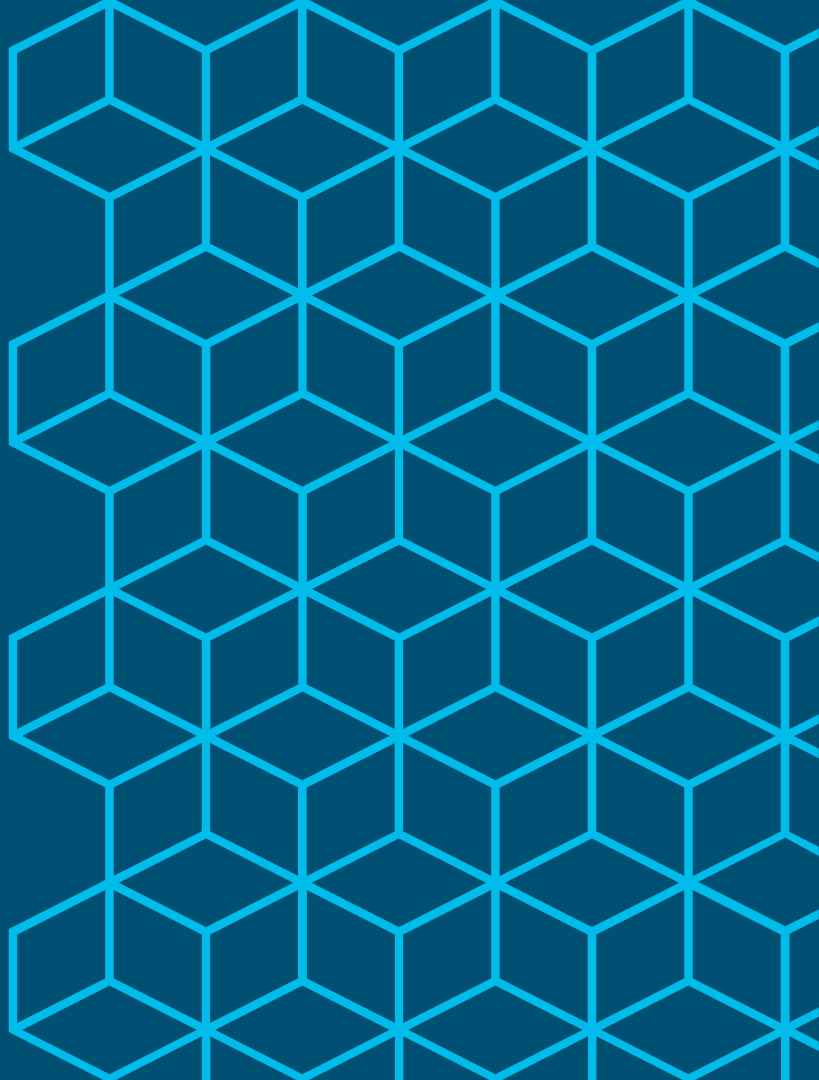
NCS 560

Cisco XE Software

Cisco XR Software

- 5G Ready
- Cost Optimized
- High Density
- Carrier Grade
- Programmability and Automation

Vortex Pricing Model



Customer Needs

Simple, Flexible Consumption Models

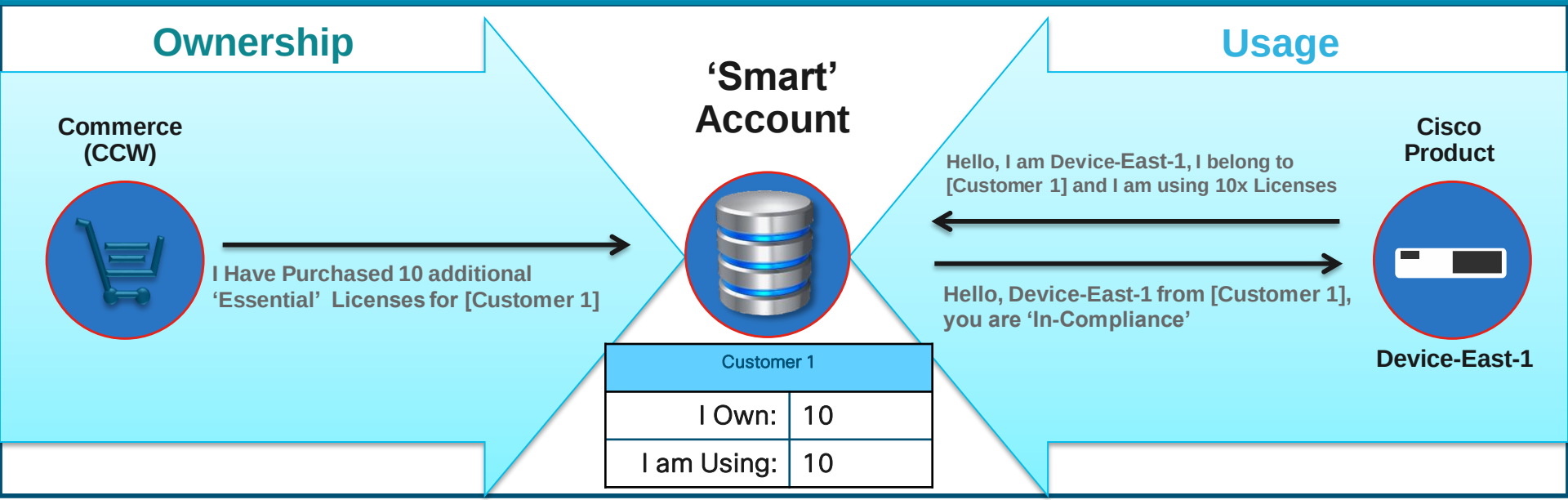
Investment Protection on Network Infrastructure

Network Wide Software with Resource Pooling

Embedded Automation for Mass Scale Networking

What is Cisco Smart Licensing?

- It's a new way of thinking about licensing being applied to all products
- Provides customers with consolidated software ownership and usage information



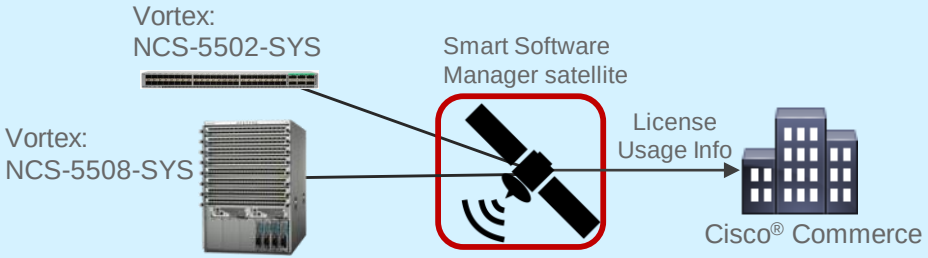
Vortex Smart Licensing Deployment Steps

1 Place Order in CCW at Cisco.com

Cisco® Commerce

I would like to buy 100 Vortex Essentials licenses

2 Activate Vortex Nodes



Enable Smart Licensing on your network, sending usage reports back to Cisco

3 Manage Licenses

Cisco Smart Software Manager
Vortex License Usage Report

Compare usage of 80 licenses to 100 licenses owned? Result is surplus 20 licenses

Efficient License Usage: License Deficit

Smart Account - Common Pool of Vortex Licenses

License Type	Essential SW (Green)	Advanced SW (Blue)
Available	40	20
Usage	35	30
Surplus / Deficit	+5	-10

With a deficit of 10 Advanced licenses, it is time to order more

Site #1:
10x 10x
Vortex Licenses

Site #2:
10x 10x
Vortex Licenses

Site #3:
15x 10x
Vortex Licenses

NCS-5502-SYS



- Common pool of SW licenses held in customer's Smart Account
- After each node reports license usage, a tally is made to see if enough licenses exist
- "Red" shows a deficit (need more licenses) and "Green" shows a surplus available

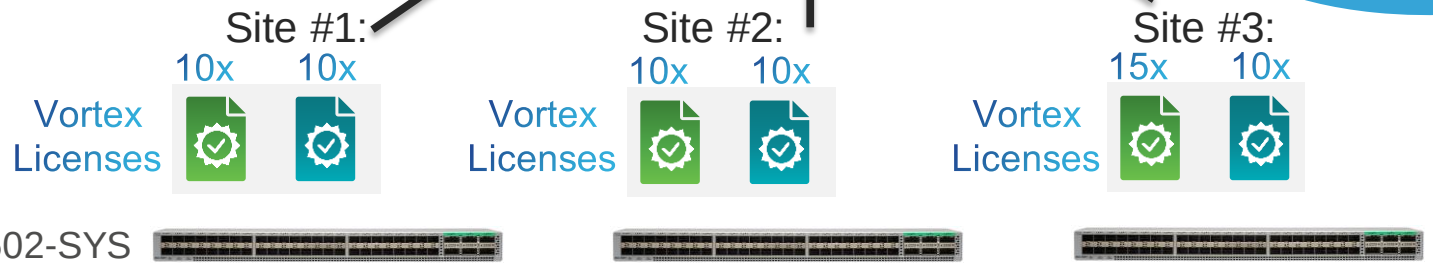
Efficient License Usage: Adding Licenses

Smart Account - Common Pool of Vortex Licenses

License Type	Essential SW (Green)	Advanced SW (Blue)
Available	40	20+20=40
Usage	35	30
Surplus / Deficit	+5	+10

Here we have added 20 new Advanced SW licenses, to get back in compliance

Now customer has a surplus of 10 Advanced SW licenses



- Here customer added 20 new Advanced Software licenses into their Smart Account
- Now with 40 Advanced Software licenses, this leaves a surplus of 10 available for growth

NCS Vortex Feature Licenses

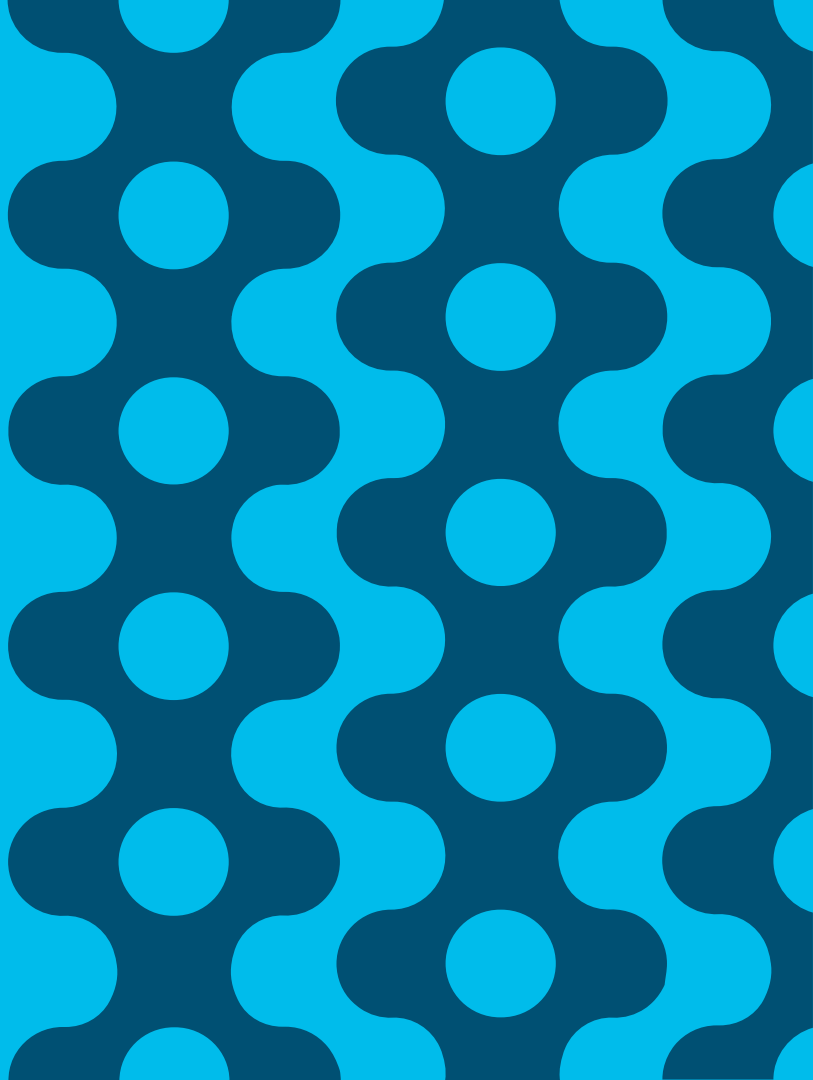
Advanced Software Suite (ADV-10G-RTU)

- VPWS/VPLS: PW, EVPN, EVPN-VPWS, PW OAM, Inter-Domain (Inter-AS) L2VPN
- EVPN: Ethernet Virtual Private Network (EVPN) – EVPN IRB, EVPN VPWS, EVPN Multi-homing
- Ethernet & L2 tunnel: IRB/BVI, L2 protocol tunneling, E-OAM (Performance Management)
- L3VPN: 256 VRFs, MPLS IPv4/v6 VPN (L3VPN/6VPE), VRF-Lite, Multicast VPN (MVPN) IPv4
- L3 Tunnel: IPv6 Provider Edge (6PE), GRE

Essentials Software Suite (ESS-10G-RTU)

- Routing: IP, ISIS, OSPF, BGP, MPLS, SR, basic Multicast (PIM) ICMP
- L2 and Interface: mLACP/MC-LAG, Dot1Q, QinQ, VLAN
- Management: basic Telemetry, Yang models, CLI/SSH, SNMP
- QOS: QoS / H-QoS
- Ethernet: E-OAM (Link-level Fault-Management)
- HA: ISSU, ISIS GR / NSR, BGP NSR, BFD, BGP PIC, SR TI-LFA FRR
- Traffic Engineering: MPLS-TE, RSVP-TE, SR-TE
- Management: Enhanced Telemetry, up to 8 mgmt VRFs
- Security: ACL's, LPTS, SSH, Radius/TACACS
- PTP timing: G.8275.1, G.8275.2, 1PPS, ToD, 10Mhz, Internal GNSS

Network OS Evolution



IOS XR: Foundation of Network Leadership

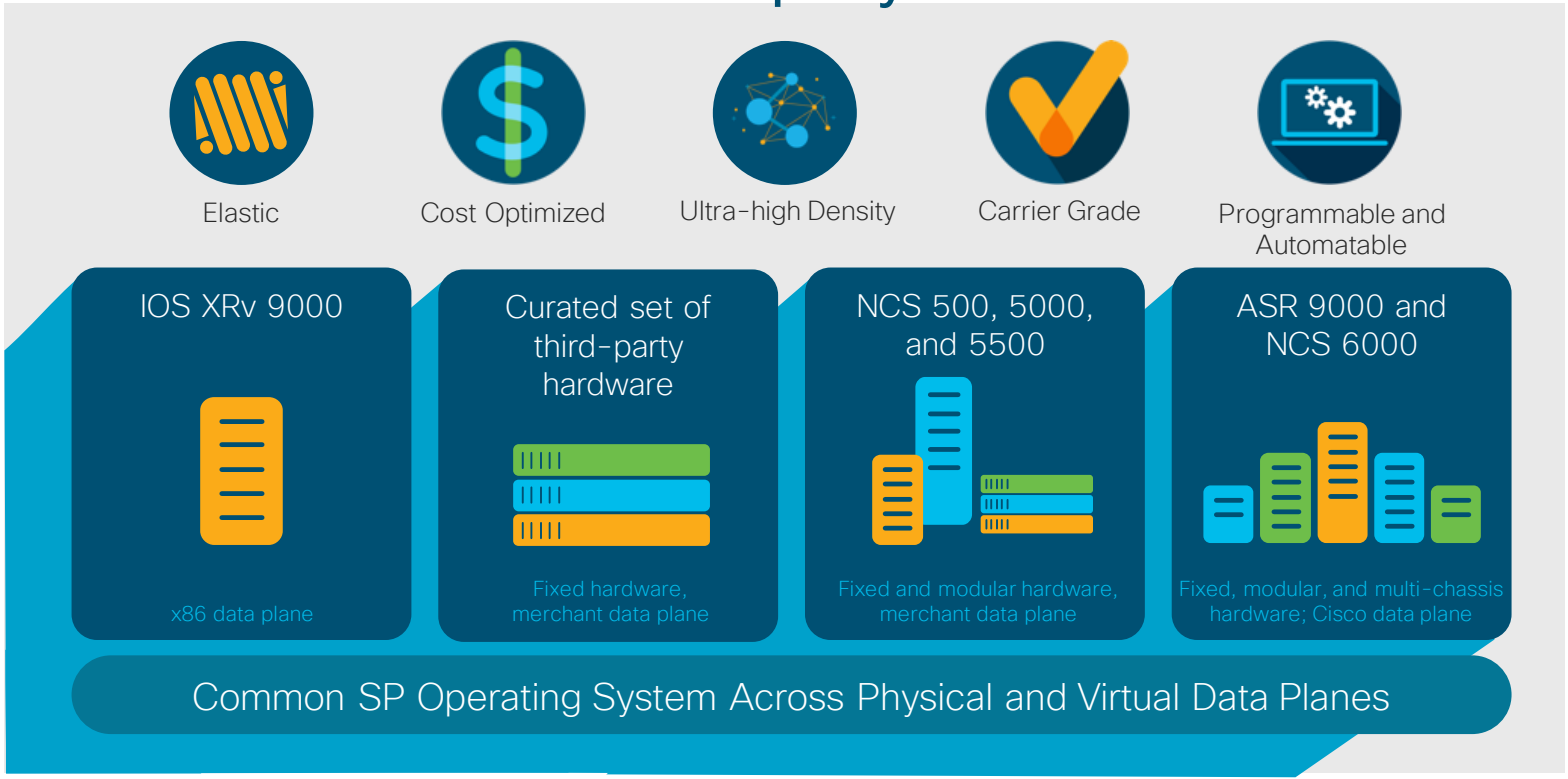
Quality Infused • Solution Driven

Automatable

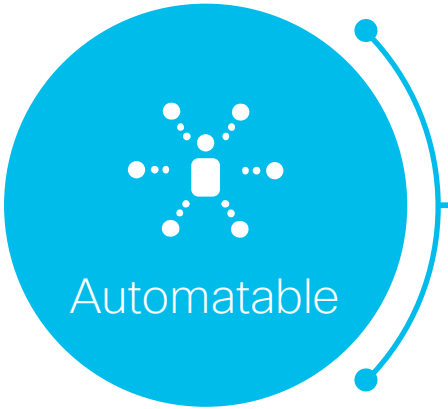
Simplified

Trusted

IOS XR 7: Built for All Deployments



IOS XR: Built for the Automated World



Advanced Telemetry

Visibility to Enable Analytics and Machine Learning

APIs into all Levels of the Software Stack

Creativity and Flexibility through
Model-driven Programmability

Extendable to Third Party Software

Complement the IOS XR Foundation with
Targeted Third Party Software

IOS XR: Simplified

Transport Simplification

Simplified Transport with Segment Routing

Service Simplification

EVPN for Unified Service Delivery, Cloud Native BNG

Operational Simplification – Ease of Use

NSO, Yang Development Kit, Yang Suite

Simplify Your Transport with Segment Routing

Create New Revenue Streams

- Differentiate Services with SR Policies
- Statelessly Chain Value-Add Services (no added protocols)

Deploy with Ease

- Seamless Brownfield Integration
- Single Control for Inter Domain Implementations

Monitor Health

- Data Path Validation Including ECMP
- Real Time Per-Link Performance Monitoring with Telemetry

Increase Availability

- Automated 50ms Protection
- Assured Loopfree Convergence upon Recovery

60% of Service Providers plan to have SR deployed by the end of CY19*

* IHS Markit Survey (2018)

Leadership in the Service Layer with EVPN

Today's Service Layer

- **Complex** — Disparate Service Solutions, Multiple Complex Protocols
- **Inefficient** — Scale Up Model Only, Lacks Control Plane Scale
- **Subpar Resiliency** — Active/Standby Only, Long Convergence at Scale

Solutions with EVPN

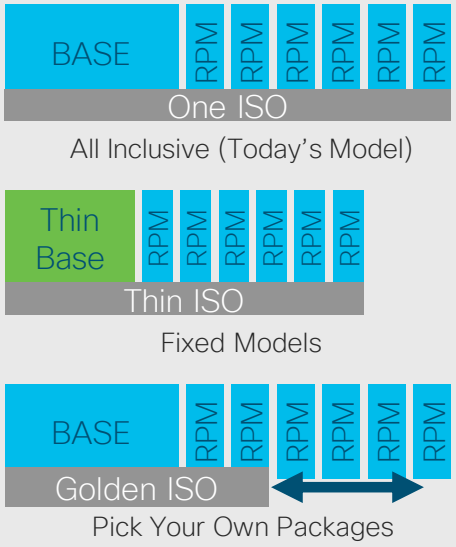
- **Simple** — Single Protocol for the Entire Service Layer
- **Built for Fabrics** — Scale Out Approach for the Service Layer
- **Optimal Resiliency** — Active/Active Solutions with Sub-Second Convergence

85% of Service Providers plan to have EVPN deployed by end of CY19*

* IHS Markit Survey (2018)

IOS XR: Simplifying Operations

Flexible Packaging



Optimized Install

Optional Server Like Install Using Yang Models

Model Based Telemetry Install Health

Programmability Tools

Simplify Service Lifecycle with Cisco NSO

16 Releases with 1000+ Commits after Open Sourcing

YANG *Suite*

Accelerate Modern Programmability Tool Adoption with YDK and Yang Suite

IOS XR: Secure Networks Based on Trusted Infrastructure

Trust Begins in Hardware

Anti-counterfeit and Trust Anchor Infrastructure

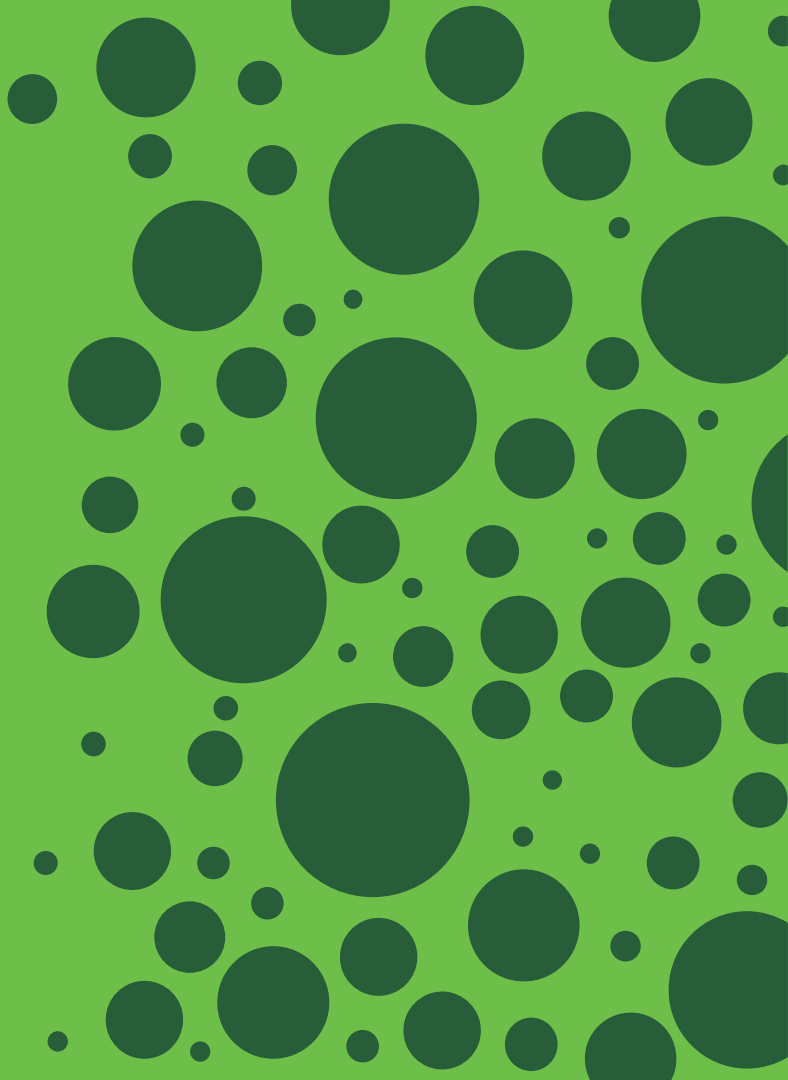
Verifying Trust in the Network OS

Image Signing and Secure Boot Infrastructure

Maintaining Trust at Runtime

Run-time Defense, Encrypted Transport, DDoS Protection

NCS 540



NCS 540 Highlights

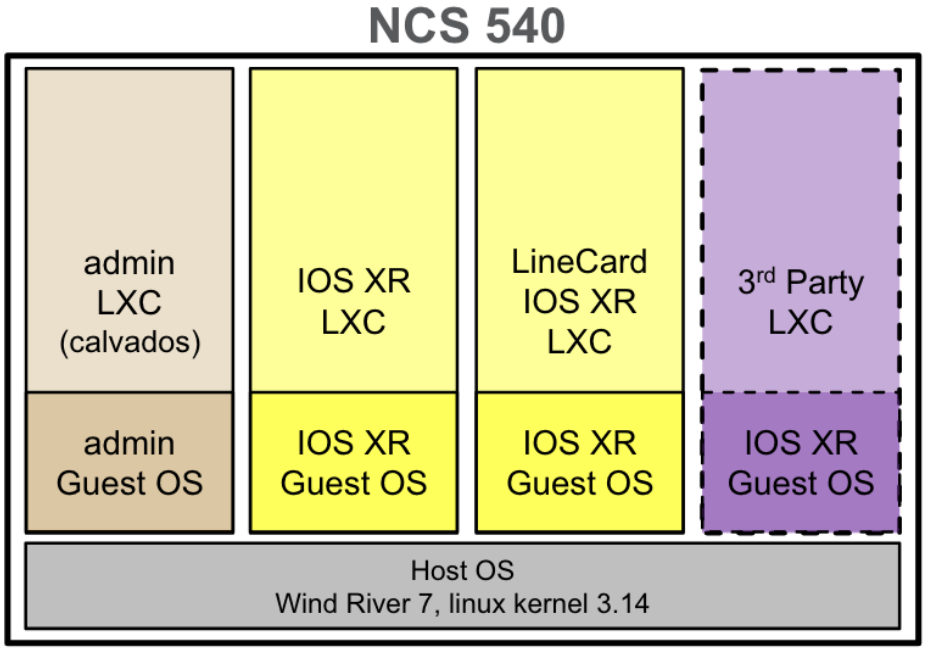
MEF 3.0 CERTIFIED

Guiding Principles	Simple, scalable design to support future growth	Ready for 5G, smart city, M2M communications & IoT	Increased reliability and security
	Services agility with guaranteed SLAs	SDN ready for better application and network interaction	Modern network automation and orchestration for lower TCO
Elements	High capacity 300G and high port density 24x10G+8x25G+2x100G	Advanced timing capabilities, and application aware routing	<50ms convergence protection with TI-LFA
	Full path programmability with Segment Routing	Programmable controller based architecture with Netconf/YANG	Network Visibility and analytics with Telemetry

Simplification Investment Protection Increase Profitability

NCS 540 Software Overview

- IOS XR 64-bit – FCS 6.3.2 March 2018
  - Software feature parity with NCS 5500
  - Advanced Timing Features
- IOS XR on NCS540 has two different XR Containers (XR and XRLC) running on one single CPU

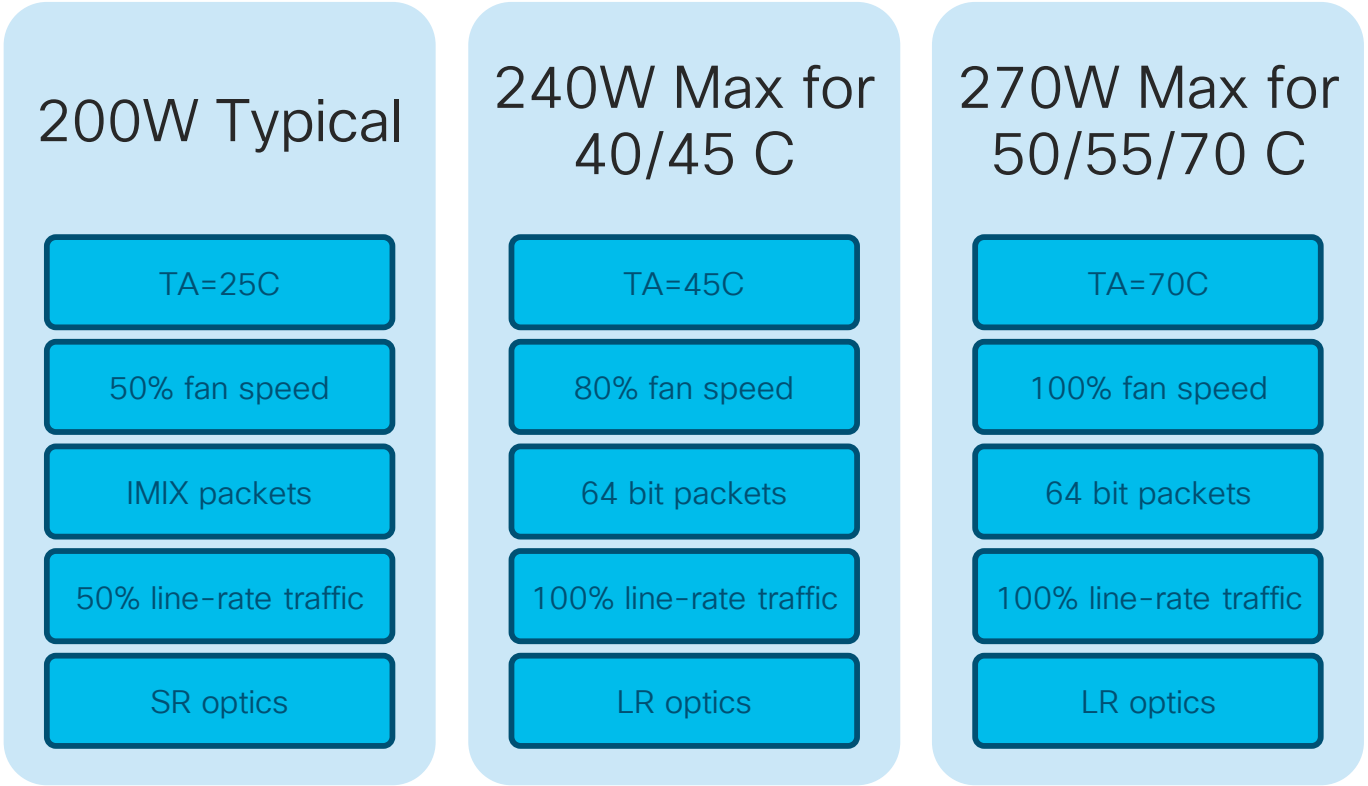


NCS 540 Timing

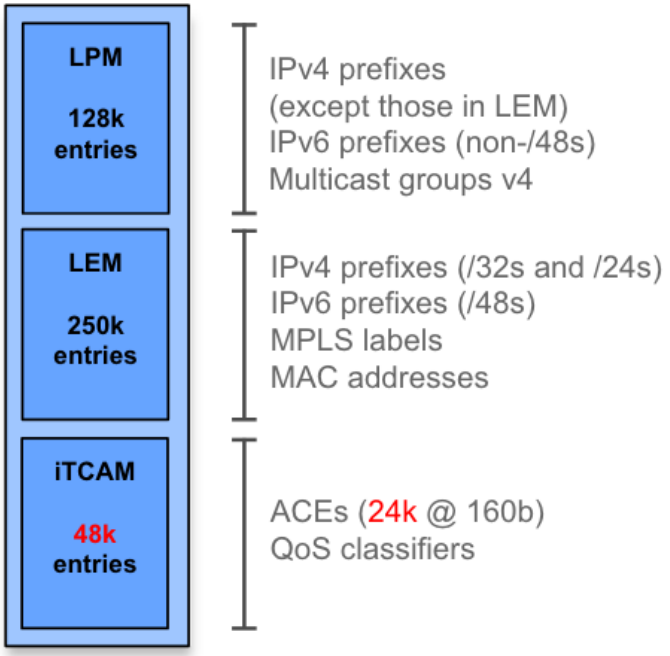
- Timing interfaces: 1pps, 10MHz, ToD in/out, Antenna
- Sync E on all interfaces (G.8262, G.8264)
- IEEE 1588-2008 PTP
- Forwarding ASIC PTP Timestamping
- G.8275.1 with G.8273.2 Class B compliant
- 64 PTP slaves with 64 pps
- Integrated GNSS receiver
- G.8265.1 IPv4/MPLS
- Original default profile with hybrid BC
- G.8275.2, G.8273.4 IPv4/IPv6/MPLS

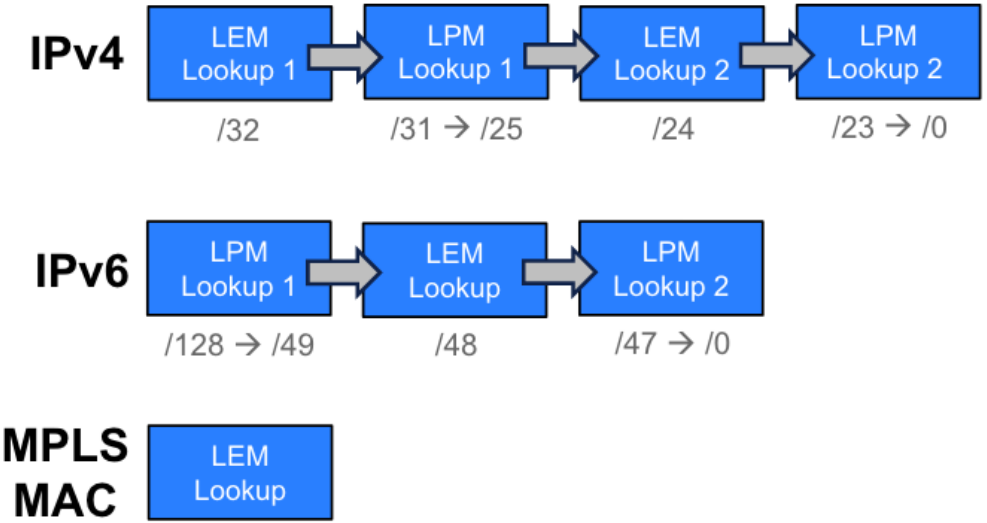
Integrated GNSS receiver

Power Consumption



Packet Memory



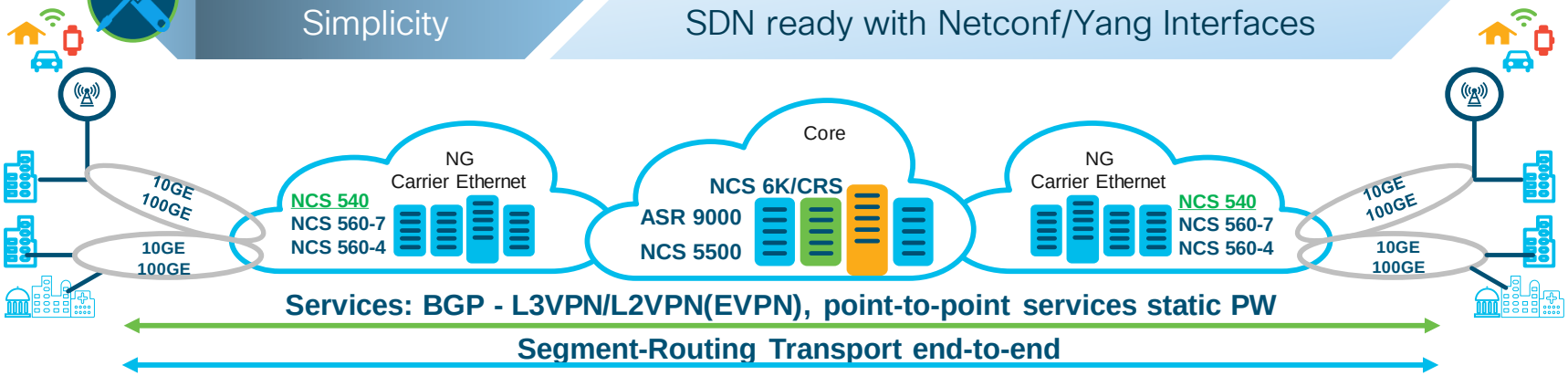


NCS 540 5G Readiness

High bandwidth 10Gbps peak data	Temp hardened high capacity systems 300 Gbps Dense 1/10G UNI with 25/40/100G NNI
Ultra low latency 1-5ms RTT	Low latency switching 2 – 8 usec Switching latency not a bottleneck for RTT
Stringent timing & sync 10-500 nsec	G8265.1, G8275.1 & 2, G.8273.2 (Class B) 1PPS, 10MHz, ToD, Inbuilt GNSS
Ultra Reliability	Secure, reliable, carrier class IOS-XR Reduced down time with SMUs
Network Slicing	Application aware network with traffic engineering SR enabled differentiated SLAs
Programmability Automation	IOS XR with Telemetry, WAE/XTC Integration SDN ready with Netconf/Yang Interfaces

Enable NG Carrier Ethernet with NCS 540

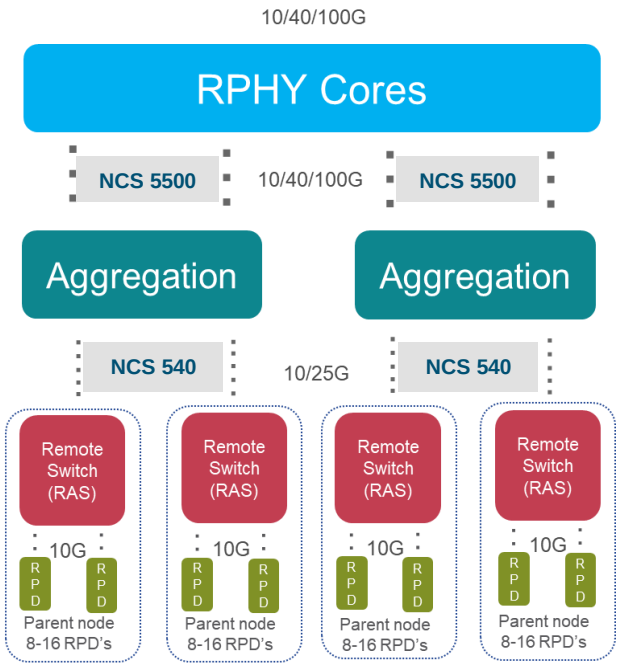
High capacity	300 Gbps with 640G port capacity Dense 1/10G UNI with 25/40/100G NNI
Service Agility	Application-based service creation with SR Unified L2 and IP VPN Services with EVPN
Reliability	Full SR path programmability & guaranteed SLAs <50ms convergence with TI-LFA protection
Operational Simplicity	IOS XR with Telemetry, WAE/XTC Integration SDN ready with Netconf/Yang Interfaces



Remote PHY Aggregation with NCS 540

- Industry coalescing around CableLabs Remote PHY architecture
- The aggregation network requires non-blocking architecture, low and predictable latency with redundant connectivity

Remote Locations	Temperature hardened systems
Long reach	DWDM limiting optics support
Timing	SyncE, 1588v2, BC support
High capacity	25G and 100G NNI options



N540-24Z8Q2C-SYS

ASIC/CPU/Mem	• 300 Gbps BCOM, Intel Broadwell 4C 1.8GHz CPU • 32GB RAM, 128G SSD
Port Config	• 24x1/10G SFP+, 8x 25G SFP28, 2x100G QSFP28 • DWDM/ZR support on all SFP+ interfaces
PSU/Fan	• Modular & redundant PSUs and fans • Front to back airflow
Temp Range	• iTemp 40C to +70C • Conformal coated SKU for hot humid conditions
Optics	• 1/10G: SR/LR/ER/ZR/DWDM • 25G: SR/LR, 40G: SR/LR/ER, 100G: SR/LR/ER4L
Timing	• 1PPS in/out, 10Mhz in/out, ToD, Internal GNSS • SyncE, G.8265.1, G.8275.1/2, Class B BC
Service Scale	• 256 L3VPN, 2K PWs
Software	• FCS 64 bit IOS XR 6.3.2 • Full SW feature parity with NCS 5500

Shipping

SFP+	SFP28	QSFP28
• 24 x GE	• 8 x GE	
• 24 x 10GE	• 8 x 10GE	• 8 x 10GE
	• 8 x 25GE	• 8 x 25GE
		• 2 x 40GE
		• 2 x 100GE

NCS 540 Variants – FCS: IOS XR 7.0.1

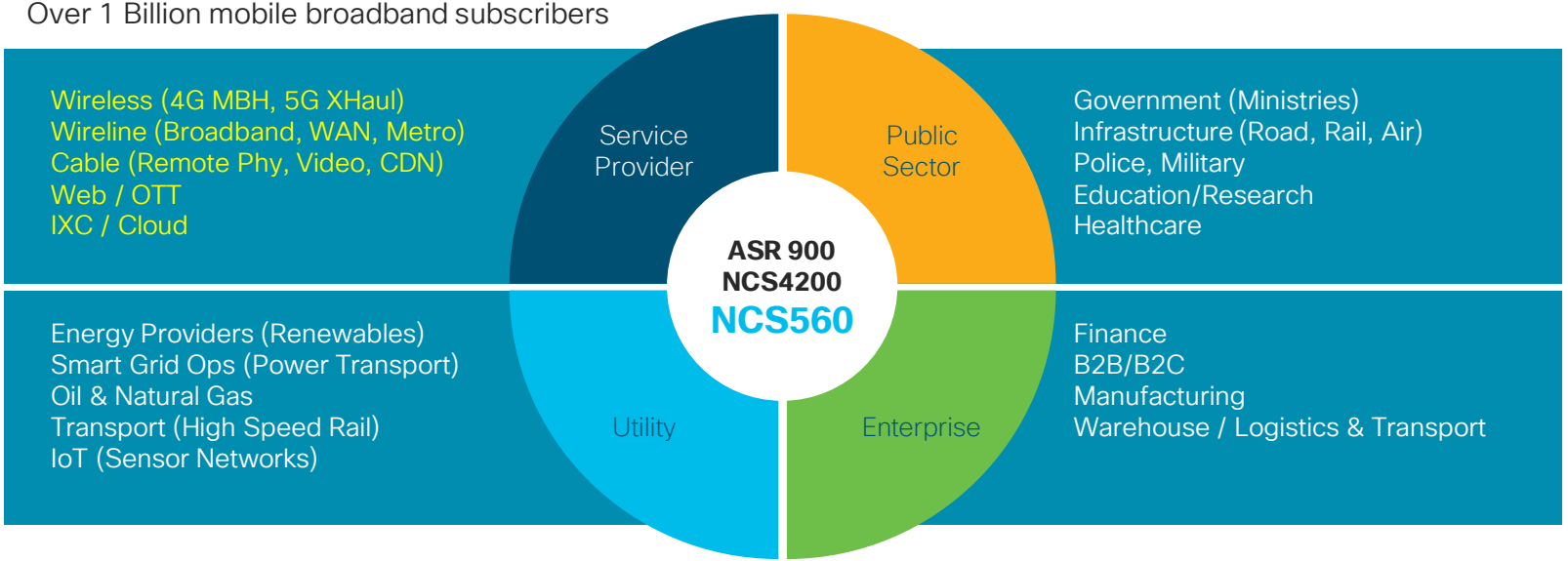
GE/10GE CSR	• 12x1G SFP + 4x1G Cu + 12x10G fixed ports. • Industrial temp, fixed redundant power supplies, side to side airflow • 1588/SyncE, GNSS, 1PPS, ToD, 10MHz, Class-C
5G xHaul	• 16x10G SFP + 4x1G Cu +8x25G+2x100G fixed ports on 1RU chassis. • Industrial temp, fixed redundant power supplies, side to side airflow • 1588/SyncE, GNSS, 1PPS, ToD, 10MHz, Class-C
Small Aggregation	• 28x10G + 4x100G fixed ports on 1RU chassis. • Controlled environment, commercial temp, fixed redundant power supplies • 1588/SyncE Timing
Carrier Ethernet – UPE	• 20x1G+12x10G 1 RU chassis with redundant and fixed power supplies/fans • Fixed redundant power supplies, commercial temp, • 1588/SyncE Timing

NCS 560

NCS 560

SP Access / Aggregation with multiple adjacent markets

- Access & Aggregation Modular Platforms: More than 50.000 Aggregation Routers deployed
- Fixed Platforms: More than 400,000 Cell Site Routers / Pre-Aggregation Routers / L2 NID's deployed
- Top 22 of the 30 Tier-1 Mobile Operators
- 80% of Global LTE subscribers
- Over 1 Billion mobile broadband subscribers



NCS 560
Next Generation Modular Aggregation Router

Guiding Principles	Capacity, Density, Scale 1G, 10G, 40G, 100G	Converged Services Delivery CE, Mobile xHaul, Cable/Remote PHY, FTTx	Security, Reliability, Stability
	Simplified and Application Aware Networking – Segment Routing	SDN ready – Network programmability	Modern network automation and orchestration for lower TCO
Elements	High capacity 800G and High port density 4x100G, 40x10G, 96x1G	Advanced timing capabilities with GNSS, SyncE, G.8265.1, G.8275.1/2 Class B	i-Temp Conformal Coated SKUs Modular and Redundant PSUs and Fan Modules
	Advanced Routing with Segment Routing, SR-TE, TI-LFA and On-Demand Next-Hop	Programmability with Netcong/YANG, BGP-LS, PCEP and XTC integration	High Availability with In Service Software Upgrade Capability

Simplification Investment Protection Increase Profitability

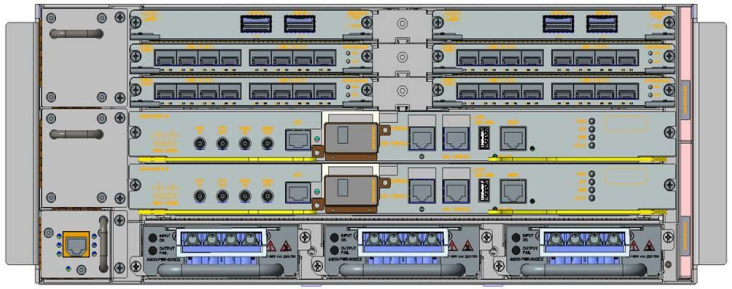
NCS 560-7 (7RU) Overview

ASIC/CPU/Mem	• 800 Gbps BCOM, Intel Broadwell 4C 1.8GHz CPU • 32GB RAM, 128G SSD
Port Config	• Modular. 4 x 100G QSFP28, 32 x 10G SFP+ or 72 x 1G CSFP
PSU/Fan	• Modular & redundant PSUs and fans • Side-to-side airflow. Front-to-back airflow plenum option (2RU)
Temp Range	• iTemp 40C to +65C • Conformal coated SKU's for hot humid conditions
Optics	• 1/10G: BX/2BX, SR/LR/ER/ZR/DWDM SFP • 40G: SR/LR/LR4L/ER QSFP+, 100G: SR/LR/ER4L QSFP28
Software	• FCS 64 bit IOS XR 6.6.2 (GA, NCS 540, NCS 5500 parity)
Timing	• 1PPS in/out, 10Mhz in/out, ToD, Internal GNSS, External GNSS • SyncE, G.8265.1, G.8275.1/2, Class B BC
Service Scale	• 2M v4/v6 prefixes, 4K VRF*, 8K Bridge Doman, 8K VFI, 16K EFP/EVC, 256K MAC, 48K Queues/Policers*
Programmability	• Netconf yang, Restconf, BGP-LS, PCEP • XTC Integration
Advanced Routing	• SR, SR-TE, TI-LFA, On Demand Next Hop

* Scale targets – To Be Confirmed

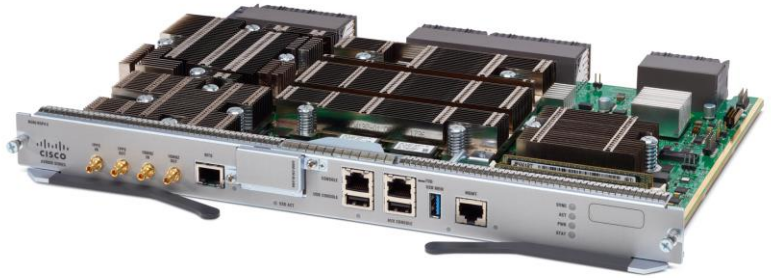
NCS 560-4 (4RU) Overview

ASIC/CPU/Mem	· 800 Gbps BCOM, Intel Broadwell 4C 1.8GHz CPU · 32GB RAM, 128G SSD
Port Config	· Modular. 4 x 100G QSFP28, 32 x 10G SFP+ or 72 x 1G CSFP
PSU/Fan	· Modular & redundant PSUs and fans · Side-to-side airflow. Front-to-back airflow plenum option (2RU)
Temp Range	· iTemp 40C to +65C · Conformal coated SKU's for hot humid conditions
Optics	· 1/10G: BX/2BX, SR/LR/ER/ZR/DWDM SFP · 40G: SR/LR/LR4L/ER QSFP+, 100G: SR/LR/ER4L QSFP28
Software	· FCS 64 bit IOS XR 6.6.2 (GA, NCS 540, NCS 5500 parity)
Timing	· 1PPS in/out, 10Mhz in/out, ToD, Internal GNSS, External GNSS · SyncE, G.8265.1, G.8275.1/2, Class B BC
Service Scale	· 2M v4/v6 prefixes, 4K VRF*, 8K Bridge Doman, 8K VFI, 16K EFP/EVC, 256K MAC, 48K Queues/Policers*
Programmability	· Netconf yang, Restconf, BGP-LS, PCEP · XTC Integration
Advanced Routing	· SR, SR-TE, TI-LFA, On Demand Next Hop



* Scale targets – To Be Confirmed

NCS 560 RSP4 / 4-E

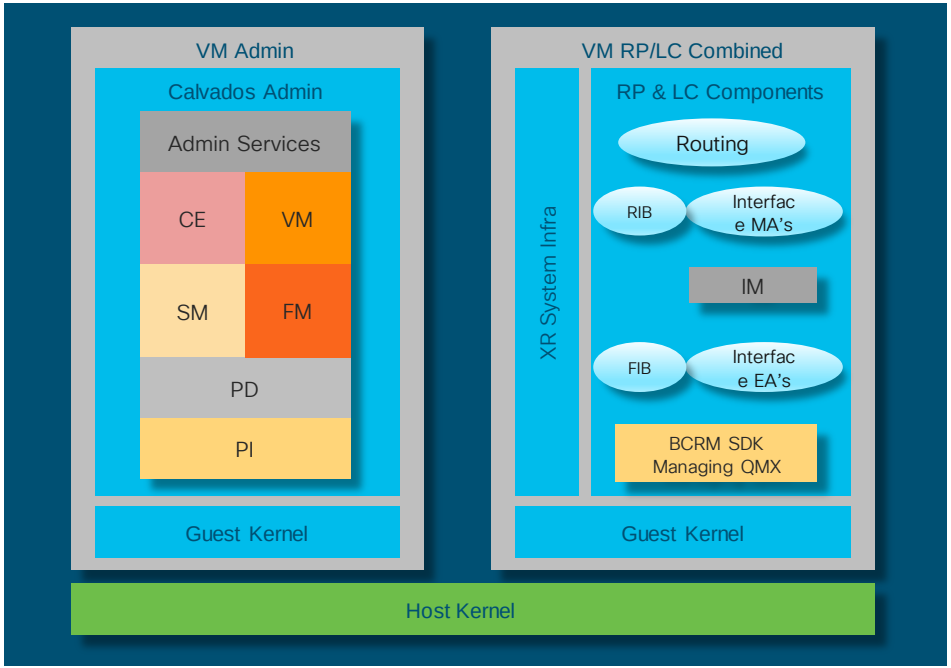


- 2 types of RSP – Large scale and XLarge scale
  - N560-RSP4 (7RU) / N560-4-RSP4 (4RU)
    - Large Scale* (32GB DRAM, w/o ext TCAM)
    - ≤ 350K L3 prefixes (v4 + v6), 2K* VRF's, 8K mcast routes
    - 8K L2 Bridge Domains, 16K EFP's, 32K Queues*, 26K Policers*
  - N560-RSP4-E (7RU) / N560-4-RSP4E (4RU)
    - XLarge Scale* (32GB DRAM /w ext. 20M/512M TCAM)
    - ≤ 2M L3 prefixes (v4 + v6), 4K* VRF's, 16K mcast routes
    - 8K L2 Bridge Domains, 16K EFP's, 48K Queues*, 26K Policers*

- Both RSP's run 64-bit IOS-XR (eXR) @ different scale**
  - IP/MPLS, Segment Routing (SR, SR-TE, TI-LFA), BFD
  - Multicast Routing (IGMPv2/v3, PIM-SM, PIM-SSM)
  - L2VPN (VPLS, EVPN-VPWS), L3VPN (v4/v6), QoS
  - Timing: SyncE, IEEE 1588v2 PTP (G.8275.1, G.8275.2, G.8273.2)
  - SDN / Programmability (Netconf/YANG, PCEP, SR-PCE, BGP-LS, Scripting)

* Scale targets – To Be Confirmed
** Post FCS – SW Testing / Scale Profile

NCS 560 RSP4 / 4-E SW Architecture Diagram



- Calvados VM/Container
  - Administrative Purposes
    - Inventory management
    - Environment management
    - ISSU
- RP VM/Container
  - control plane (routing protocols, etc.)
- LC VM/Container
  - data plane
  - configure and manage the underlying NPU for packet forwarding and switching

NCS 560 RSP4 / 4-E

Backplane Resources – Capacity Mapping – 7 RU

FPGA Option 1 = Port Expansion

14	20G	20G	15
12	40G	40G	13
10	80G	80G	11
8	10G	200G (CAUI 4)	9
N560-RSP4(-E)			
N560-RSP4(-E)			
6	10G	200G (CAUI 4)	7
4	80G	80G	5
2	40G	40G	3
0	20G	20G	1

- Serdes (XFI) capacity from QMX ASIC to individual Slots
- Port Expansion Mode (CAUI4 to 9 XFI Port Expansion)
  - 2x100G or 8x10G in slots # 7+9
  - 8x10G in slots # 4+5+10+11
  - 16x1G + 1x10G in slots # 2+3+12+13
  - 8x1G + 1x10G in slots # 0+1+14+15
  - Support for Stats, Netflow*, PTP – TC, PTP, LI*
- If 8x10G IM in Slots # 4+5, No IM can be in slot 6
- If any IM in slot # 6 > 10G, 8x10G cannot be used in slots # 4+5
- If 8x10G IM in Slots # 10+11, No IM can be in slot 8
- If any IM in slot # 8 > 10G, 8x10G cannot be used in slots # 10+11

* Post FCS – To Be Confirmed

NCS 560 RSP4 / 4-E

Backplane Resources – Capacity Mapping – 7 RU

FPGA Option 2 = Pass Through

14	20G	20G	15
12	20G	20G	13
10	40G	40G	11
8	100G (CAUI 10/4)	200G (CAUI 4)	9
N560-RSP4(-E)			
N560-RSP4(-E)			
6	100G (CAUI 10/4)	200G (CAUI 4)	7
4	40G	40G	5
2	20G	20G	3
0	20G	20G	1

- Serdes (XFI) capacity from QMX ASIC to individual Slots
- Port Expansion Mode (CAUI4-to-CAUI10)
  - 2x100G or 8x10G in slots # 7+9
  - 1x100G or 8x10G in slots # 6+8
  - 16x1G + 1x10G in slots # 4+5+10+11
  - 8x1G + 1x10G in slots # 0+1+2+3+12+13+14+15
  - Support for Stats, Netflow*, PTP – TC, PTP, LI*

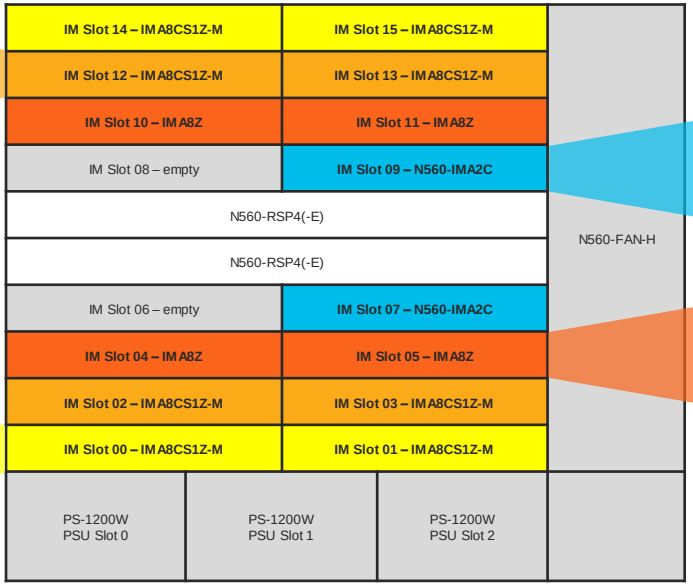
NCS 560 RSP4 / 4-E

7 RU – Example configurations

Configuration : 4 x 100GE + 40 x 10GE + 96 x 1GE @ I-Temp (65 C)*

A900-IMA8CS1Z-M Interface Module
16 x 1GE + 1 x 10GE mode
(8 x C-SFP : GLC-2BX-D)

A900-IMA8CS1Z-M Interface Module
8 x 1GE + 1 x 10GE mode
(8 x regular SFP)



N560-IMA2C Interface Module
2 x 100GE QSFP28

A900-IMA8Z Interface Module
8 x 10GE SFP+

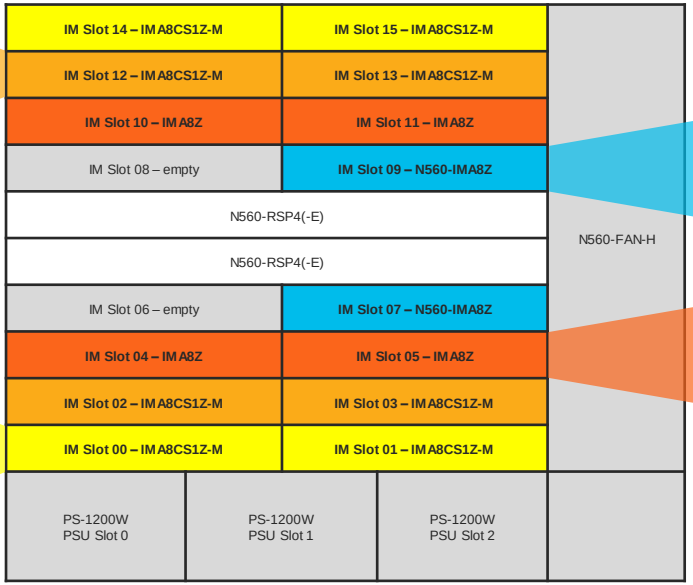
NCS 560 RSP4 / 4-E

7 RU – Example configurations

Configuration : 56 x 10GE + 96 x 1GE @ I-Temp (65 C)*

A900-IMA8CS1Z-M Interface Module
16 x 1GE + 1 x 10GE mode
(8 x C-SFP : GLC-2BX-D)

A900-IMA8CS1Z-M Interface Module
8 x 1GE + 1 x 10GE mode
(8 x regular SFP)



A900-IMA8Z Interface Module
8 x 10GE SFP+

A900-IMA8Z Interface Module
8 x 10GE SFP+

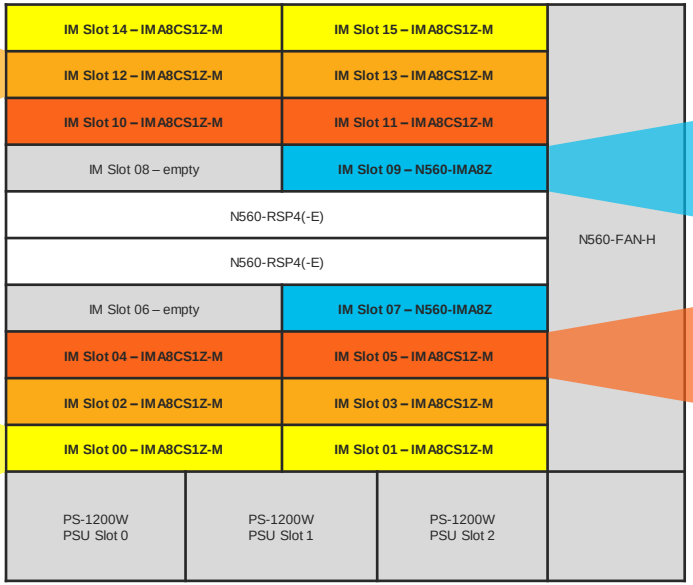
NCS 560 RSP4 / 4-E

7 RU – Example configurations

Configuration : 28 x 10GE + 160 x 1GE @ I-Temp (65 C)*

A900-IMA8CS1Z-M Interface Module
16 x 1GE + 1 x 10GE mode
(8 x C-SFP : GLC-2BX-D)

A900-IMA8CS1Z-M Interface Module
8 x 1GE + 1 x 10GE mode
(8 x regular SFP)



A900-IMA8Z Interface Module
8 x 10GE SFP+

A900-IMA8CS1Z-M Interface Module
16 x 1GE + 1 x 10GE mode
(8 x C-SFP : GLC-2BX-D)

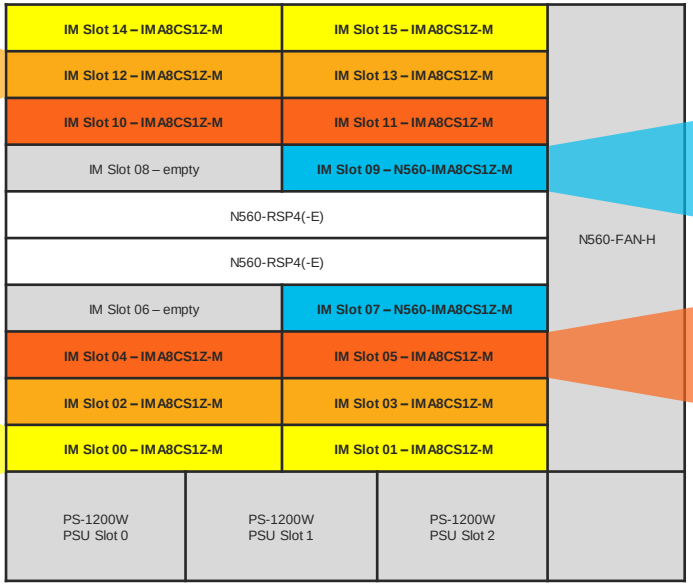
NCS 560 RSP4 / 4-E

7 RU – Example configurations

Configuration : 14 x 10GE + 192 x 1GE @ I-Temp (65 C)*

A900-IMA8CS1Z-M Interface Module
16 x 1GE + 1 x 10GE mode
(8 x C-SFP : GLC-2BX-D)

A900-IMA8CS1Z-M Interface Module
8 x 1GE + 1 x 10GE mode
(8 x regular SFP)



A900-IMA8CS1Z-M Interface Module
16 x 1GE + 1 x 10GE mode
(8 x C-SFP : GLC-2BX-D)

A900-IMA8CS1Z-M Interface Module
16 x 1GE + 1 x 10GE mode
(8 x C-SFP : GLC-2BX-D)

NCS 560 RSP4 / 4-E

Backplane Resources – Capacity Mapping – 4 RU

FPGA Option 1 = Port Expansion

4	80G	80G	5
2	100G	100G	3
0	200G	200G	1
N560-4-RSP4(-E)			
N560-4-RSP4(-E)			

- Serdes (XFI) capacity from QMX ASIC to individual Slots
- Port Expansion Mode (CAUI4 to 9 XFI Port Expansion)
  - 2x100G or 8x10G in slots # 0+1
  - 8x10G in slots # 2+3+4+5
  - 16x1G + 1x10G in slots # 2+3+4+5
  - 8x1G + 1x10G in slots # 2+3+4+5
  - Support for Stats, Netflow*, PTP – TC, PTP, LI*

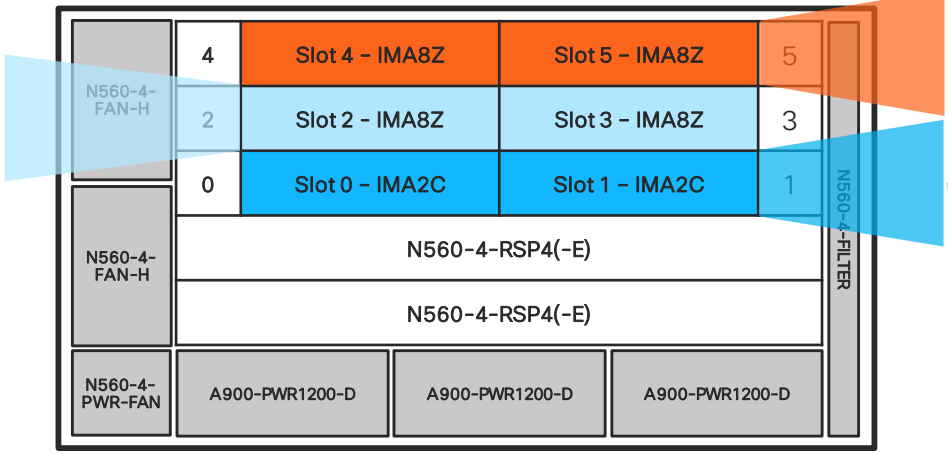
* Post FCS – To Be Confirmed

NCS 560 RSP4 / 4-E

4 RU – Example configurations

Configuration : 4 x 100GE + 32 x 10GE @ I-Temp (65 C)

A900-IMA8Z Interface Module
8 x 10GE SFP+



A900-IMA8Z Interface Module
8 x 10GE SFP+

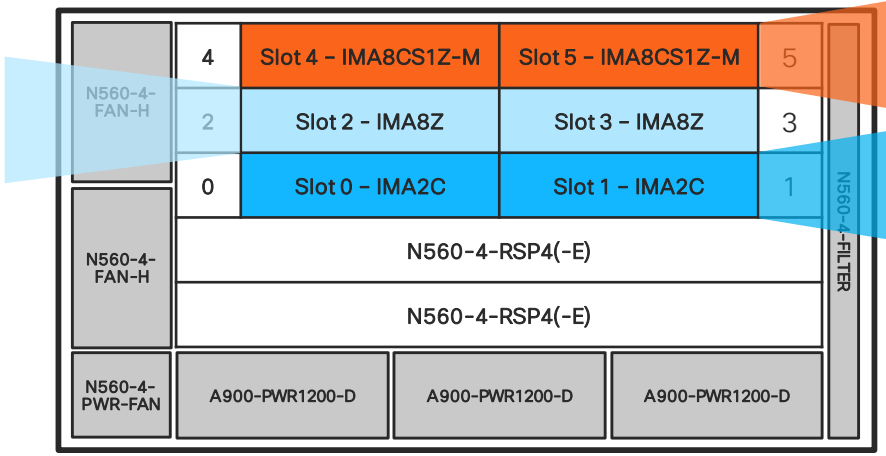
N560-IMA2C Interface Module
2 x 100GE QSFP28

NCS 560 RSP4 / 4-E

4 RU – Example configurations

Configuration : 4 x 100GE + 18 x 10GE + 32 x 1GE @ I-Temp (65 C)

A900-IMA8Z Interface Module
8 x 10GE SFP+



A900-IMA8CS1Z-M Interface Module
16 x 1GE + 1 x 10GE mode
(8 x C-SFP : GLC-2BX-D)

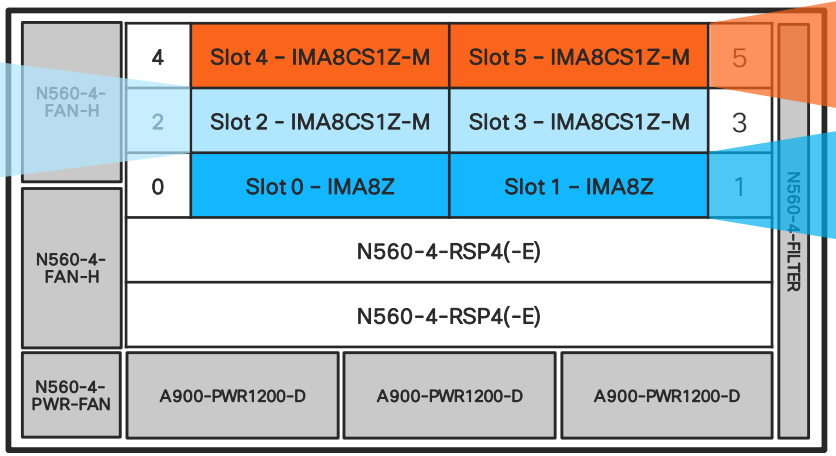
N560-IMA2C Interface Module
2 x 100GE QSFP28

NCS 560 RSP4 / 4-E

4 RU – Example configurations

Configuration : 20 x 10GE + 64 x 1GE @ I-Temp (65 C)

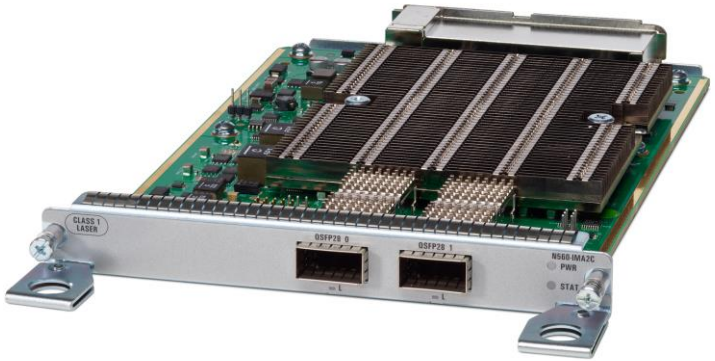
A900-IMA8CS1Z-M Interface Module
16 x 1GE + 1 x 10GE mode
(8 x C-SFP : GLC-2BX-D)



A900-IMA8CS1Z-M Interface Module
16 x 1GE + 1 x 10GE mode
(8 x C-SFP : GLC-2BX-D)

A900-IMA8Z Interface Module
8 x 10GE SFP+

NCS 560 – 100GE - IMA2C



- 2 x 100GE Interface Module (or 2 x 40GE)
  - Increased 100GE Interface Density per ASR 907 / NCS4216 System
  - Each port can be configured as 100G or 40G independently
  - Support for OTU4 and OTU3 with G.709 FEC
    - Tentative 100GE QSFP28 optics support*
      - QSFP-100G-LR4-S
      - QSFP-100G-SR4-S
      - QSFP-100G-ER4L-S
      - QSFP-100G-CWDM4-S**
      - QSFP-100G-SM-SR**
    - Tentative 40GE QSFP+ optics**
      - QSFP-40G-LR4
      - QSFP-40G-SR4
      - QSFP-40G-ER4
      - QSFP-40G-LR4-S
      - QSFP-40G-SR4-S

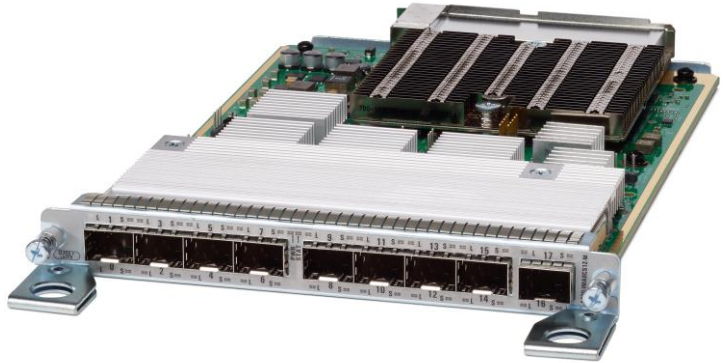
* I-Temp 100G QSFP optic under review
** Not planned for FCS

NCS 560 – 10GE – IMA8Z

- 8-Port 10GE SFP+ Line Card
- A900-IMA8Z
  - Regular SFP+ support
    - SFP-10G-SR/LR/ER/ZR
  - Bidir SFP+ support
    - SFP10G-BXD/U-I, SFP-10G-BX40D/U-I
  - DWDM SFP+ support
    - DWDM-SFP10G-XX.XX, DWDM-SFP10G-C
    - ONS-SC+-10G-xx.x, ONS-SC+-10GEP-xx.x
- Capabilities
  - SyncE, 1588v2 PTP
  - G.709 / OTN Wrapper - GFEC
  - OTU2 framing on 10GE port (Future – Post FCS)

NCS 560 – High Density 1GE - IMA8CS1Z-M

- 1-Port 10GE SFP+/1GE CSFP & 8-Port 1GE/FE SFP/CSFP Line Card
- A900-IMA8CS1Z-M
  - 10/100/1000 Copper SFP support
  - SFP/CSFP FX support
  - SFP/CSFP SX/LX/ZX support
  - SFP+ SR/LR/ZR and WDM
- Capabilities
  - 1GE density increase from **8** (SFP) to **16** (CSFP) GE Ports per Card
  - MACsec for 1G ports (Future – Post FCS)
  - OTU2 framing on 10GE port (Future – Post FCS)
- 1GE Port Expansion directly on the Card
  - Enables Oversubscription on the Card



1 x SFP+/CSFP and 8 x SFP/CSFP
(A900-IMA8CS1Z-M)

In Service Software Upgrade (ISSU)

In use today

Ease of Upgrade

Operational Efficiency - planning/execution improvements

Time to Market

Faster Service introduction / Roll-out

OPEX Reduction

scheduled / dependable maintenance windows
Automation

Minimal Service Interruption

Network availability / Service Quality improvements (SLA)

Risk Mitigation

Faster Critical issue resolution / mitigation (PSIRT/DDoS/P1 bug)

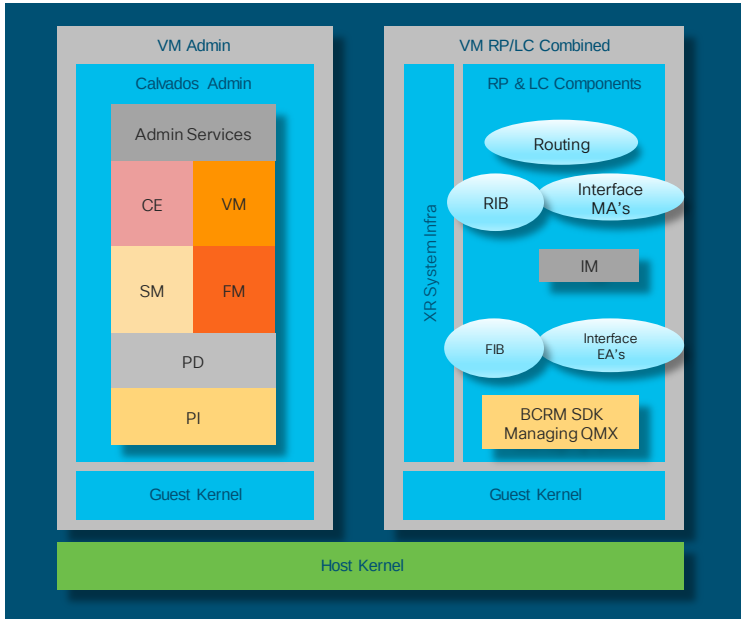
Customer Satisfaction

less downtime perceived, service quality improved

NCS 560 / RSP4 – ISSU

Design Principles

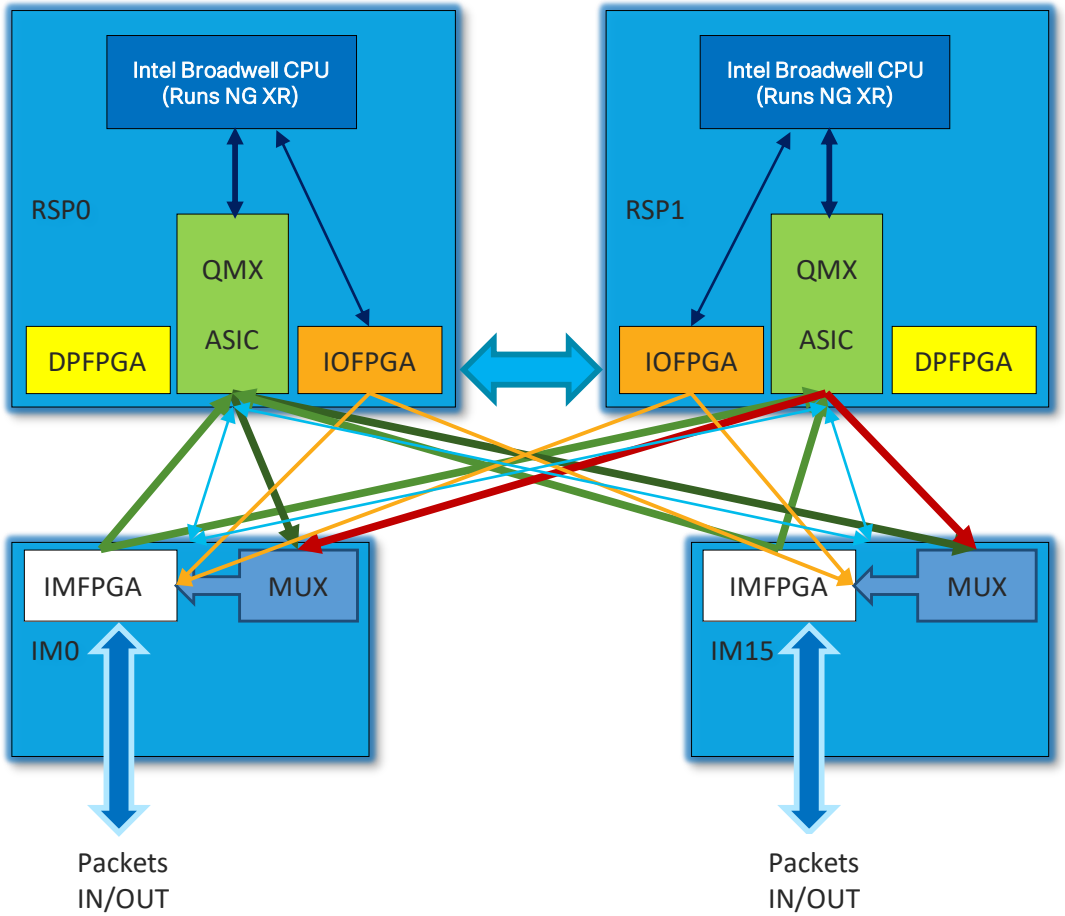
- Use of Virtualization where possible
  - Active VM on Active-RSP and Standby VM on Standby RSP
- ISSU with HA Option
  - GR
  - NSF
  - Modified NSR design (Zero Topology Loss, minimal Packet Loss ≦ 50 msec)
- No SDR support, No Multi-Chassis support
- OCU (Orchestrated Calvados Upgrade) based ISSU



NCS 560 / RSP4 – ISSU

- The RSP cards run in 1:1 redundancy model. They talk to each other over backplane directly, managed by IOFPGA.
- The LC slots support different types of interface modules (IM's) like 16x1G, 8x10G, 2x100G. There is no dedicated CPU on the LCs, and the IMFPGA manages the module in terms of programmability and monitoring.
- IMs bi-cast all ingress packets to both RSP cards, which perform the switching/exception handling.
- Egress traffic from the card that runs Standby XR VM is discarded by the IM, using a hardware MUX logic. The MUX is flipped whenever there is an XR redundancy switchover, so that packets from the new Active RSP starts getting sent out to wire.

NCS 560 / RSP4 – ISSU



EOBC interactions for inter-RP communication and HA synchronization

Ingress packet path (Bicast) from IM to QMX of both RSP cards

Egress packet path from QMX on Active RSP to IM cards

Egress packet path from QMX on Standby RSP to IM cards (the packets are dropped at IM MUX)

1pps signal from IOFPGA to IMs, which is overloaded for the HW assisted switchover notification mechanism.

Punt / Inject path from QMX to RSP CPU for Control/Exception packets

IOFPGA access / interrupts for Card Management, system level functions, Timing control

IMFPGA access/interrupts for IM management, IM system level functions and programming, from Active RSP.

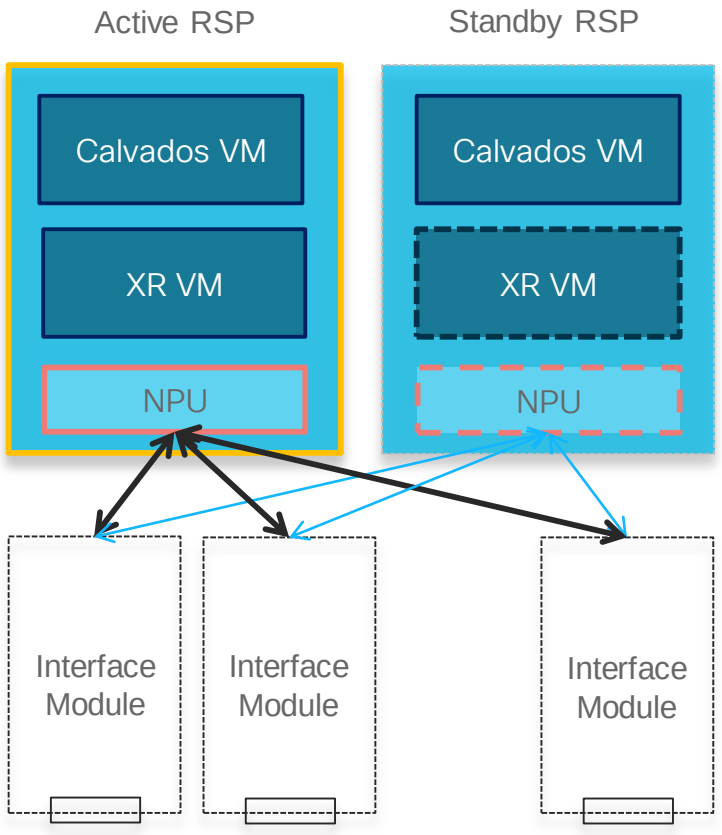
NCS 560 / RSP4 – ISSU

- NCS 560 RSP ISSU uses Virtualization (2 VM's from the Intel CPU)
- With Virtualization, we spawn a second instance, running in parallel with the first instance that executes as part of everyday' s operations.
- The second instance is the target to which the system is upgraded to, and is said to be V2, while the first instance is said to be V1.
- The V2 instance learns the configuration from V1, as well as the initial operational data (routes, adjacencies, segments, etc.). It is updated in real-time when operational data is changing (route discovery, etc.)
  - 1st VM (V1 Active & V2 Standby) = Host OS and Admin VM (aka Calvados VM)
  - 2nd VM (V1 Active & V2 Standby)= IOS-XR (Service) VM (aka XR VM)
- The diagrams on the next slides illustrate ISSU from one release to another with:
  - Fully Redundant Control / Data Plane
  - XR Admin Plane (Calvados VM) has active modules spread across Active & Standby RSP
  - Control planes are in sync allowing for stateful switchover
  - XR Nodes on both RSPs (XR VM)
  - NPU in hot-standby mode
  - Each Interface Module connects to both Data Planes of the RSP's

NCS 560 / RSP4 – ISSU

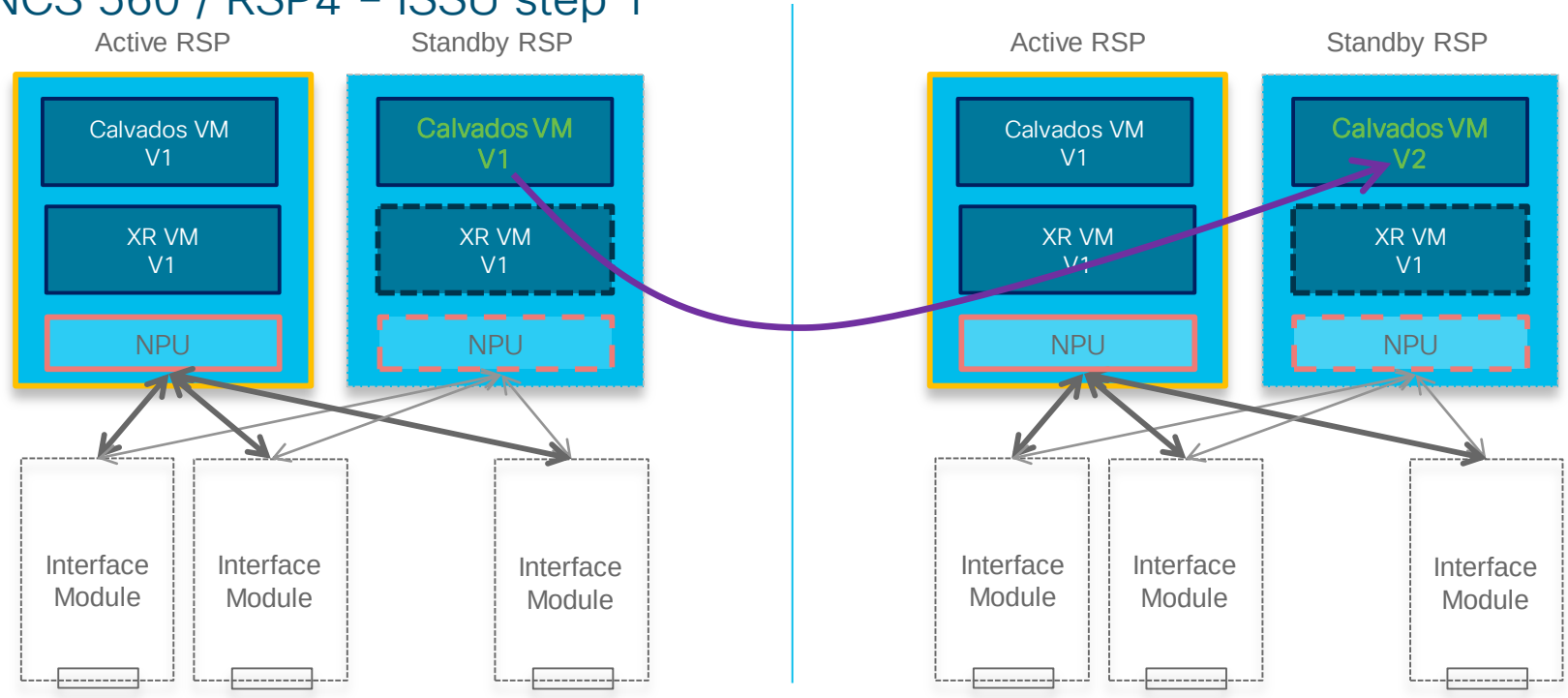
NCS 560 / RSP4 – Normal HA operation

- Fully Redundant Control / Data Plane
  - XR Nodes on both RSPs
  - NPU in hot-standby mode
  - Each Interface Module connects to both Data Plane of RSPs but only uses one at a time (active RSP)
- Control planes are in sync allowing for statefull switchover
- Admin Plane (Calvados) has active modules spread across Active & Standby RSP



NCS 560 / RSP4 – ISSU

NCS 560 / RSP4 – ISSU step 1

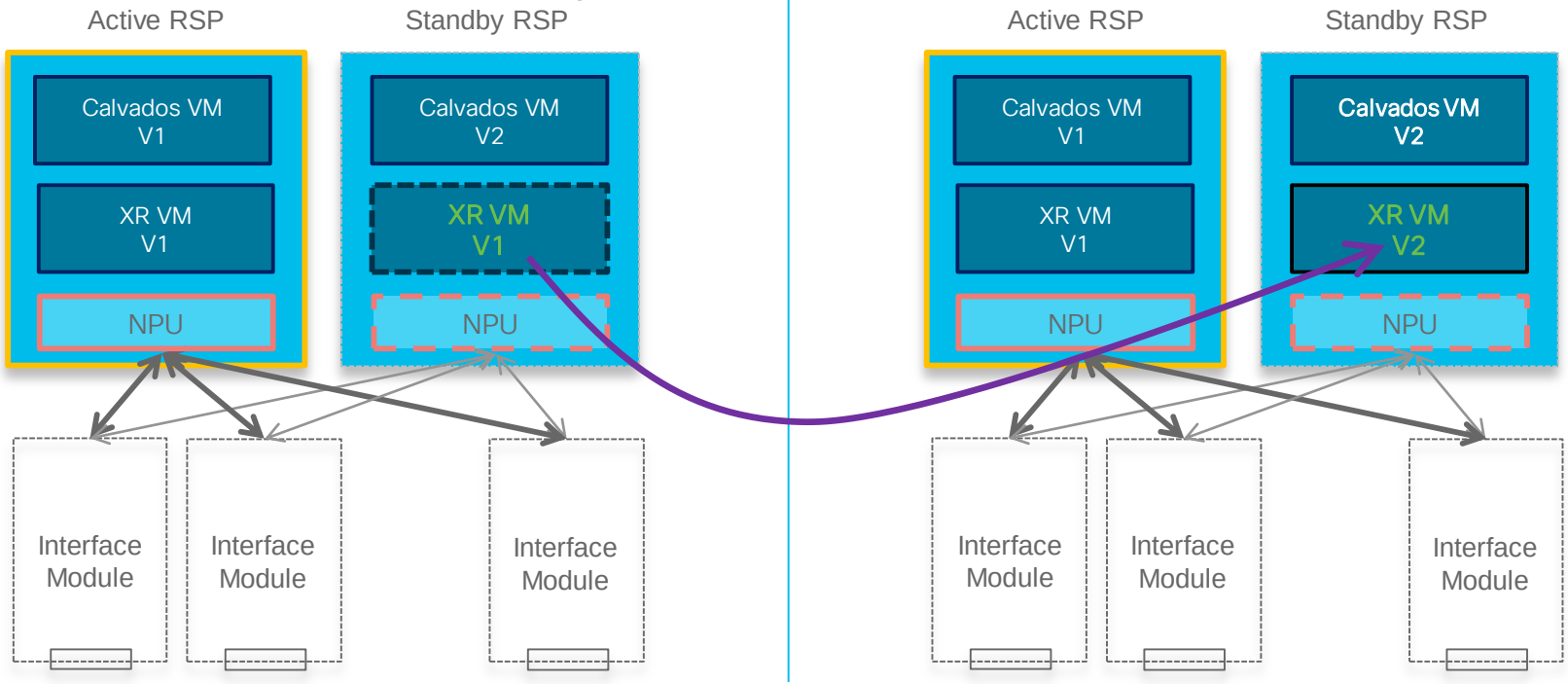


Calvados VM ISSU consists of three phases: Prepare, Activate & Commit and is done one RP at a time, as shown above:

1. In Prepare phase, new V2 VM get spawned / loaded with new V2 packages on Standby.
2. Post Reload (Activate) of Standby RSP, V2 VM takes control
3. The last final step involves the “Commit” stage, where Host OS and Admin VM are finalized and committed to the system

NCS 560 / RSP4 – ISSU

NCS 560 / RSP4 – ISSU step 2

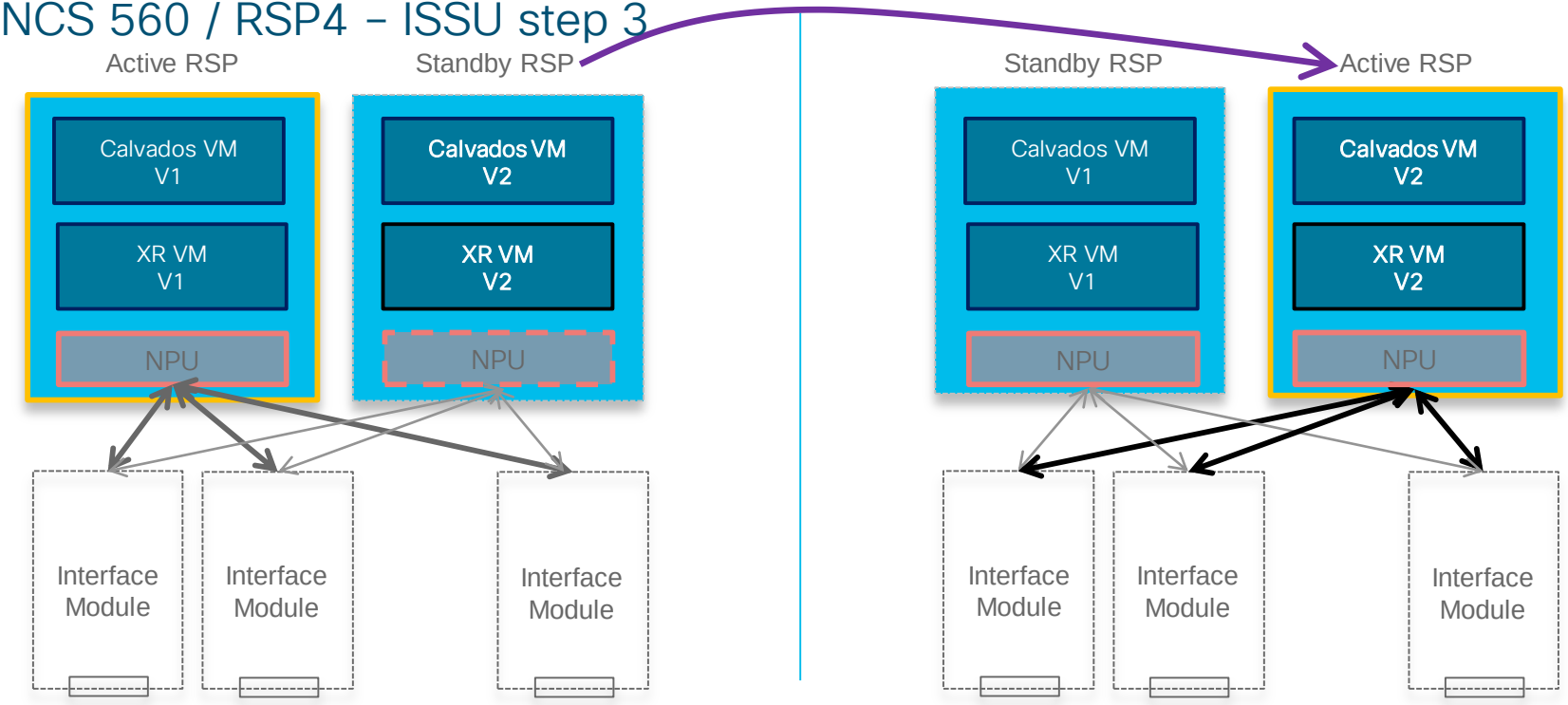


XR VM ISSU has 5 phases Prepare, Load, Run, Cleanup, Commit :

1. During Prepare phase pre-checks such as space and capability checks are performed.
2. The Load phase of the upgrade is when the install image is verified, and placed on Standby RSP. In this phase, basic resource and version compatibility checks are done. The v2 VMs are instantiated, XR processes are spawned, configuration is downloaded to the spawned VMs, v2 processes sync with their corresponding v1 instances on the Active RSP VM.

NCS 560 / RSP4 – ISSU

NCS 560 / RSP4 – ISSU step 3



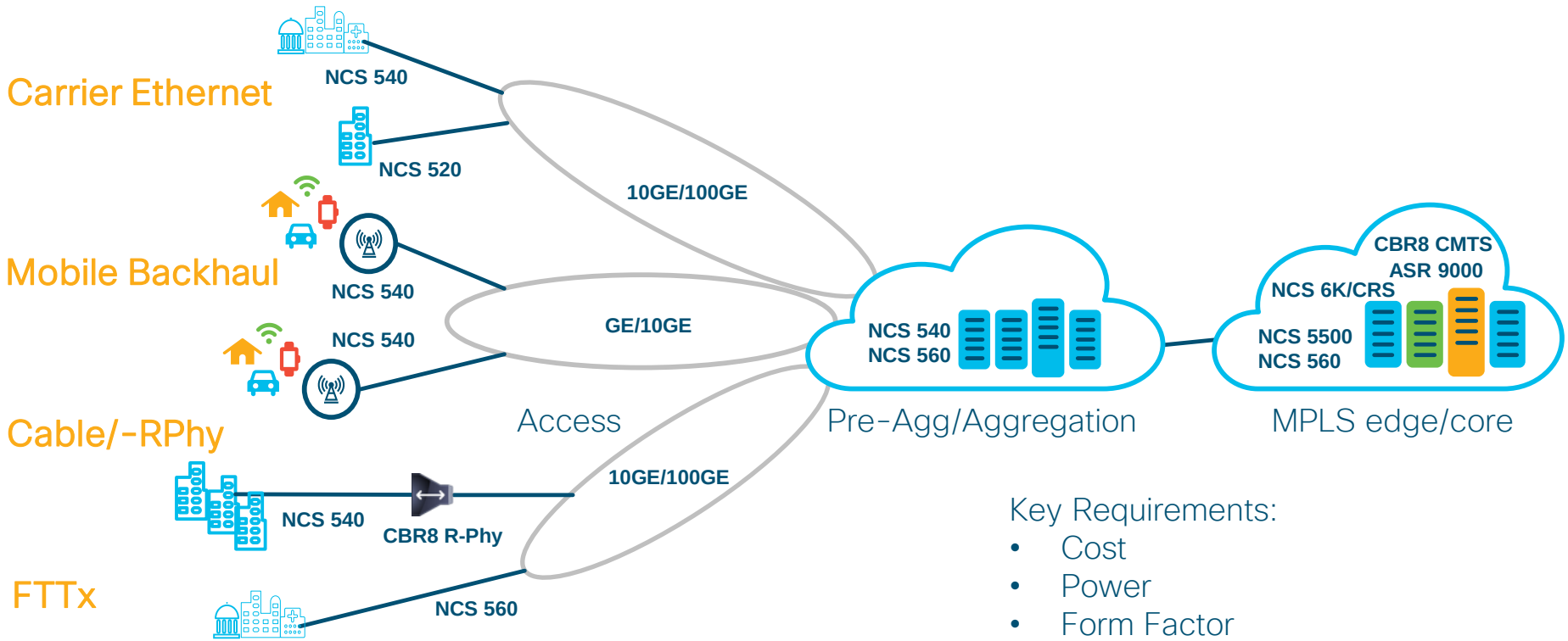
XR VM ISSU has 5 phases Prepare, Load, Run, Cleanup, Commit

3. In Run phase, the Standby RSP V2 VMs take over mastership on each RSP
4. In Cleanup phase, RSP0 gets the new version of SW (v2) through a reload, and internal sync.
5. The V1 partitions are removed at commit phase. At this point, it will not be possible to revert to V1 version.

Deployment Use-Case Review

NCS 540/560, focused on uses cases:

Carrier Ethernet, Mobile Backhaul, Cable/Remote-Phy and FTTx, Small PE*

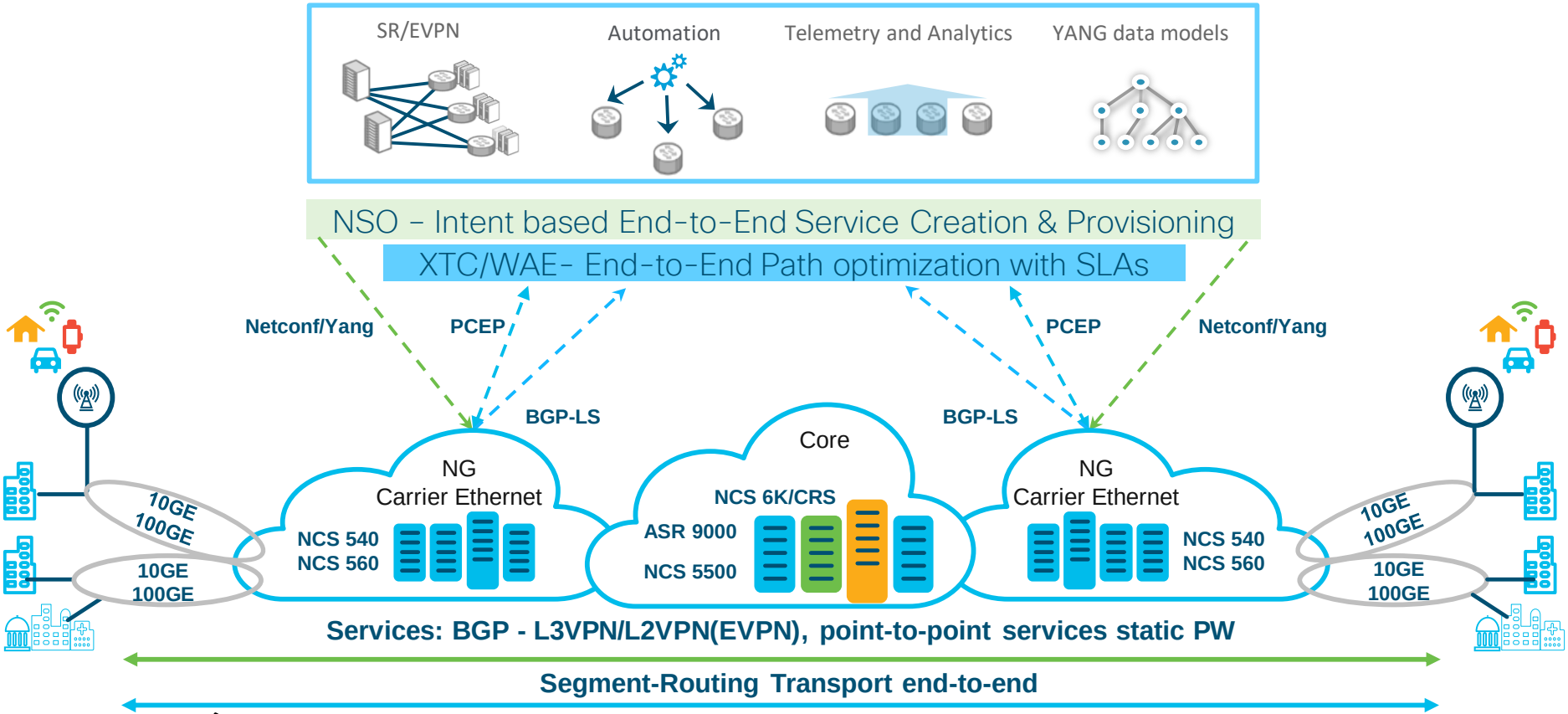


Key Requirements:

- Cost
- Power
- Form Factor

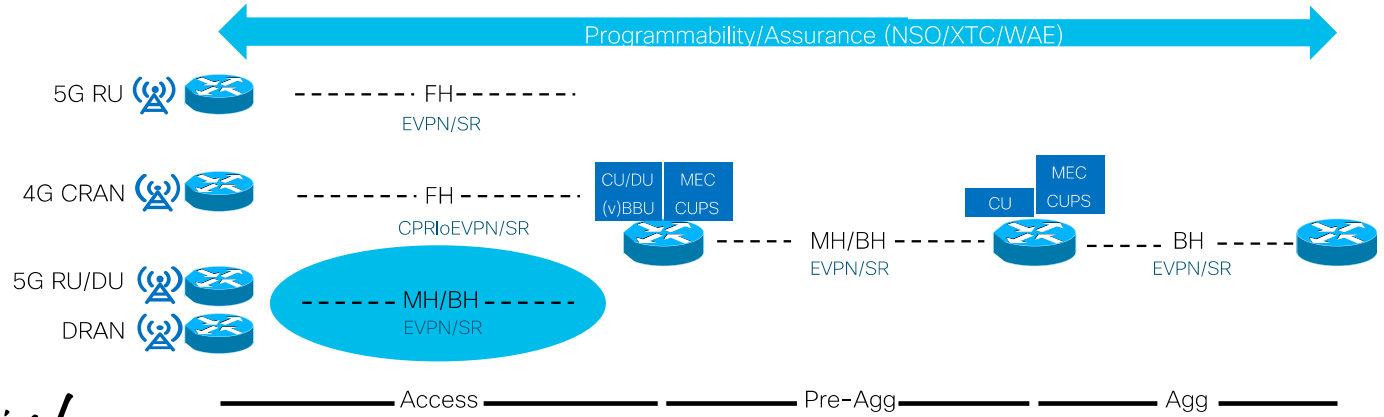
* Sufficient scale for PE role in Tier 2 Providers, replacing ageing 7600/RSP720

5G-Ready Carrier Ethernet and MBH



Cisco 5G-Ready Transport

- SR/EVPN end2end – from the cell site, including the Fronthaul, into the distributed DC
- Cross domain orchestration/automation
- SDN programmability and automation integrated with SR
- Built-in security in every product, extending it to ZTP processes



Cisco 5G-Ready Transport
Segment Routing – Key Capabilities

Foundation for Network Operations Simplification and Automation, and Service Agility via Programmability

Simplification of network protocols
Improved scalability

Simplification of Traffic Engineering
FlexAlgo

Application enabled policy using SDN techniques

Automated 50ms convergence

Built-in Redundancy & HA

Support MPLS & v6 Forwarding

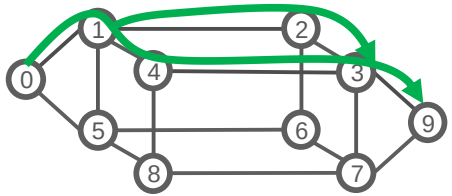
Universal Forwarding Plane
From Access to DC

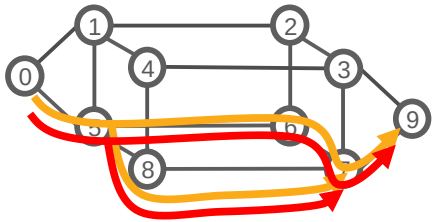
Cisco 5G-Ready Transport
Segment Routing - FlexAlgo

- Flex-Algo
  - The algorithm is defined by the operator, on a per-deployment basis
- Flex-Algo is defined as
  - The minimization of a specified metric: IGP, delay, …
  - The exclusion of certain link properties: link-affinity, SRLG, …
- Leverages the SRTE benefits of simplicity and automation
  - Automated sub-50msec FRR (TILFA)
  - On-Demand Policy (ODN)
  - Automated Steering (AS)
- Example
  - Operator1 defines Flex-Algo 128 as “minimize IGP metric and avoid link-affinity “green”
  - Operator2 defines Flex-Algo 128 as “minimize delay metric and avoid link-affinity “blue”

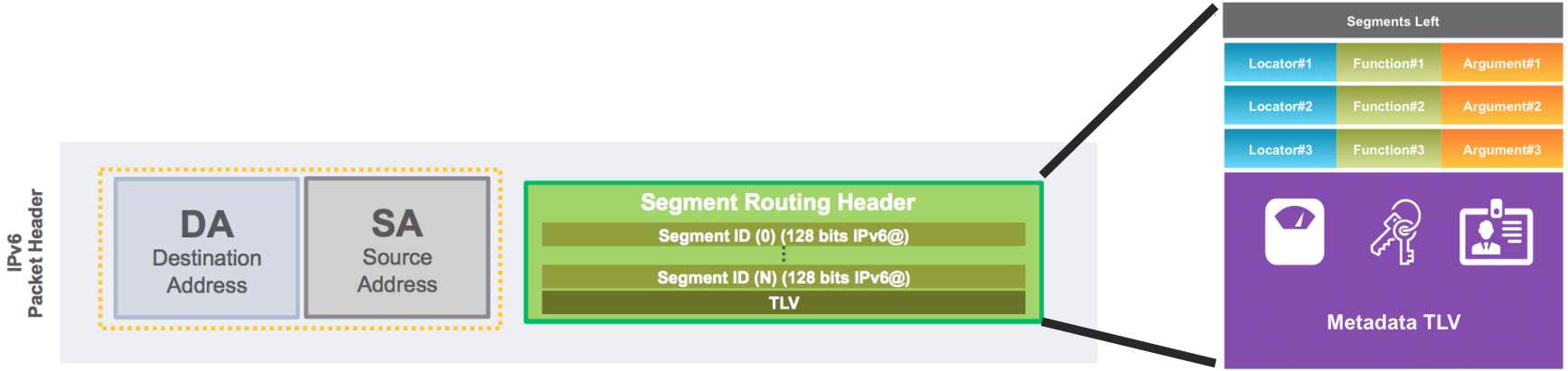
Cisco 5G-Ready Transport
SR for Transport Network Slicing

- Cisco's SR/Diffserv/VPN is well proven soft slice approach
- TE / Flex Algo can harden the approach
- High Reliability built-in mechanisms: TI-LFA (automated 50msec convergence), ECMP, Anycast SID, backup disjoint paths
- Full programmability and control over the end2end path definition – explicit path that complies with defined network slice constraints
- Simple and limited configuration required @node level with ODN (on demand next hop)– scalable and dynamic network slice life cycle changes (create, modify and delete)
- Provides quasi realtime measurements of link and node metrics to the SDN controller – continuous and automated network slice SLA compliance





Cisco 5G-Ready Transport
Evolution to SRv6: Merging benefits of SR & IPv6



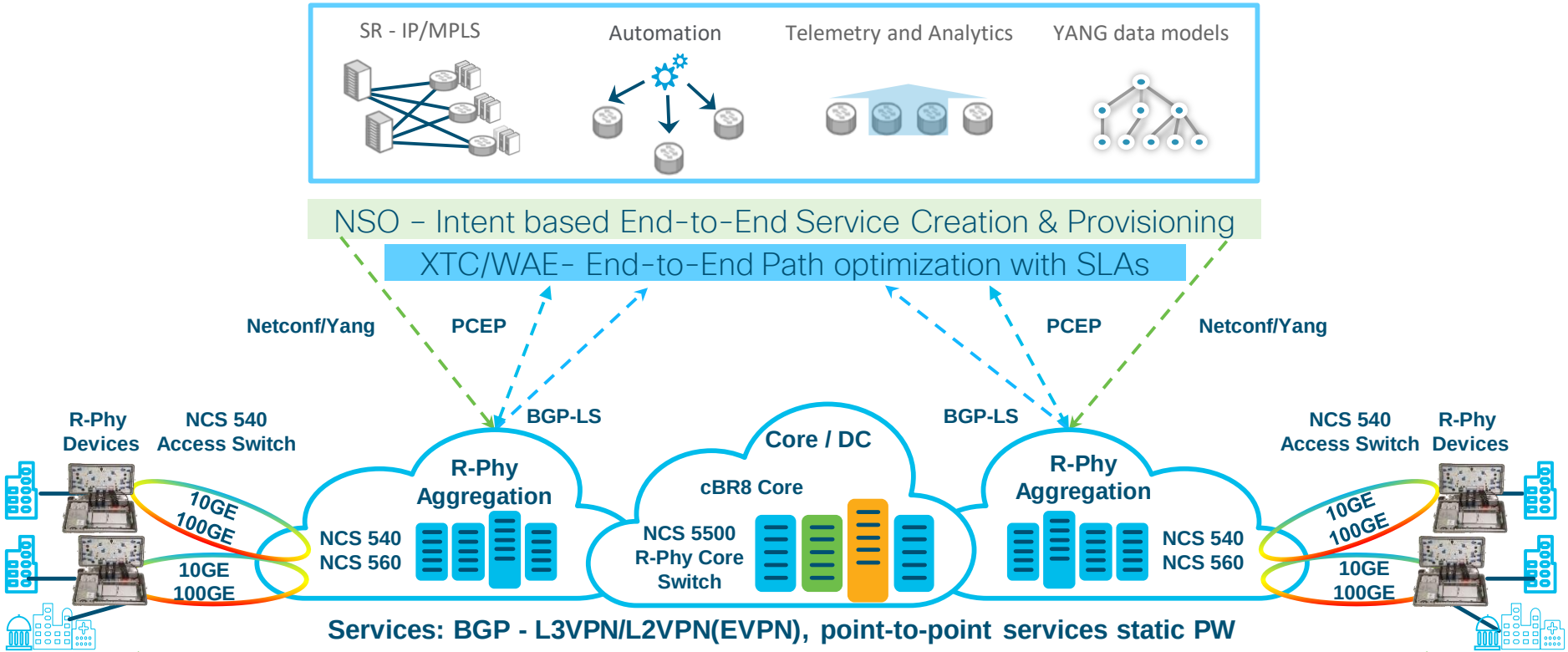
IPv6	Segment Routing
Exponential growth of IP addresses from containerization, micro-services and 5G	Provides Traffic Engineering and VPN service

SRH is an IPv6 Extension Header that brings benefits of both directly in the IPv6 Header.
Enables Service Chaining and Network Slice in Future

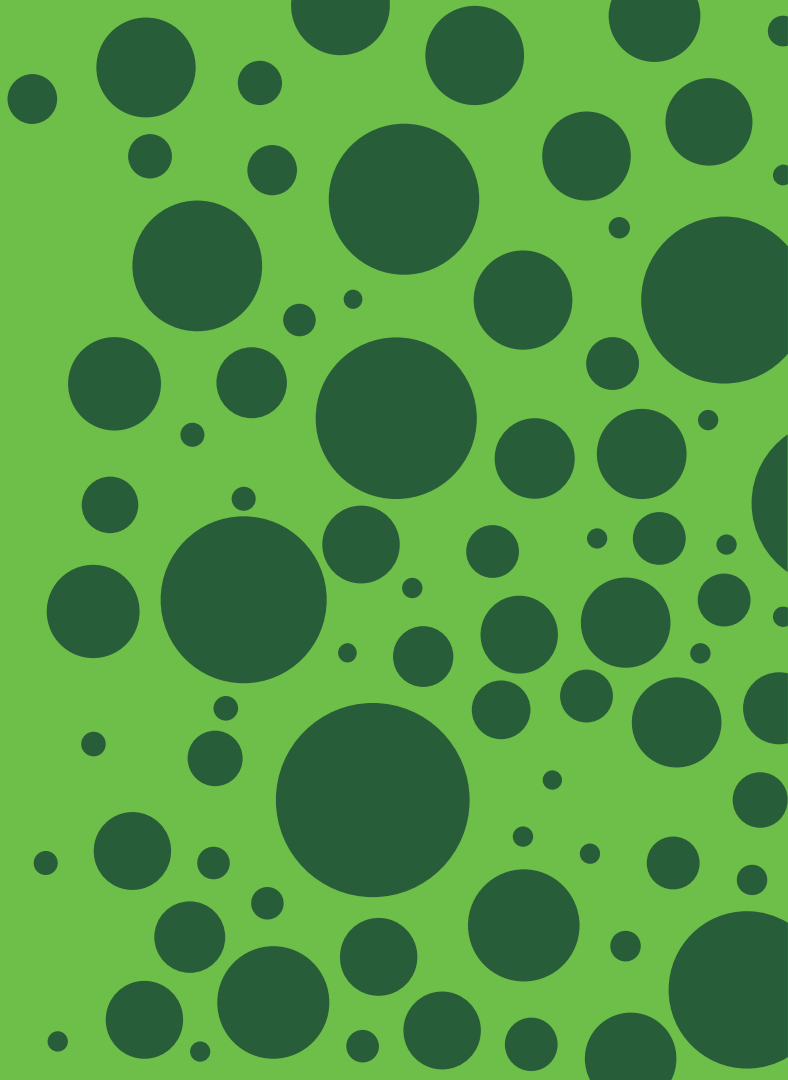
Cisco 5G-Ready Transport Service Chaining with SRv6

- Packets are steered through a sequence of services on their way to the server

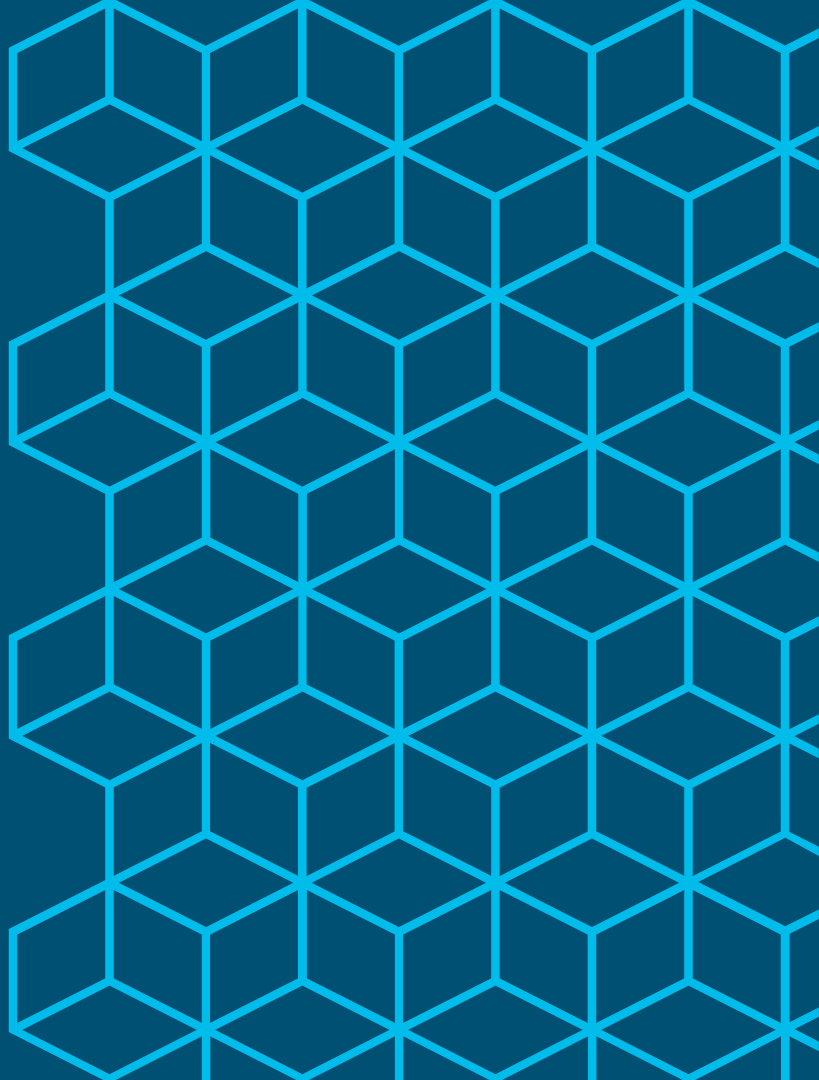
Remote Phy with NCS 540/560



Software Roadmap



Takeaways



5G Transport Requirements

Throughput

New Services driving higher peak throughput, higher aggregated throughput, guaranteed BW

CRAN (LLS) bringing 25/100G requirements to the access

Latency

URLL Services require low latency RTT
Lower latency also benefits existing services

CRAN (LLS) imposing very low latency in the transport

Synchronization

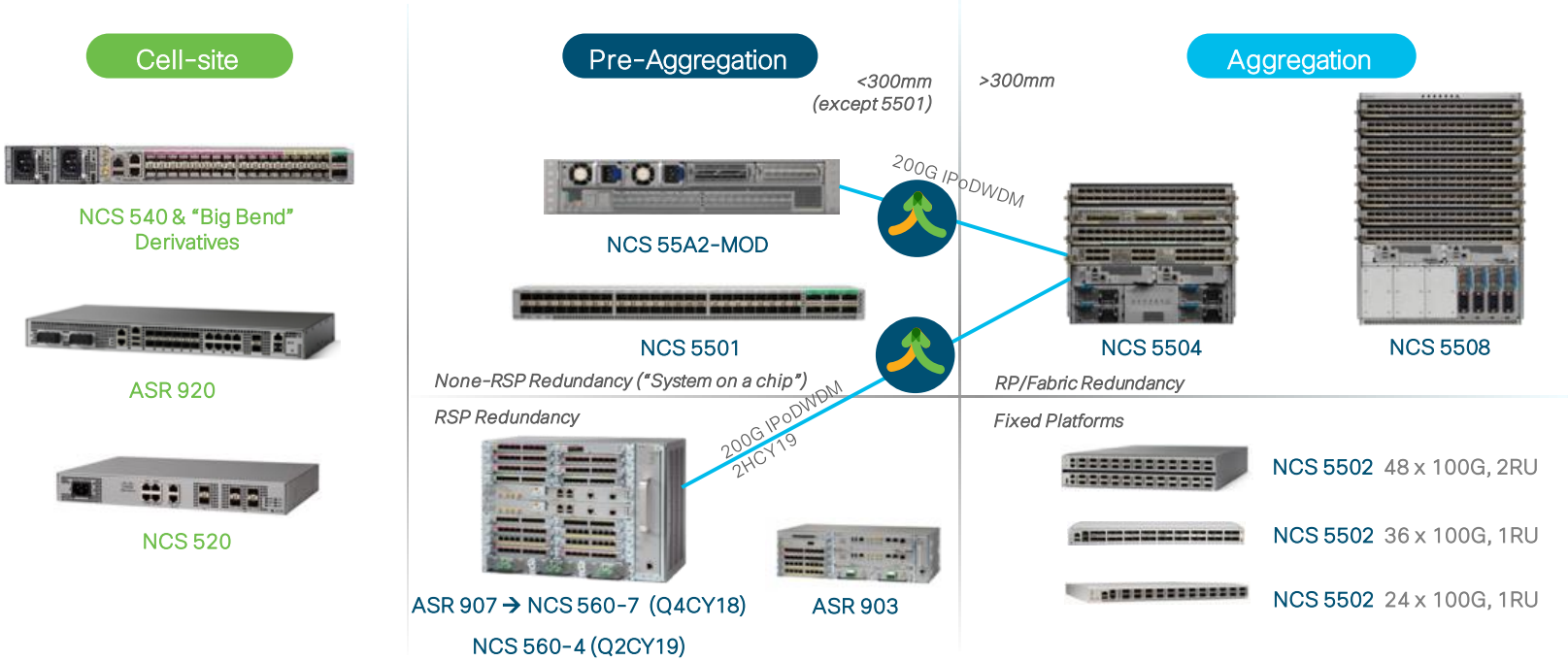
Radio technologies and NR driving strict phase and frequency synchronization

Services using accurate network clocking

CRAN (LLS) imposing very strict phase accuracy

New and Enhanced Platforms, Strict QoS, Traffic Engineering, Network Design and Operation

5G Ready Access/Aggregation Portfolio



EVPN

Segment Routing (SR)

Cisco is ready for the Access Evolution

Events

Capacity Drivers



Low Latency Apps



Actions

- Upgrade access/agg capacity mid CY18~
- Content Caching, but not far enough
- Cost control; converge networks/layers

- Distributed network intelligence
- Network Slicing
- Service chaining
- e2e, real-time intelligence
- More nodes
- OpEx control

Why Cisco


Density & Scale


PaYG


Complexity Abstraction


Convergence


SR & Programmability


Telemetry


Orchestration & Automation


Power Efficiency


Embedded Security


Advanced Services

Don’t miss the Service Provider Hub !

Demos

Experience 7 Essential Technology and **3 Generate Revenue with 5G demos** and join our guided demo tours

More Sessions

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Take a meeting session to benchmark your digital readiness against your industry peers

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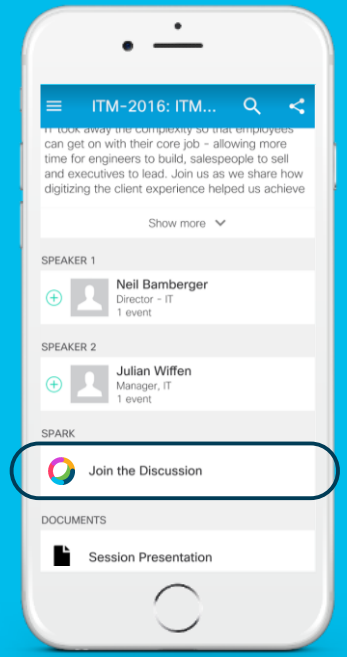

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- Please complete your Online Session Survey after each session
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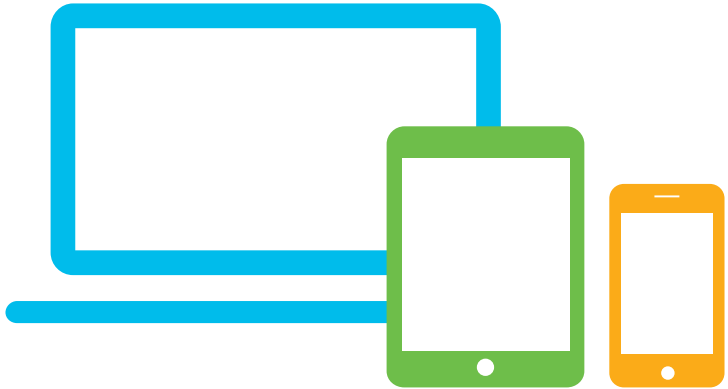

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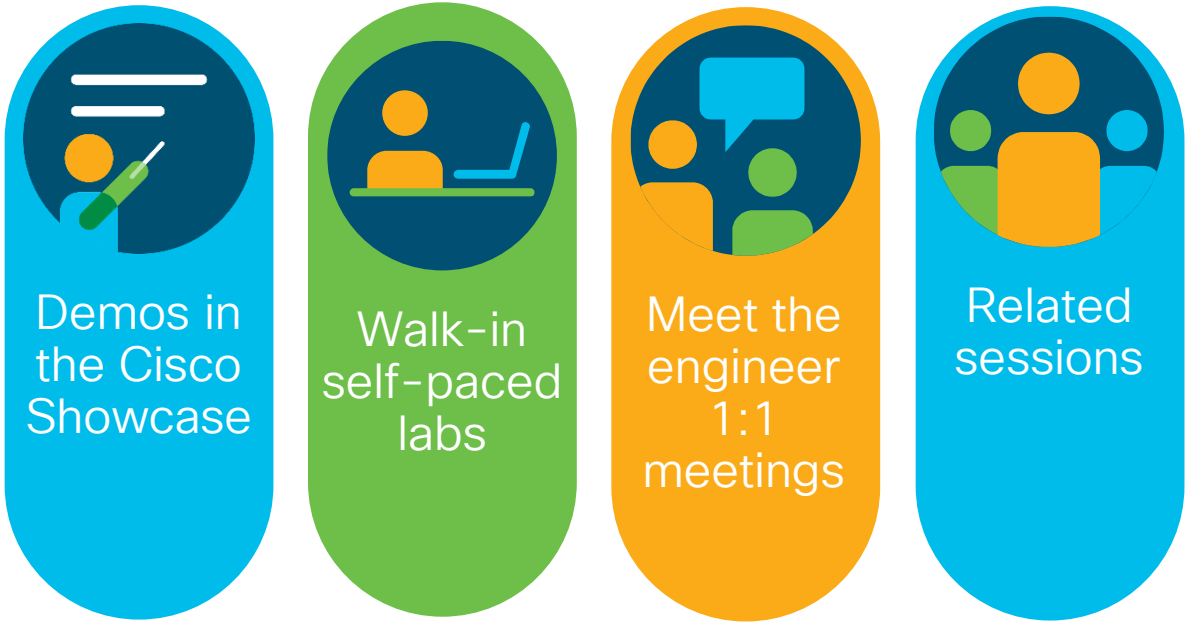
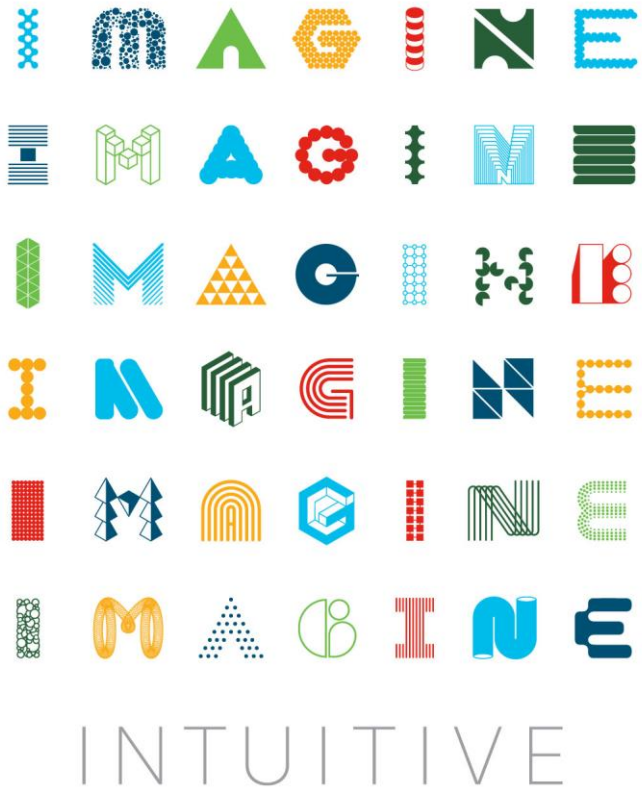


Thank you



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