



Cisco *live!*

January 29 – February 2, 2018 · Barcelona

CSR1000v and XR9000v Based Cisco vBNG Solutions

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Cisco Spark

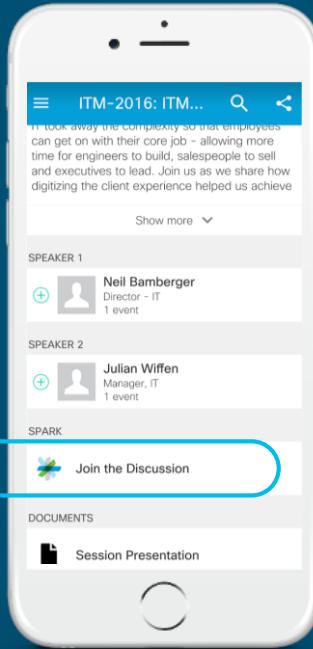


Questions?

Use Cisco Spark to communicate with the speaker after the session

How

1. Find this session in the Cisco Live Mobile App
2. Click “Join the Discussion” ——————
3. Install Spark or go directly to the space
4. Enter messages/questions in the space



cs.co/ciscolivebot#BRKSPG-2063

The New Subscriber Era is here

58%

Of the population will be
using internet
Up from 44% in 2016



61 GB

Of Internet traffic per
month, per User
Up from 24GB in 2016



3.5

Networked devices and
connections per person
Up from 2.3 in 2016



80%

Of all Internet traffic will
be video
Up from 67% in 2016



53 Mbps

Average broadband speed
Up from 27.5Mbps in 2016



20 Mbps

Average mobile speed
Up from 6.8Mbps in 2016



Network Drivers for the New Subscriber

56%



connected flat-panel
TV sets will be 4K

20%



CAGR of traffic share
of DDoS Attacks

27.1B



Networked devices and
connections

4Pb



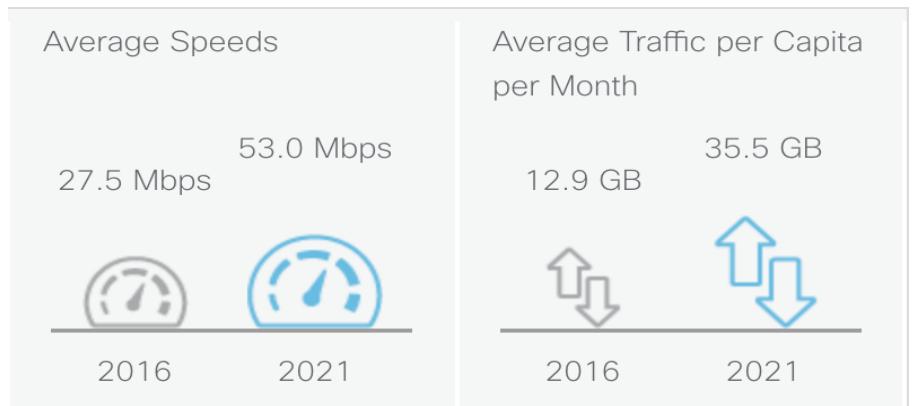
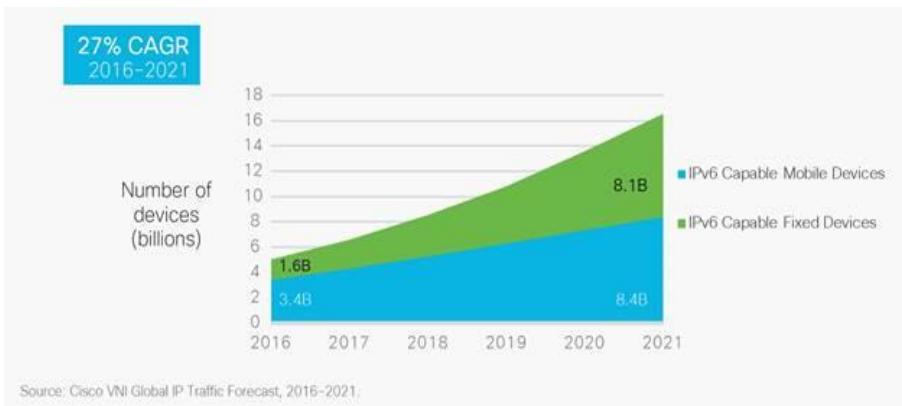
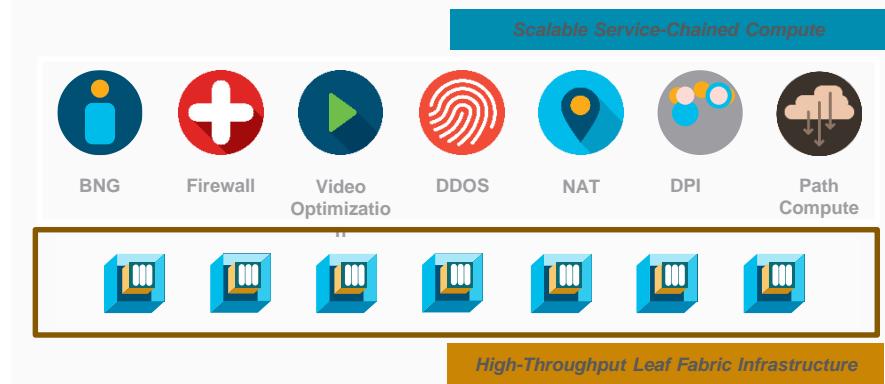
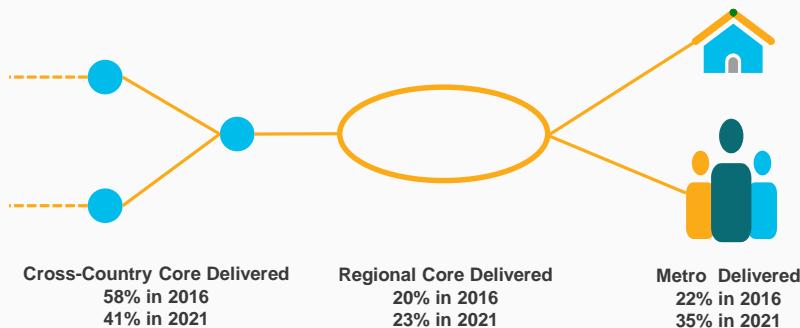
Busy Hour Internet
Traffic

71%



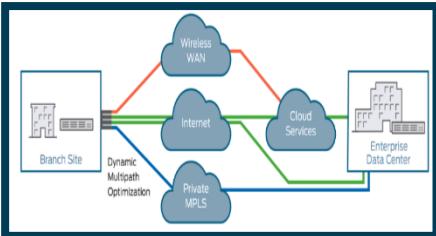
Of internet traffic will
be carried by CDNs

Network Shifts for the new Era



Industry trends driving Network Virtualization

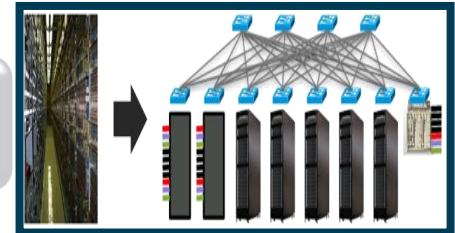
SD-WAN



WAN costs optimization through Network Infra Virtualization

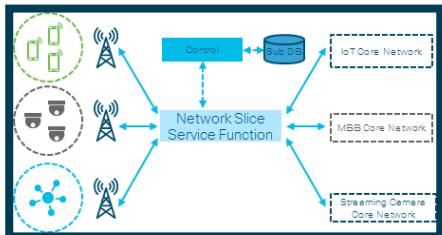
Cost effective deployment of VPN, IPSEC, BNG, NAT, etc

CORD ARCH EVOLUTION



TIME FOR VIRTUALIZATION IS NOW!

5G



Network slicing through RAN & Network Infra Virtualization

IOT Mgmt & provisioning using Virtual Network Function

IOT



With Cisco vBNG solutions you can build



Scalable



Flexible



Cost-
Effective

Agenda

- Introducing Cisco vBNG Solutions
- NSO / ESC – VNF Life Cycle Management
- Smart Licensing
- CSR1000v – IOS XE Based vRouter / vBNG Solution & Use Cases
- XRV 9000 – IOS XR Based vRouter / vBNG Solution
- Conclusion

What this Session will include

- Introduction to CSR1000v and IOS XRV9000 platforms
- Overview of Deployment capabilities and use-cases
- Introduction to vBNG Lifecycle Management
- Impediments to vBNG Performance
- Overview and Benefits with Smart-Licensing

What this Session will not include

- Roadmap update on vBNG, vRouter Functionality
- Deep-dive on NFVI Solutions
- BNG Roadmap update
- Demo for vBNG

vBNG Solutions Overview

vBNG VNF

CSR 1000v, XRV 9000

Smart License

Automatic Provisioning, Cost Savings with License Sharing



Orchestration

ESC Software for vBNG Lifecycle Management

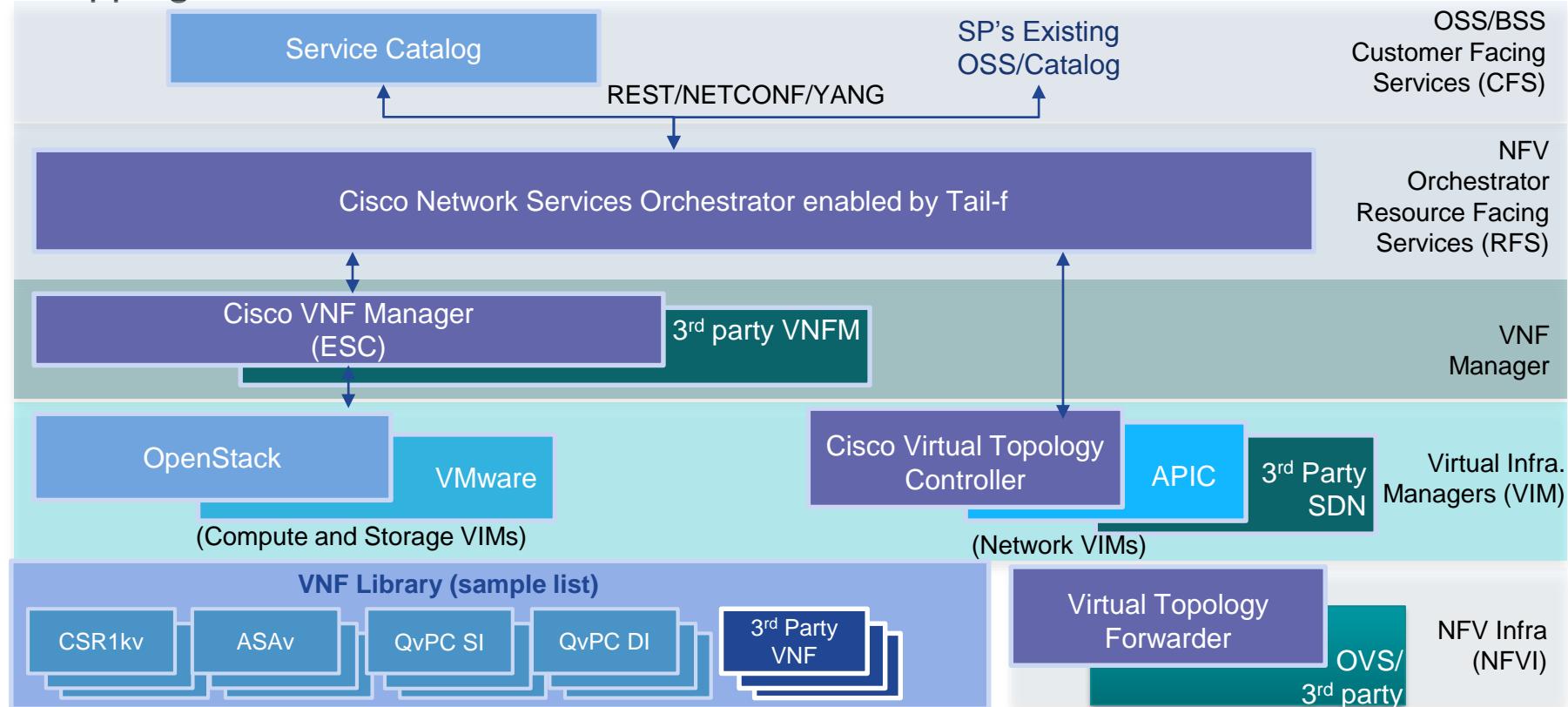
Hardware, Host OS

UCS, KVM/VMware/..., Performance

VNF Lifecycle Management

Modular ETSI NFV Framework

Mapping to ETSI NFV Framework



Roles and Responsibilities



NSO manages the Network Service

Service Lifecycle:

Design, Configure (Day 1/2..n), Modify, Deactivate
Orchestrate across Physical and Virtual, Multi-Vendor



VTS manages the Connections

The Virtual cabling: Wire the boxes together

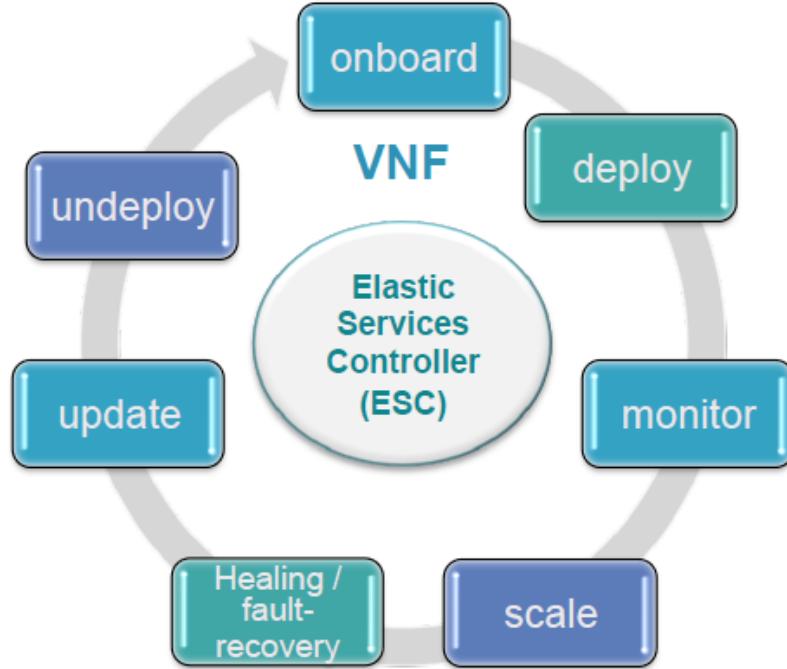


ESC manages the VNFs

The Virtual Appliances: **VNF Lifecycle:**
Commission (Rack, Power on, Day 0/1 config),
Monitor, Scale up/down, Move, Downgrade,
Decommission

Cisco Elastic Services Controller Functions

- Agentless VNF management (Any Vendor, Any Application, Any VNF)
- VNF lifecycle management (Create, Read, Delete)
- VNF Day0 configurations
- VM and service monitoring, elasticity
- VNF Auto-healing, recovery
- VNF license management
- End to End customization support for VNF operations
- Transaction resume and rollback
- Coupled VNF management (VM Affinity, startup order, manage VM interdependency)
- Service Advertisement



Service Creation with NFVO NSO/ESC

1. End user signs on to user portal or NFVO to create a service request

2. NFVO identifies which network components it needs to deliver the service request

3. NFVO maps Service Intent to the topology (i.e. DCs), and identifies the appropriate ESC to spin up the VNF VMs



1

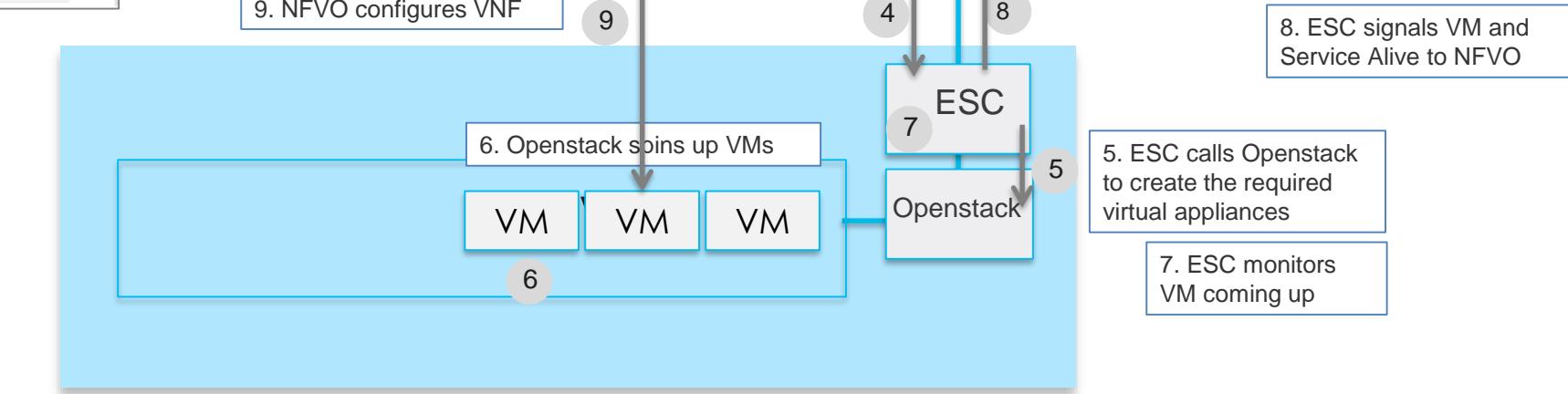


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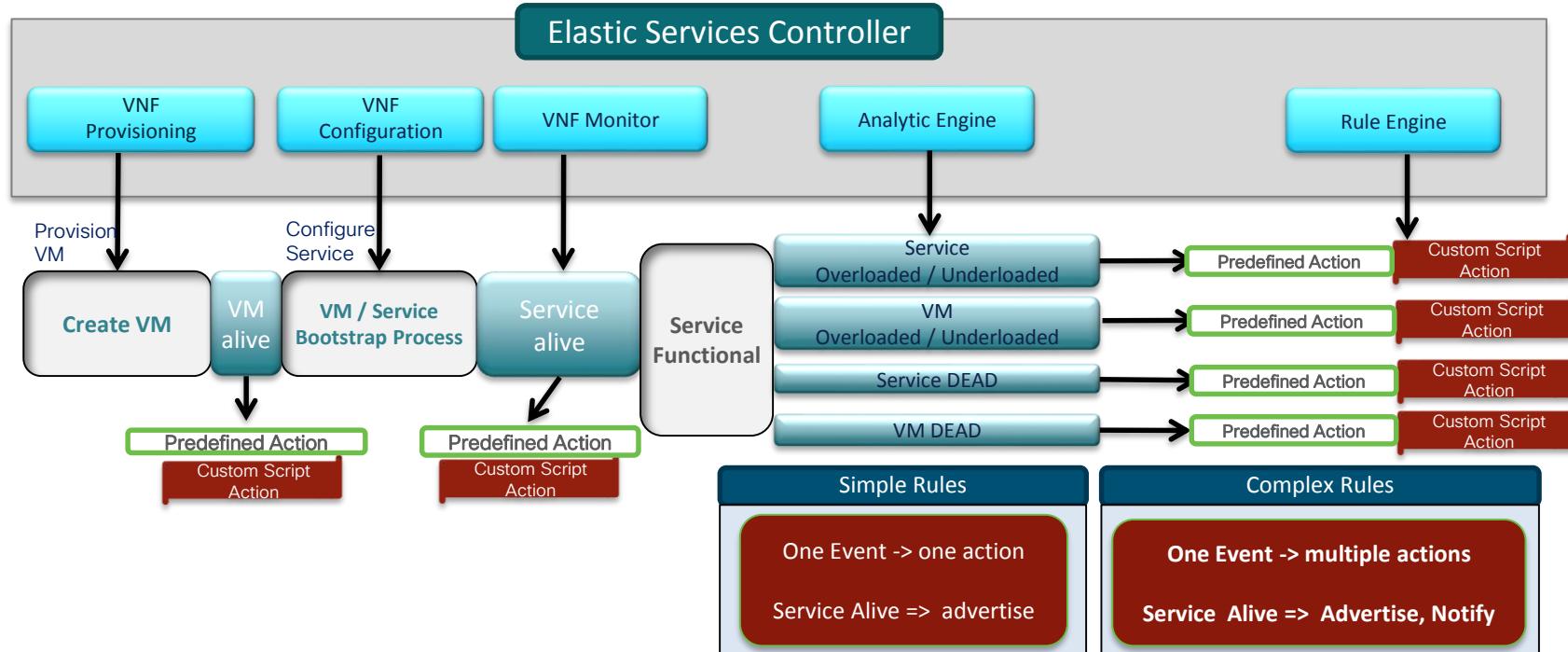
3

NFVO (NSO)

4. NFVO configures Service on ESC (NETCONF/REST)



Details Of ESC VNF Lifecycle Management



KPI Thresholds - VM Monitoring On ESC

Threshold Name	Threshold Type	Metric	Value	ESC Action	Customized Action
VM_ALIVE	Rising/Falling	ICMP Ping Reachability	3 successful pings	Service Booted	Verify CSR connectivity Add to Radius
VM_OVERLOADED	Rising	Session Count	>7000	Service Scale-Up (add VM)	Adjust Radius Load-Balancing
VM_OVERLOADED_FULL	Rising	Session Count	>8000	None	Adjust Radius Load-Balancing to exclude this CSR
VM_OVERLOADED_LIGHT	Falling	Session Count	<2000	None	Adjust Radius Load-Balancing
VM_OVERLOADED_EMPTY	Falling	Session Count	<1	Service Scale-Down (remove VM)	Remove CSR from Radius Load-Balancing

KPI XML Definition:

```

<kpi>
    <event_name>VM_OVERLOADED</event_name>
    <metric_value>7000</metric_value>
    <metric_cond>GT</metric_cond>
    <metric_collector>
        <type>SUBSCRIBER_SESSION</type>
        <nid>0</nid>
        <poll_frequency>15</poll_frequency>
        <polling_unit>seconds</polling_unit>
    </metric_collector>
</kpi>

```



Specification of actions in the same file:

```

<rule>
    <event_name>VM_OVERLOADED</event_name>
    <action>ALWAYS log</action>
    <action>TRUE servicescaleup.sh</action>
    <action>TRUE sp_script_service_scale_up</action>
</rule>
...
<configuration>
    <dst>iosxe_config.txt</dst>
        <file>file://cisco/csr_SP_config.sh</file>
</configuration>

```

Scalable vBNG solution Enabled By ESC

1.500 active VMs supported by a single ESC

x

8.000 Subscribers per CSR1000V

=

12.000.000 Subscribers

Scalable vBNG solution Enabled By ESC

1.000 active VMs supported by a single ESC

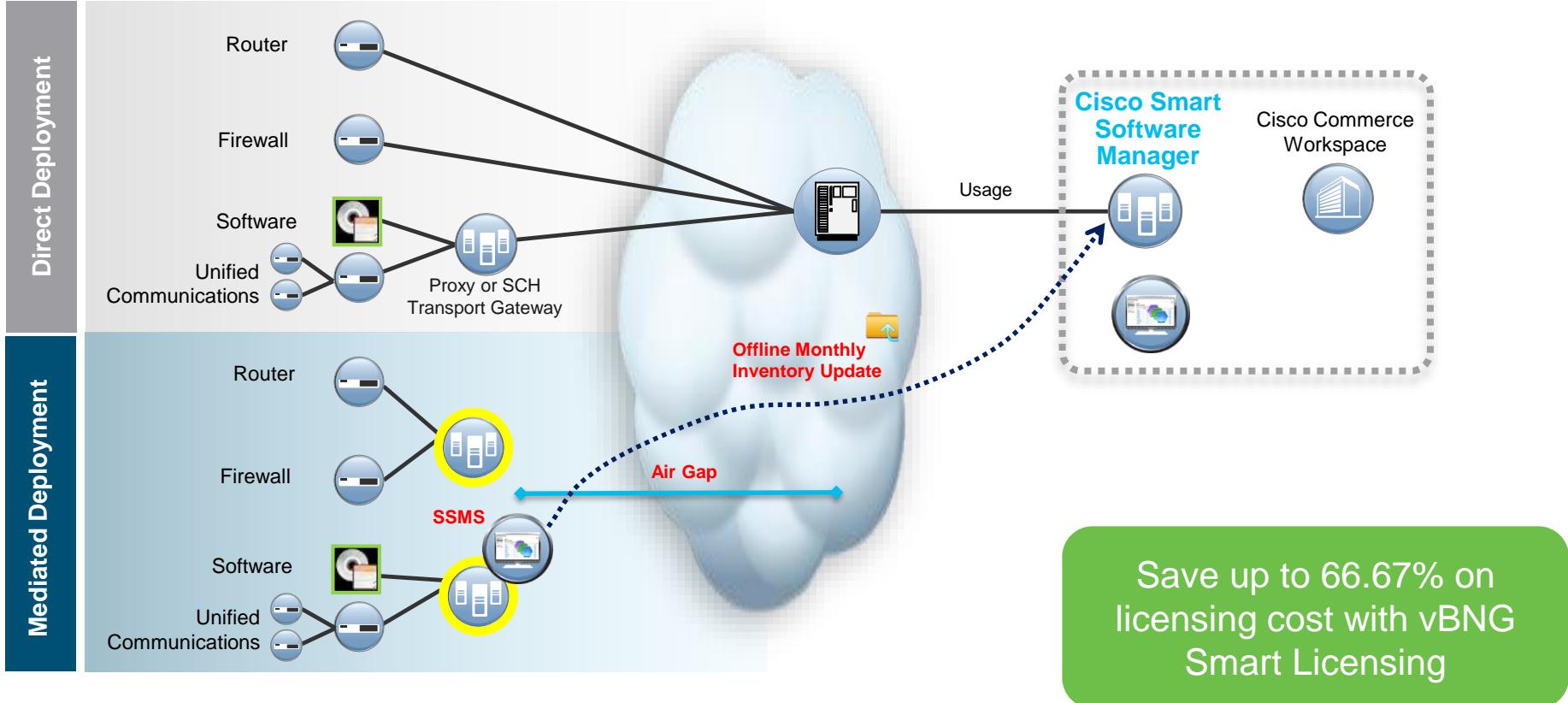
x

32.000 Subscribers per XRv9000

=

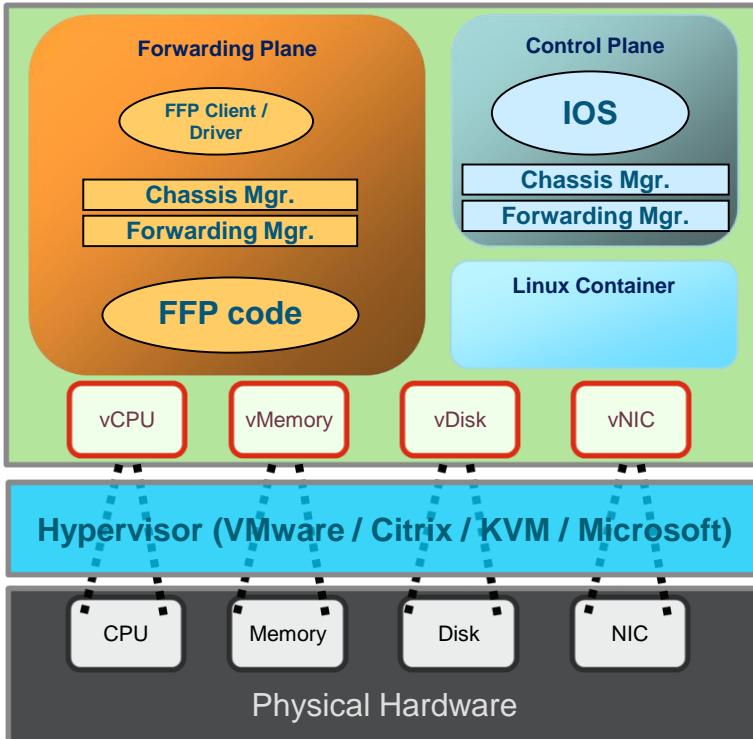
32.000.000 Subscribers

Smart Licensing



CSR1000v – IOS XE Based vRouter / vBNG Solution

CSR1000v – A Virtualized ASR1001-X



Infrastructure agnostic software

- Familiar IOS XE software
- No dependency on specific server or vSwitch

Throughput Elasticity

- Licensable throughput from 10 Mbps to 10 Gbps
- Footprint options from 1 to 8 virtual CPUs

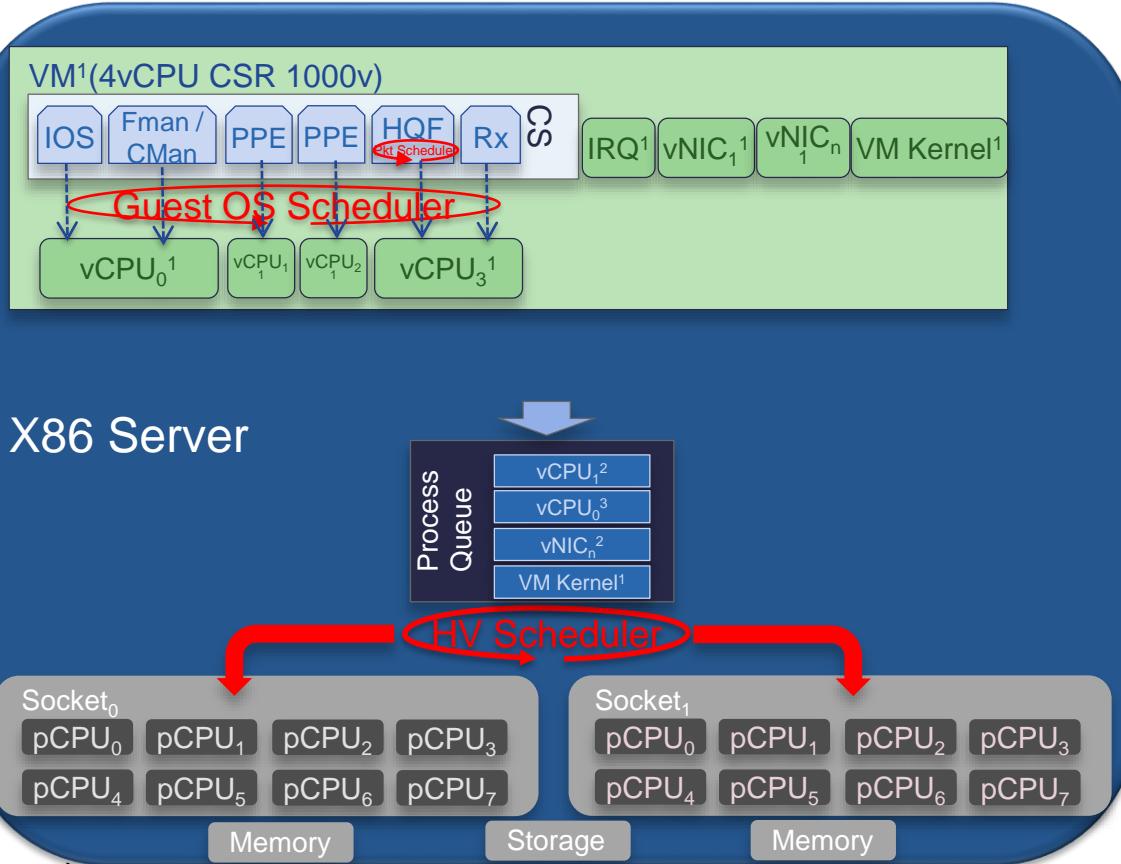
Multiple Licensing Models

- Term (1 or 3 Year), perpetual, hourly (AWS) usage

Programmability

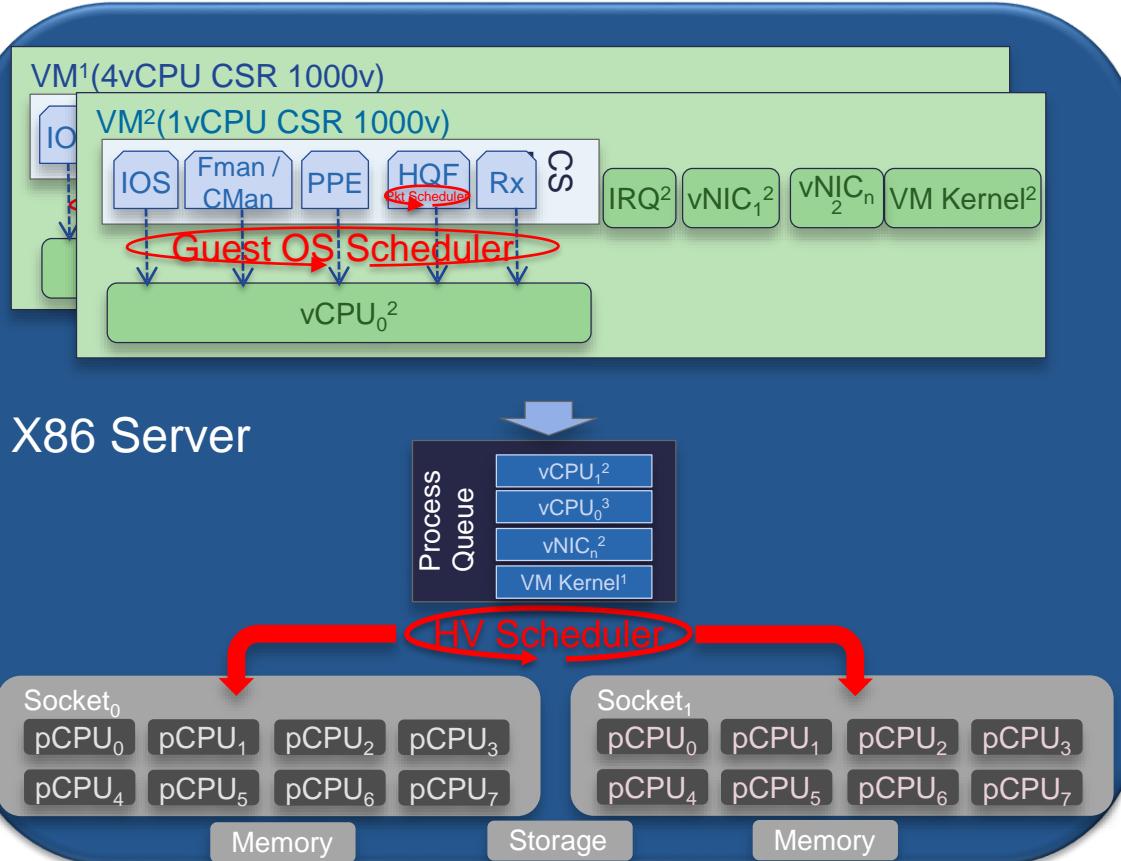
- NetConf/Yang, RESTConf and SSH/Telnet for automated provisioning and management

CSR1000v Multi-VM System Architecture



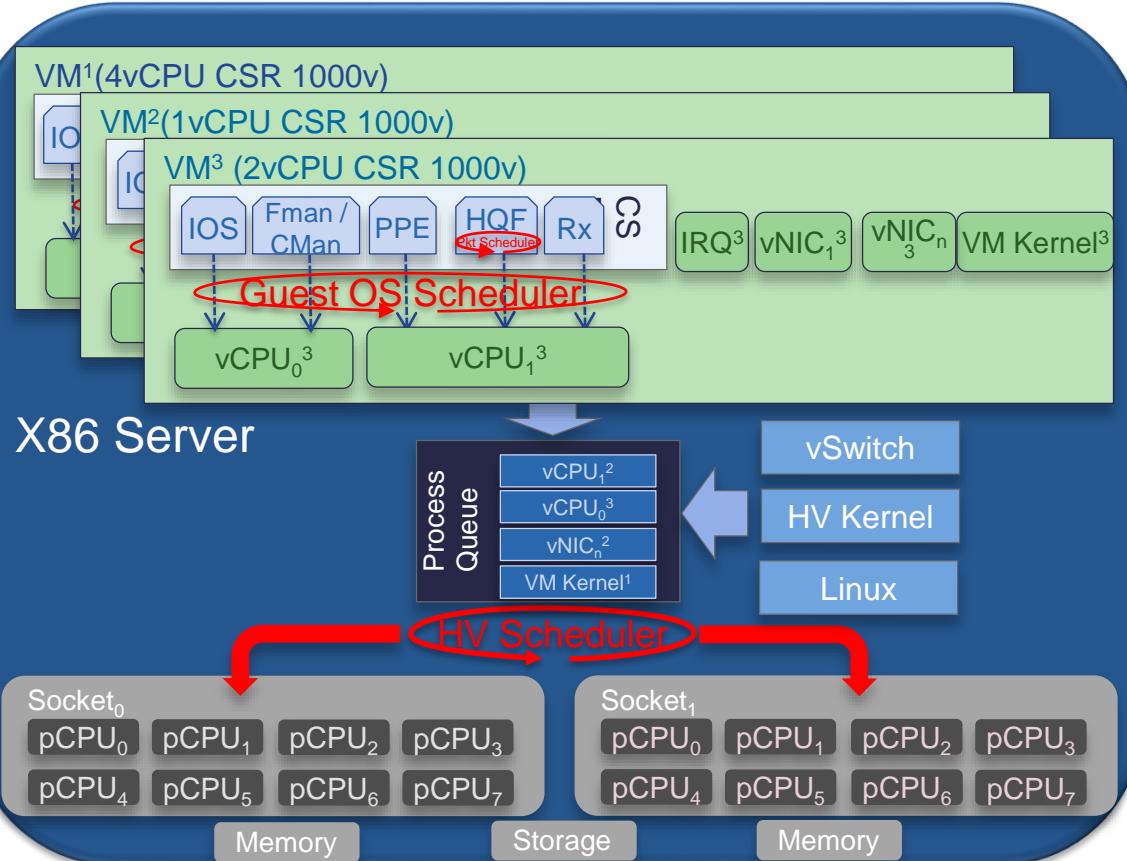
- Example: 3 CSR VMs scheduled on a 2-socket 8-core x86
 - Different CSR footprints shown
- Type 1 Hypervisor
 - No additional Host OS represented
- HV Scheduler algorithm governs how vCPU/IRQ/vNIC/VMKernel processes are allocated to pCPUs
- Note the various schedulers
 - Running ships-in-the-night

CSR1000v Multi-VM System Architecture



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CSR 1000v IOS XE Threads to vCPU Associations

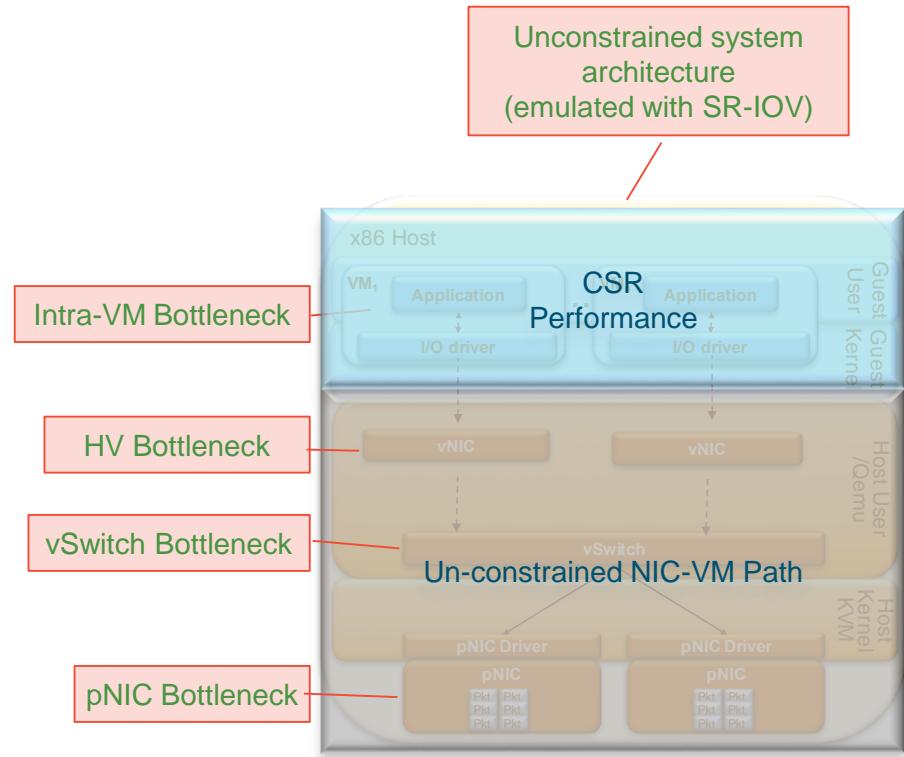
IOS XE processing threads in the Guest OS are statically mapped to vCPUs threads
vCPU threads in turn are allocated to physical cores by the hypervisor scheduler

CSR footprint	Control Plane	Data Plane PPE	Data Plane HQF / Tx Processing	Data Plane Rx processing / Tx Processing
1	vCPU 0			
2	vCPU 0	vCPU 1		
4	vCPU 0	vCPU 1 & 2	vCPU 3	
8	vCPU 0	vCPU 1-5	vCPU 6	vCPU 7

NOTE: vCPU allocations subject to change without further notice

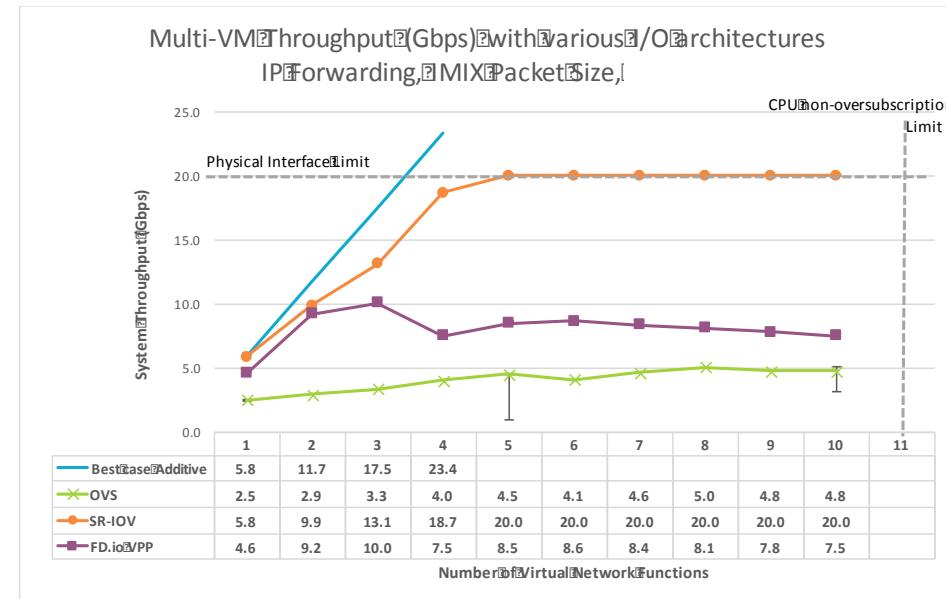
NfV Performance Bottlenecks

- Need to differentiate performance at different levels
- System performance vs. single-VM performance
- At system level, other bottlenecks may affect throughput
 - Physical NIC capacity
 - vSwitch
 - Hypervisor performance
 - Number of concurrent VMs
 - Performance tuning
- VM performance emulated by assuming an unconstrained I/O path (e.g. SR-IOV)



Multi-VM System Throughput: KVM CEF IMIX

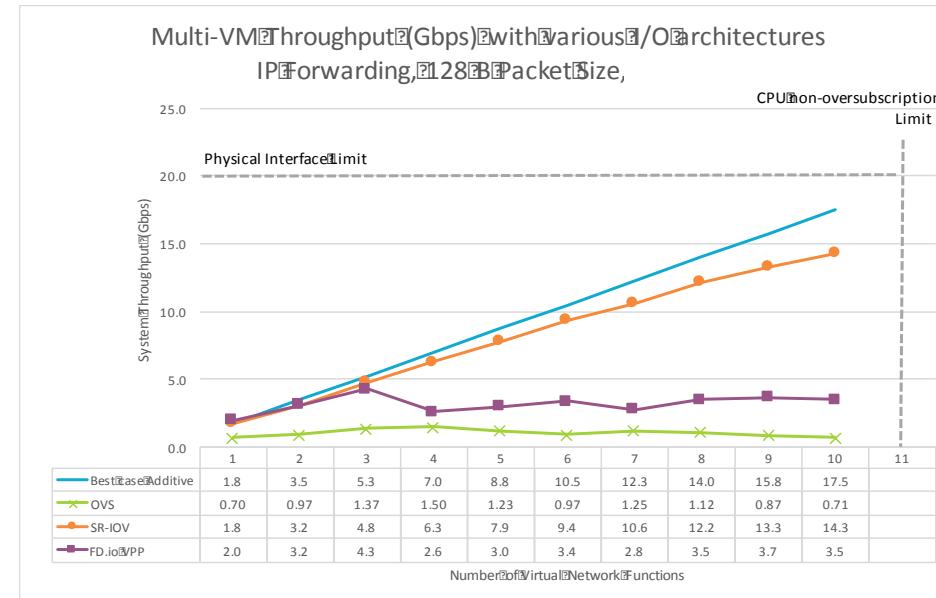
- 2vCPU CSR footprints configured for CEF
- SR-IOV and VPP outperform OVS
- SR-IOV is near linear up to physical interface bandwidth
- OVS maxes out below 5 Gbps
 - Implies that for each VM added, average throughput for ALL VMs drops



x86 Host	Cisco UCS C240 M4 Series: 2 Sockets Intel Xeon E5-2699v3 2.3 GHz with 18 cores each, 262GB RAM
Physical Interfaces	1 NIC with 2 x 10GE ports; Intel X520-DA2 NIC
Hypervisor	Redhat KVM version 7.2; Linux kernel 3.10.0-327.18.2.el7.x86_64; Libvirt 1.2.17; QEMU version 2.3.0
I/O Paths	OVS version 2.4.0, Cisco FD.io VPP release 16.06, configured for 3 cores

Multi-VM System Throughput: KVM CEF 128B

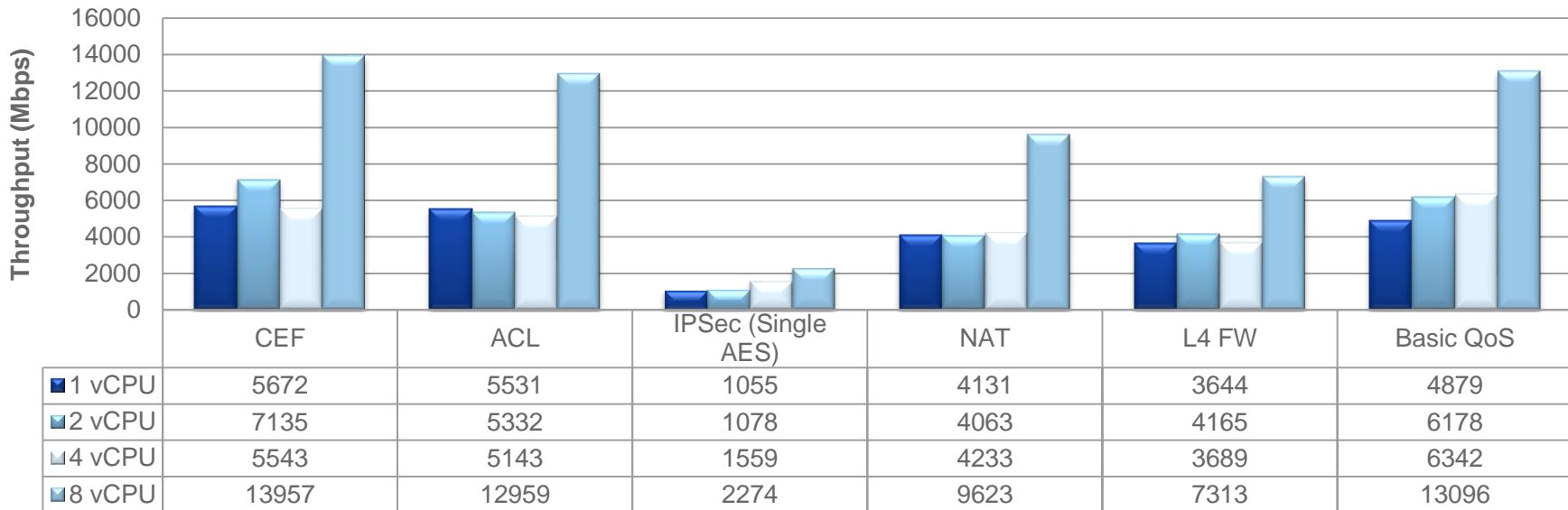
- 2vCPU CSR footprints configured for CEF
- 128B packets -> slope of benchmark shallows
 - SR-IOV again near-linear
 - VPP linear up to 3 VMs
 - OVS always below 1.5 Gbps per sever
- 1500B: very steep benchmark
 - Can hit physical limit with 2 VMs



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I/O Paths	OVS version 2.4.0, Cisco FD.io VPP release 16.06, configured for 3 cores

CSR1000v Performance – ESXi / SR-IOV

ESXi / SR-IOV/ Single Feature / IMIX



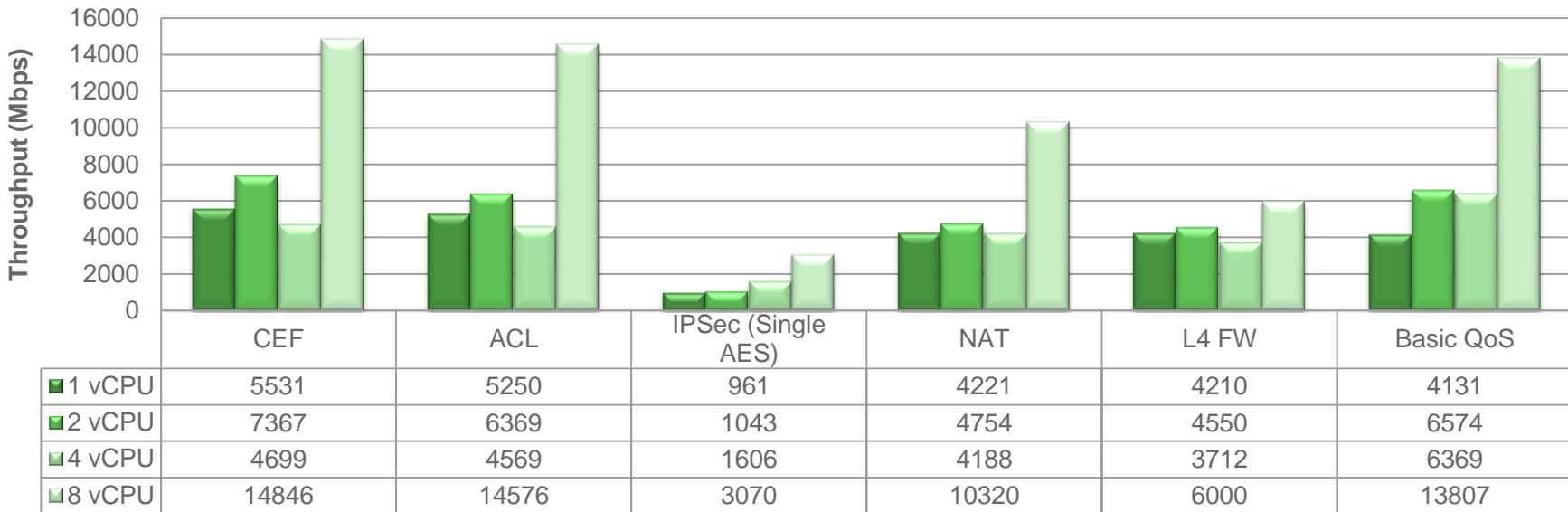
Traffic Profile : IMIX {64 bytes (58.33%), 594 bytes (33.33%), 1518 bytes (8.33%)}

PDR(Packet Drop Rate): 0.01%

*The max throughput license we offer today is 10Gbps and please contact us if you have use-case requiring more than 10Gbps

CSR1000v Performance – KVM / SR-IOV

KVM-REHL / SR-IOV/ Single Feature / IMIX



Traffic Profile : IMIX {64 bytes (58.33%), 594 bytes (33.33%), 1518 bytes (8.33%)}

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CSR1000v vBNG Key Numbers to Remember

8.000 PPPoE / IPoE sessions

2,5 Gbps throughput for PPP sessions per CSR1000v *

5 Gbps throughput for IP sessions per CSR1000v *

* *single instance, IMIX, without IO/Performance optimization*

Smart Licensing - Options

The CSR 1000V first boots in evaluation mode with throughput limited to 2.5 Mbps. Smart Licensing is used to automatically download and install needed license.

Two Options:

1. Connection over Internet to Cisco Smart Licensing Server.
2. Install a Smart Software Manager Satellite (SSMS) in your network.

License Sharing Across vBNGs - Saves Money

Smart licenses can be shared among **different** CSR 1000v!

Example: 16 x CSR 1000V running as vBNG, each with 8.000 Broadband Sessions.

Option 1: 16 x L-CSR-BB-8K= would cost \$24.000 * 16 = \$384.000

Option 2: 1 x L-CSR-BB-128K-S= shared among 16 vBNGs would cost \$128.000.

Result: saving of \$256.000 on BB license, which is **66.67% saving!**

...
Option 1 →	L-CSR-BB-8K-S=	8K BB session smart license, 4G add-on memory, Perpetual	Perpetual \$24,000
Option 2 →	L-CSR-BB-128K-S=	128K BB session smart license, 4G add-on memory, Perpetual	Perpetual \$128,000

CSR1000 vBNG Roadmap

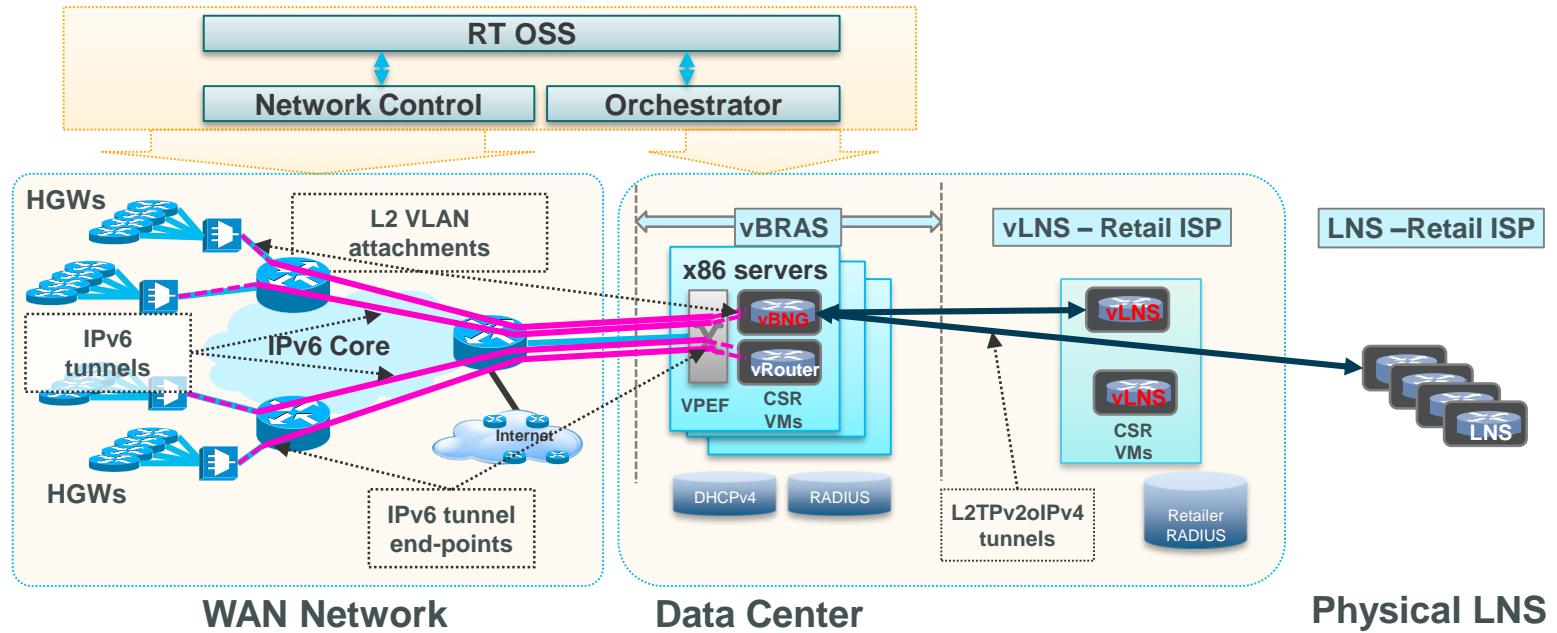
Next:

- 16,000 PPPoE or IPoE sessions per-VM (2HCY2018)
- 16,000 authen + 32,000 walk-by sessions per-VM (EoGRE) (2HCY2018)

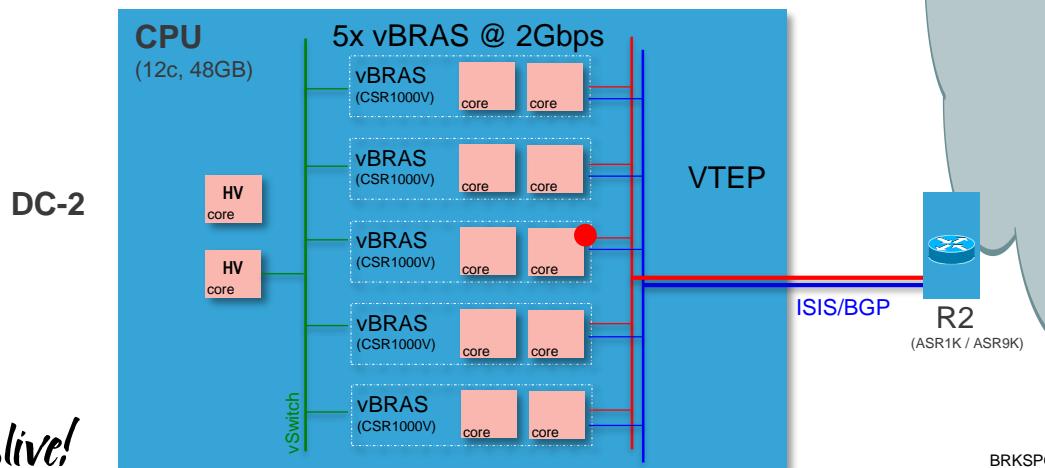
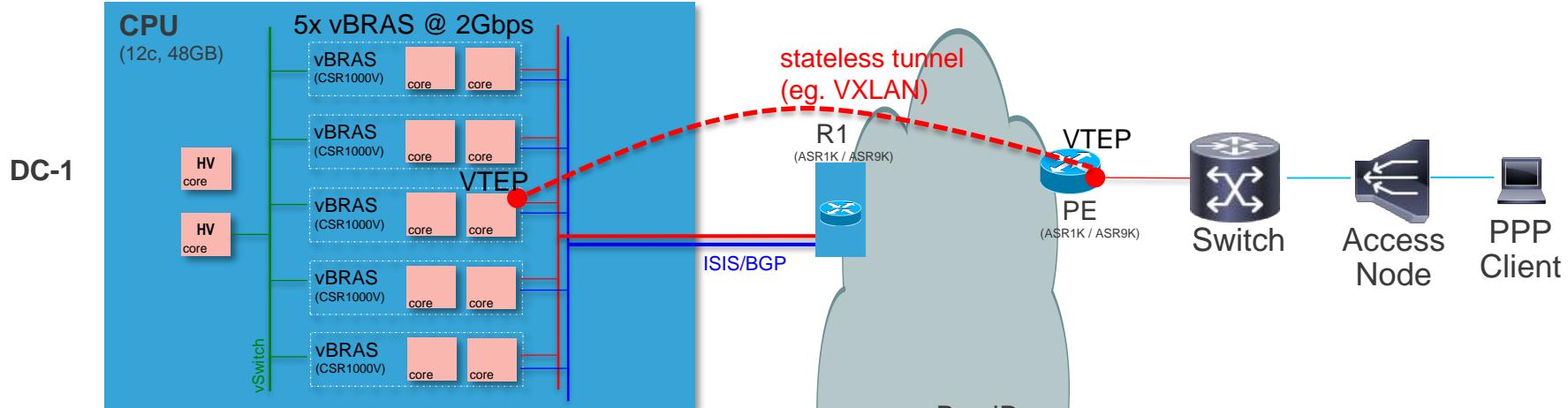
On radar:

- VM-VM HA
- Server-server HA
- 48,000 PPPoE or IPoE sessions with 40Gbps throughput per-VM

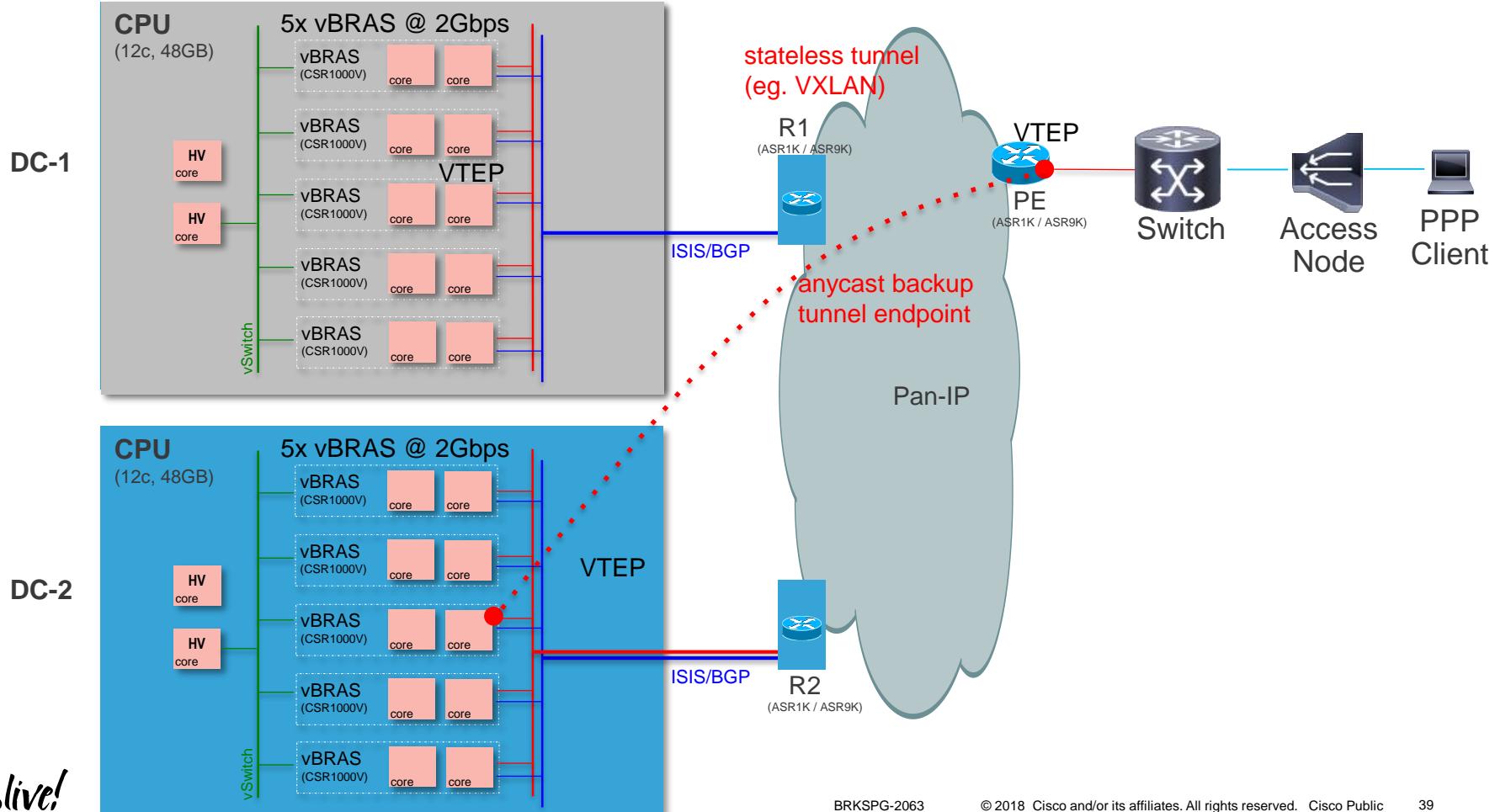
Tier1 SP Use Case - CSR1000v as virtual BNG



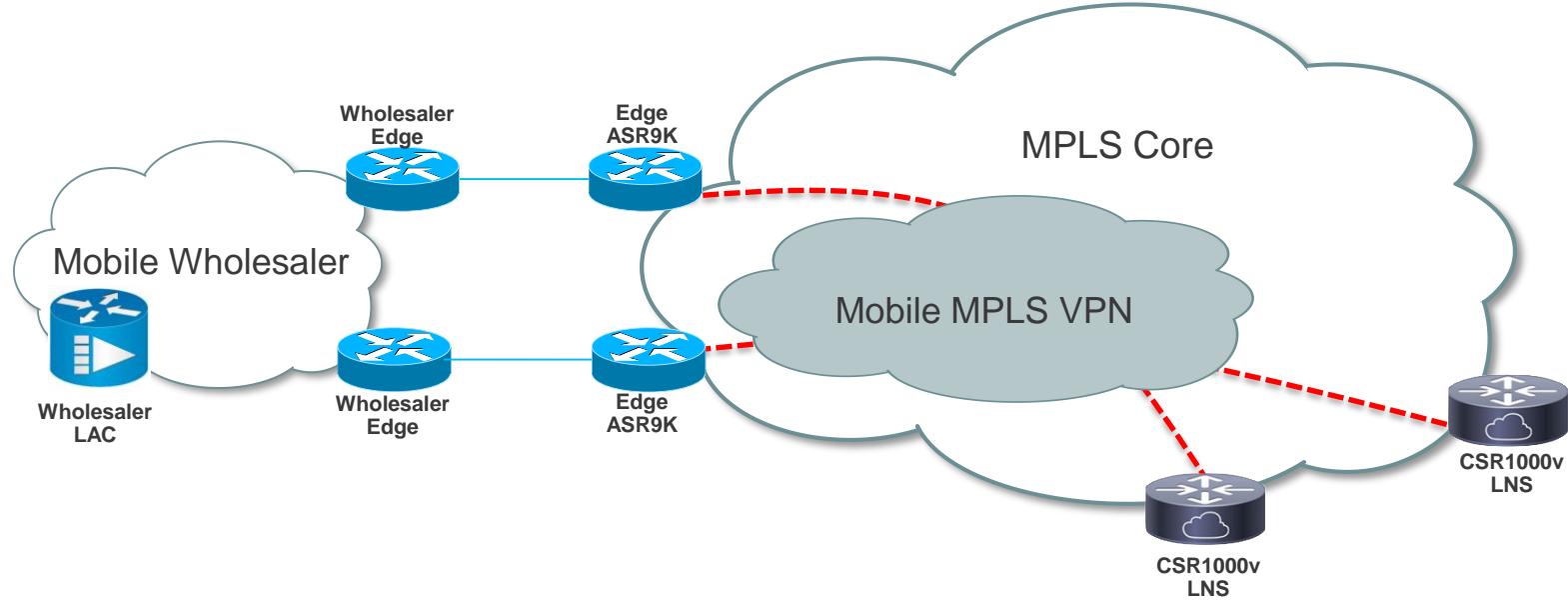
Use Case - PPPoVXLAN to vBNG with GEO Resiliency



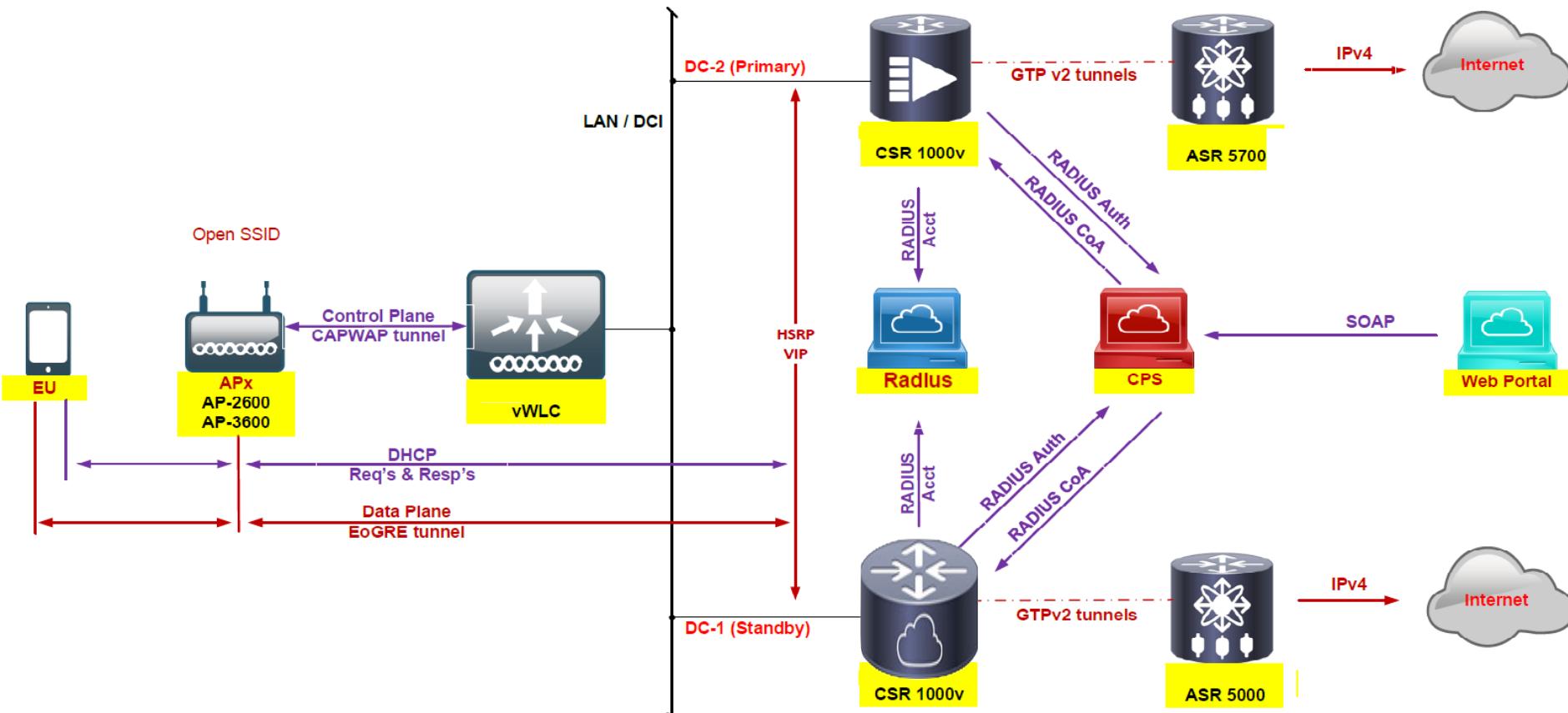
Use Case - PPPoVXLAN to vBNG with GEO Resiliency



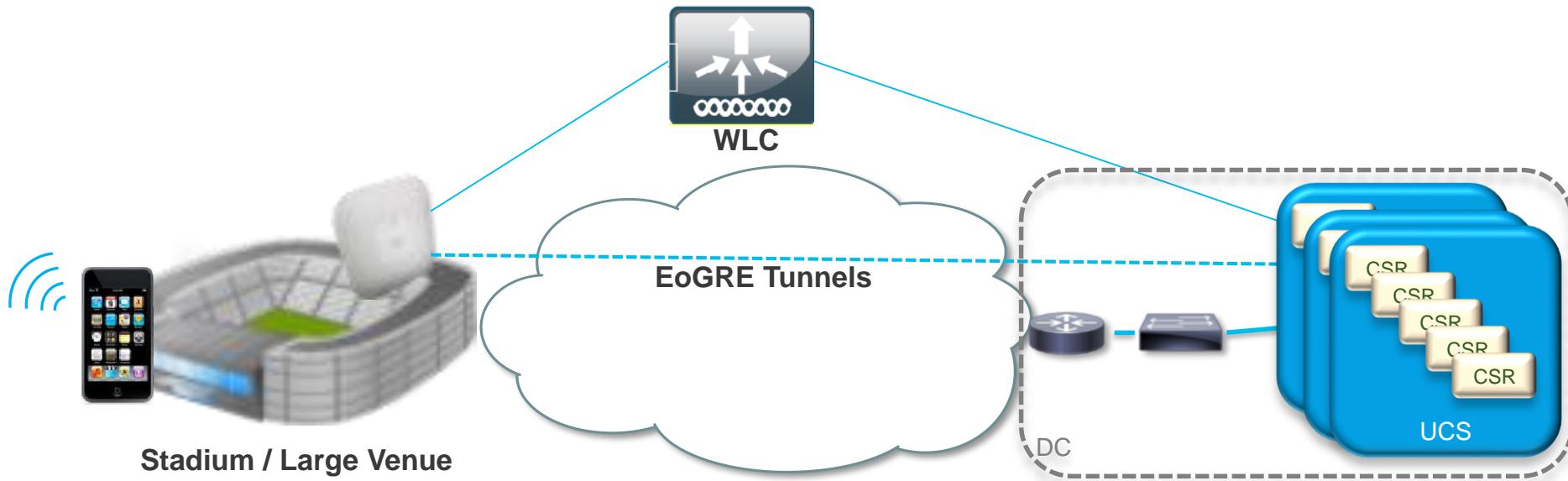
ISP Use Case - CSR1000v As virtual LNS



ISP Use Case - CSR1000v as iWAG using EoGRE



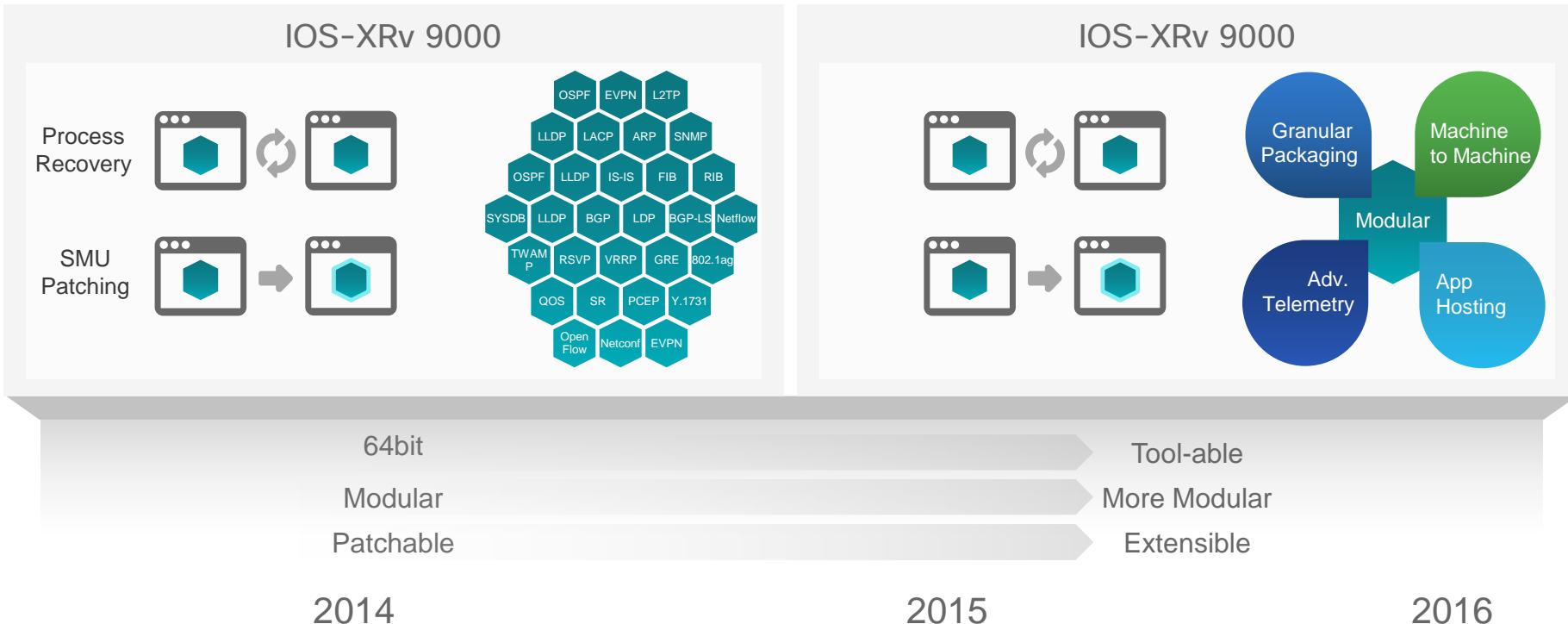
ISP Use Case - CSR1000v as WiFi using EoGRE



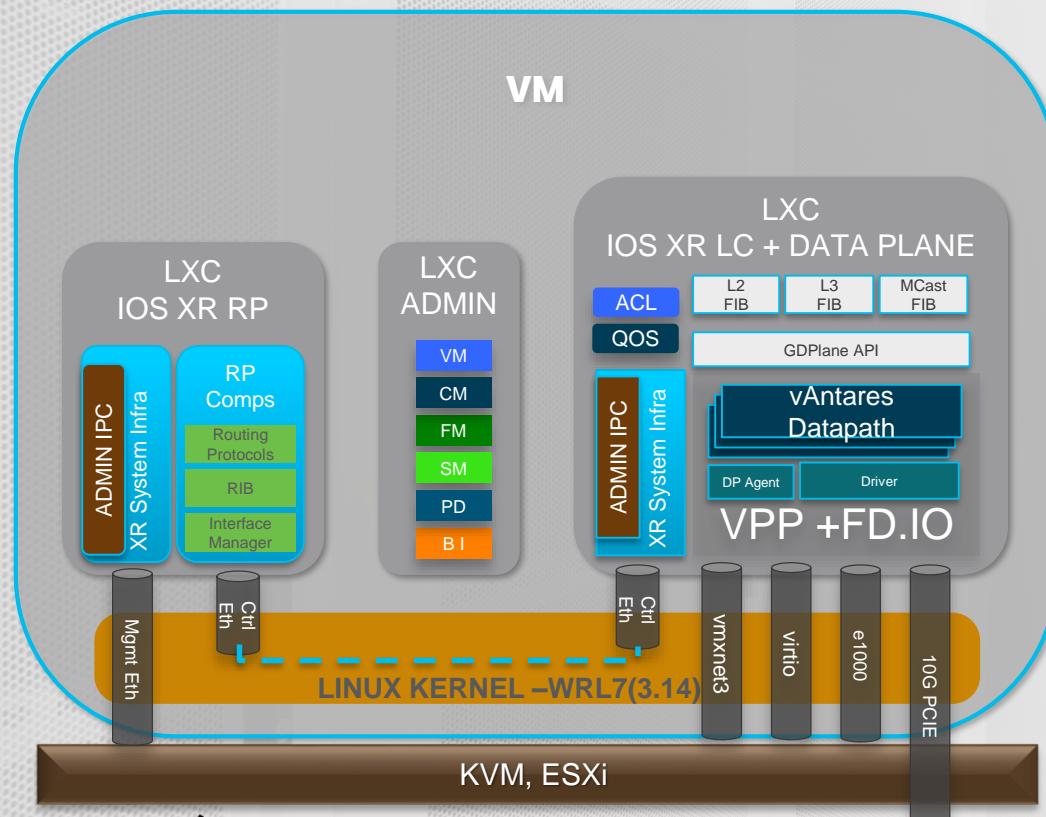
Cisco IOS XRv 9000 – An Introduction

IOS XRv 9000: Built on proven IOS-XR

Inheriting the evolution of XR to eXR



IOS XRv 9000: Architected for Success



ARCHITECTURE ADVANTAGES



Separate Control Plane & Data-Plane. Architected for distributed DP & redundant CP*

*Roadmap Item



Designed to mimic Antares(ASR9000) data-path. Easier to use and Easier to trouble-shoot



CISCO's proprietary SW based HW assists produce best-in-class data-path performance

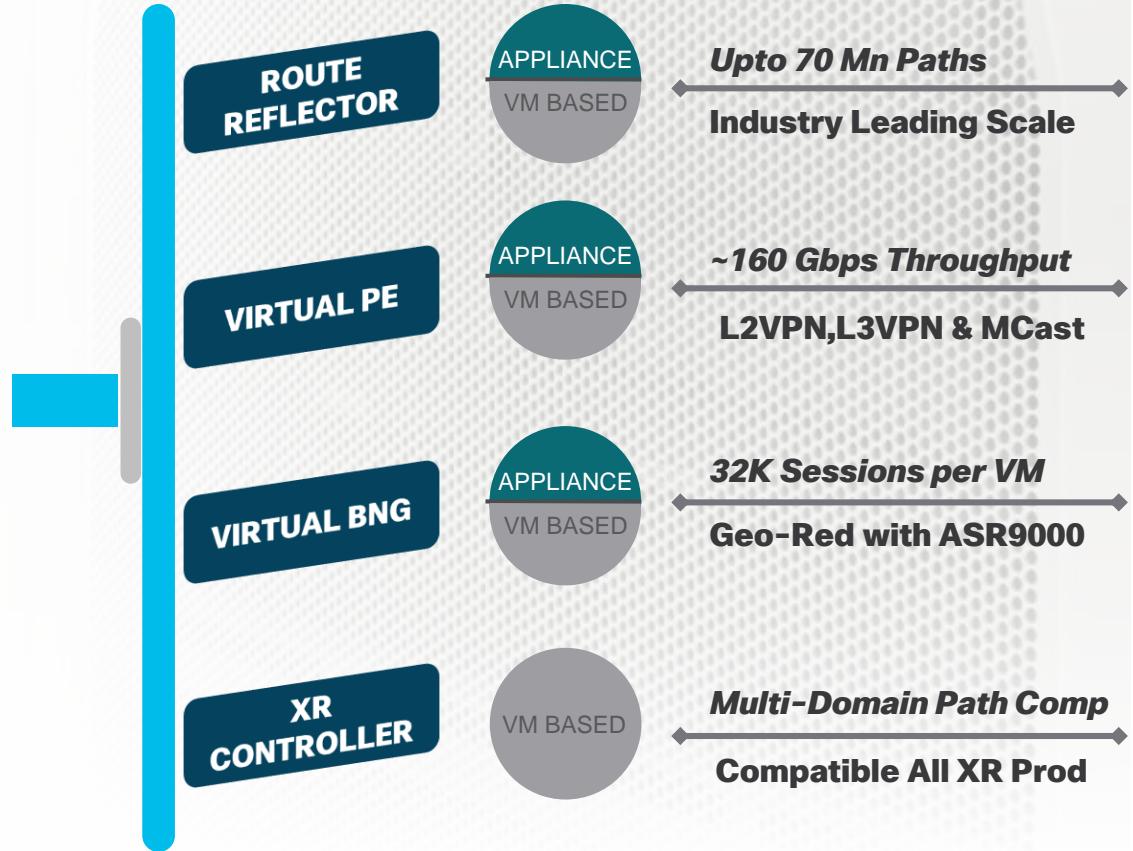
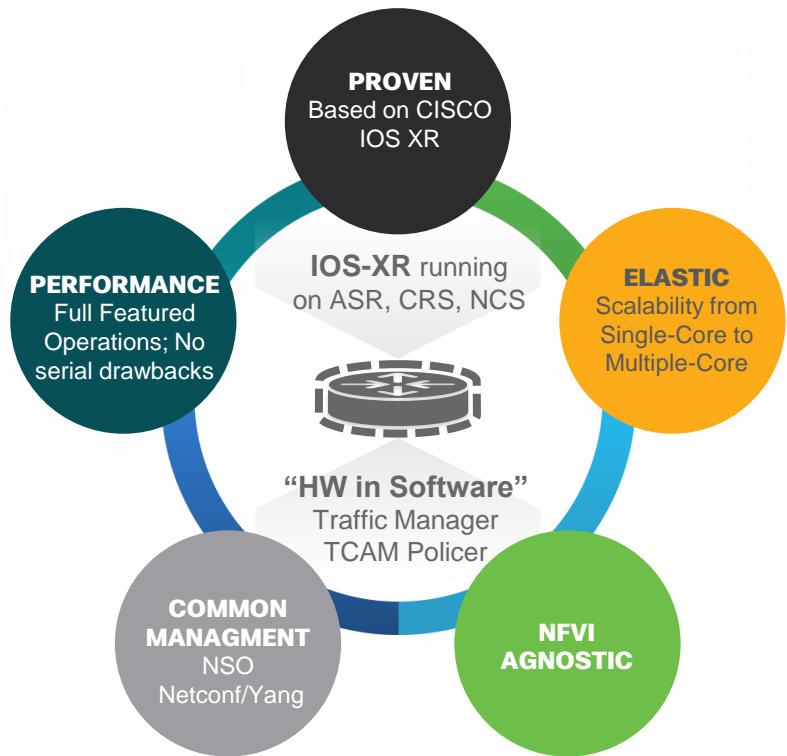


Constructed on Open-source VPP & FD.IO Projects. Feature & Performance Advantage

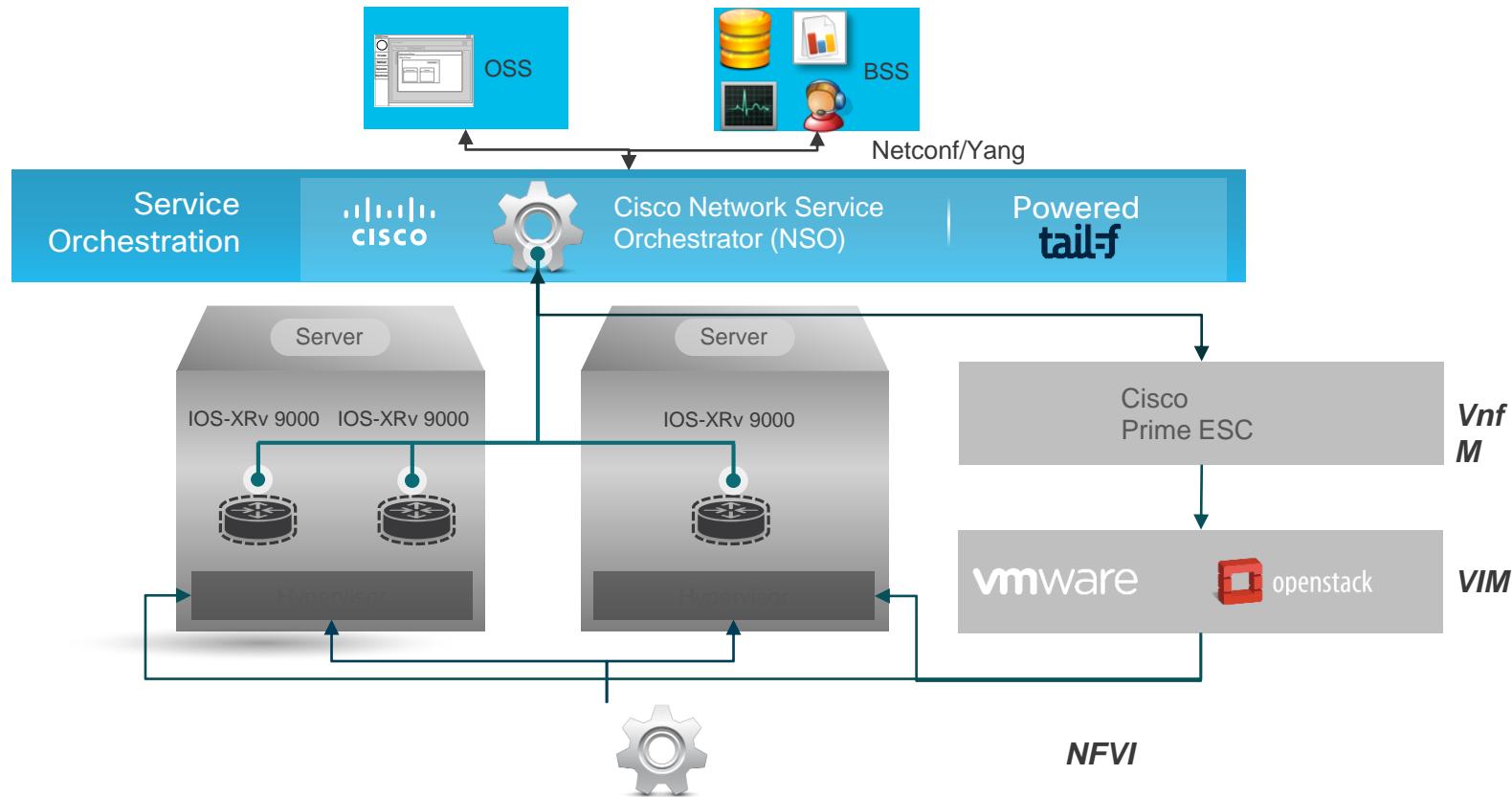


Supports a variety of I/O Options : Virtio, SR-IOV, vmxnet3, e1000, PCIE Pass-through

Key Use-Cases of XRv9000



IOS XRV 9000: Life Cycle Management



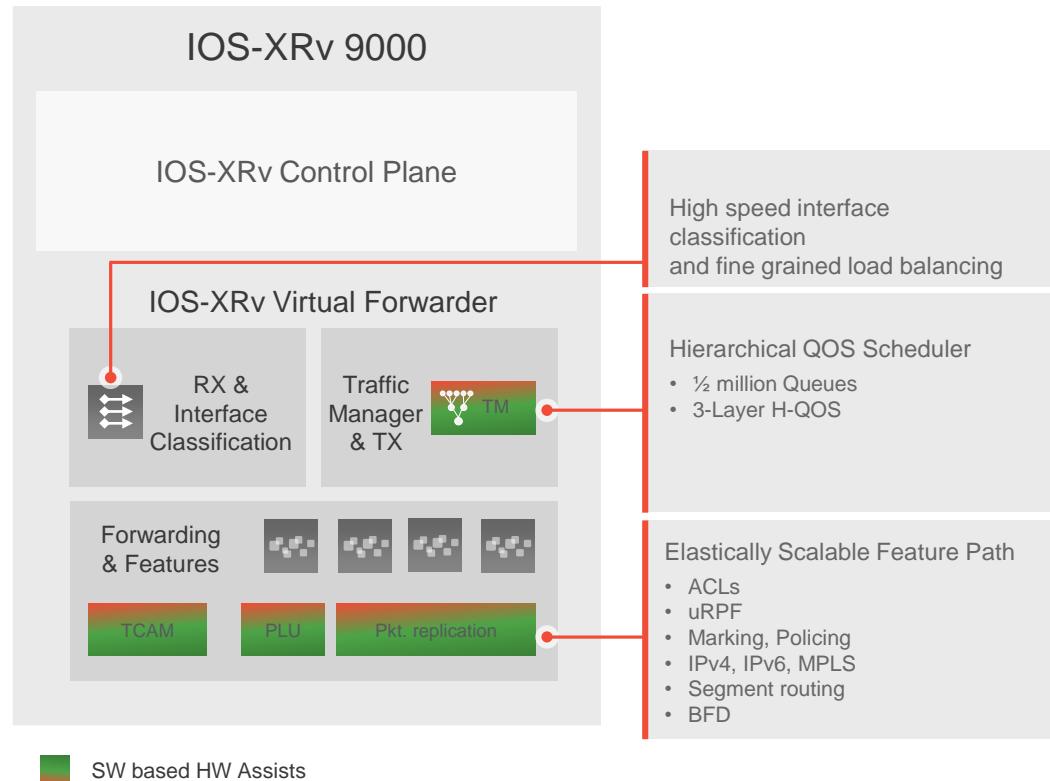
IOS XRv 9000: Efficient Virtual Forwarder

Innovative virtual forwarder

x86-optimized SW based hardware assists:

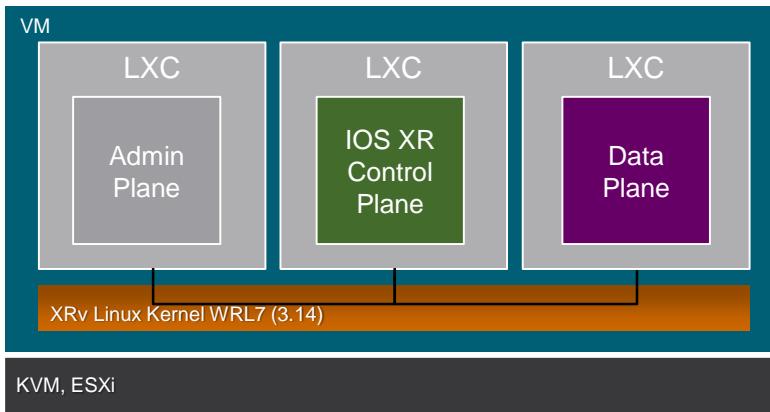
- SW hierarchical traffic manager with 3 level HQoS, 512K queues
- SW policers that is color aware and nearly 4x faster than DPDK based SW routers
- SW TCAM with logical super key & heuristic cuts algorithms
- Data plane optimized for fast convergence
- Portable 64bit C-code (to ARM based platforms)

Common code base with Cisco nPower X family

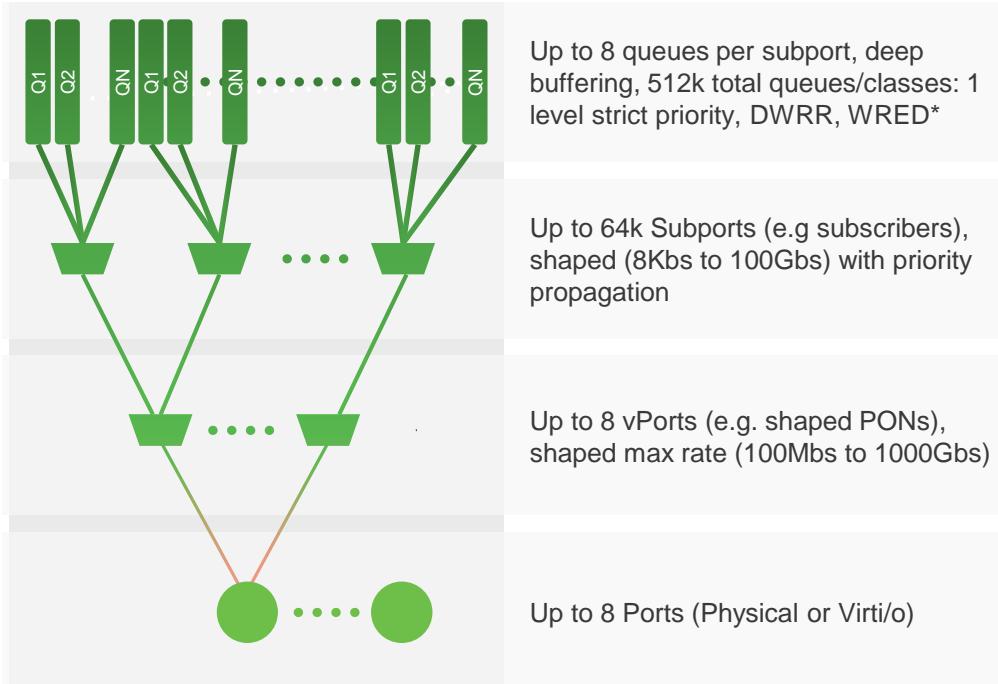


IOS XR based Virtual Router

- Single VM vRouter
- CP/DP Separated in Linux Containers
- Fully Featured, High Speed, Elastic Virtual data plane
- Modular/Lightweight Admin Plane
- In-Service Software patches (for majority of bugs)
- Single Socket and multi-socket support
- PCIe Passthrough for high performance
- RSS and Hyperthreading for highest performance



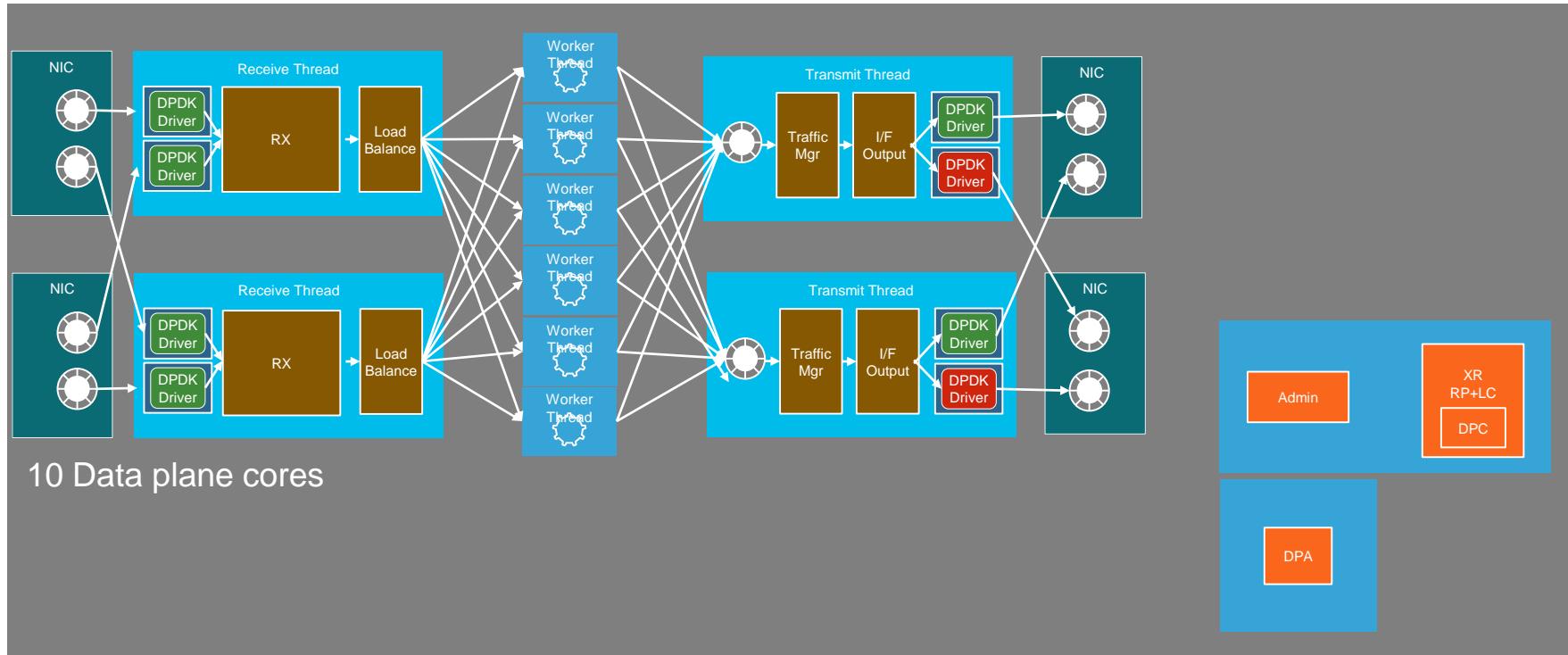
Egress Traffic Manager Capabilities



*also Policing, Marking on classes (not done in TM), with up to 128000 policers, 2500 unique policy-maps
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IOS XRv 9000 – Single Socket

2c CP, 10c DP (2xRx, 6xWT, 2xTx)

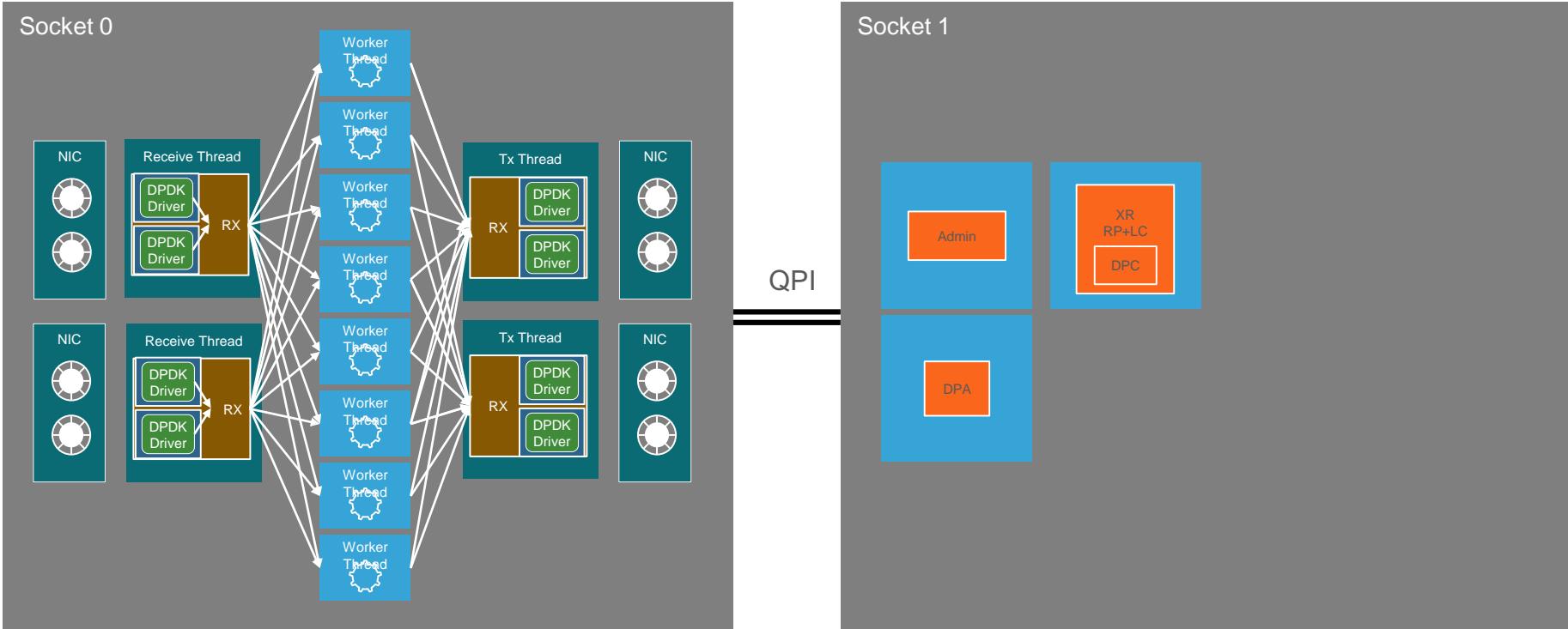


Dedicated
CPU CoreDPDK
& NIC

Multi-socket with CP / DP split

Dedicated DP socket Configuration

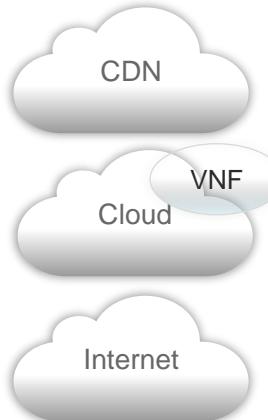
2c CP, 10c DP (8xWT)



vBNG on IOS XRv 9000

XR Residential Services

Density and bandwidth

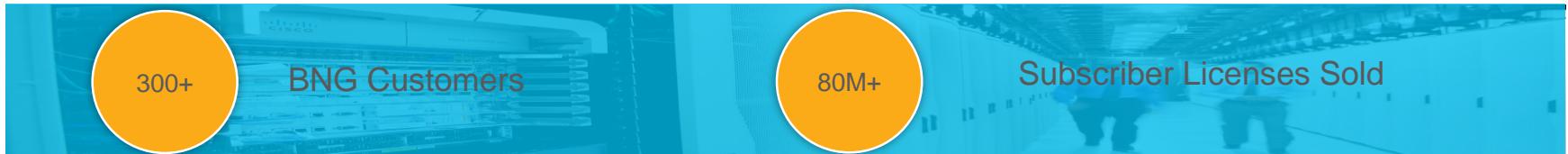


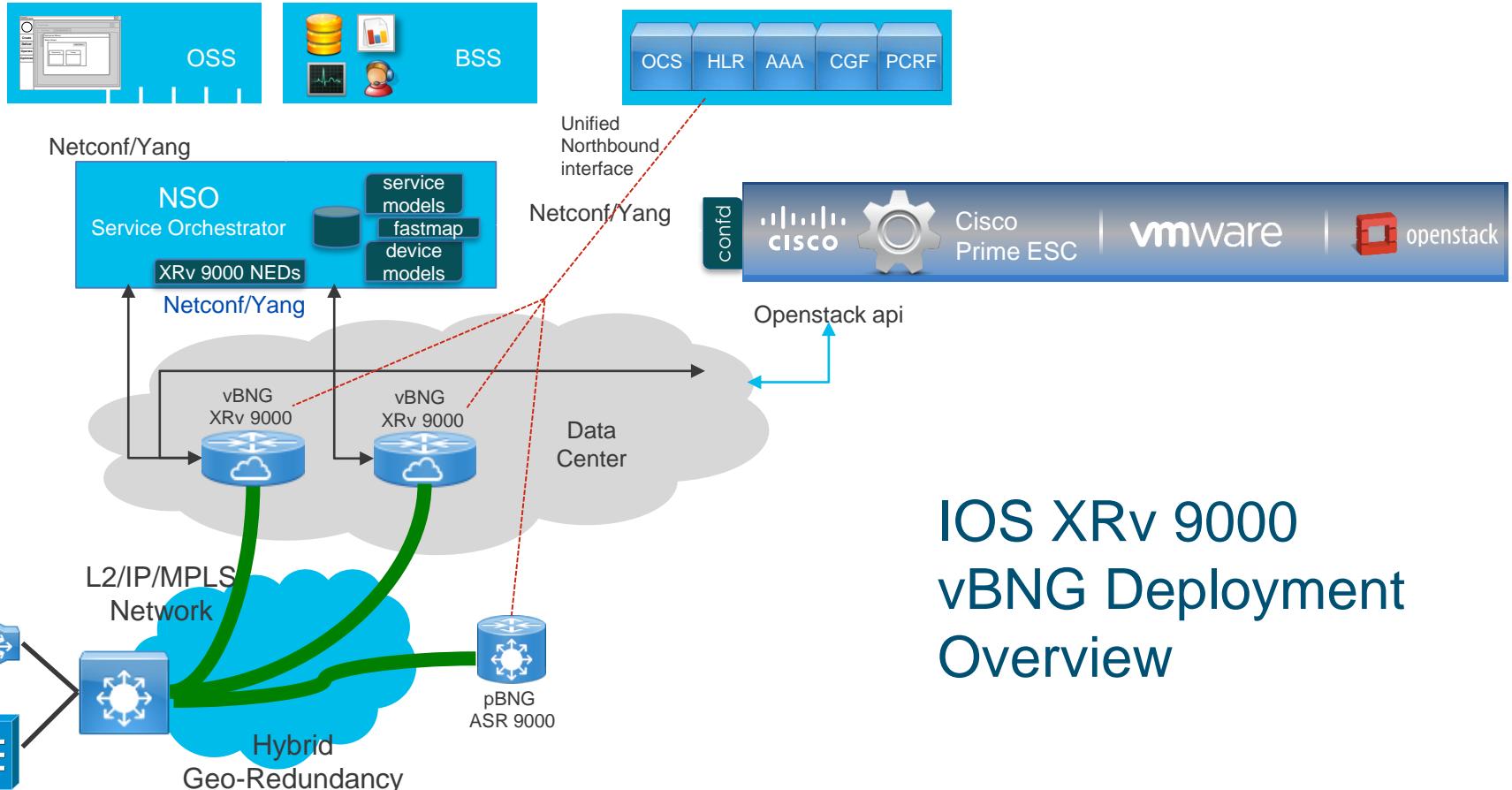
Flexible Deployment Options

Bandwidth & Density

Geo-Redundancy

Analytics & Telemetry

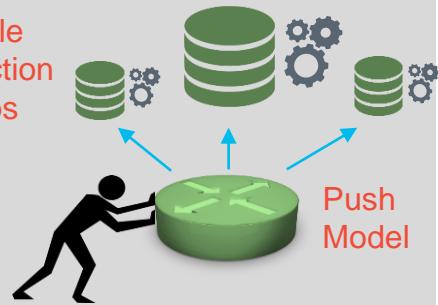




IOS XRv 9000 vBNG Deployment Overview

Embrace the Push Model

Multiple Collection Groups

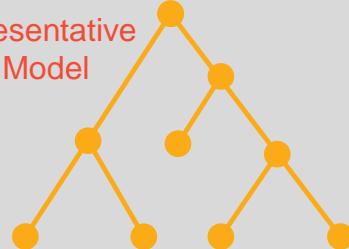


- Cloud-scale performance
- Mandatory for real-time automation in the network

BUILT FOR SCALE

Model-driven Telemetry

Representative Yang Model



- Structured, common Yang models (OC, Native) for easy ingestion

EASY TO AUTOMATE

Event-driven Telemetry

Exceeding Thresholds



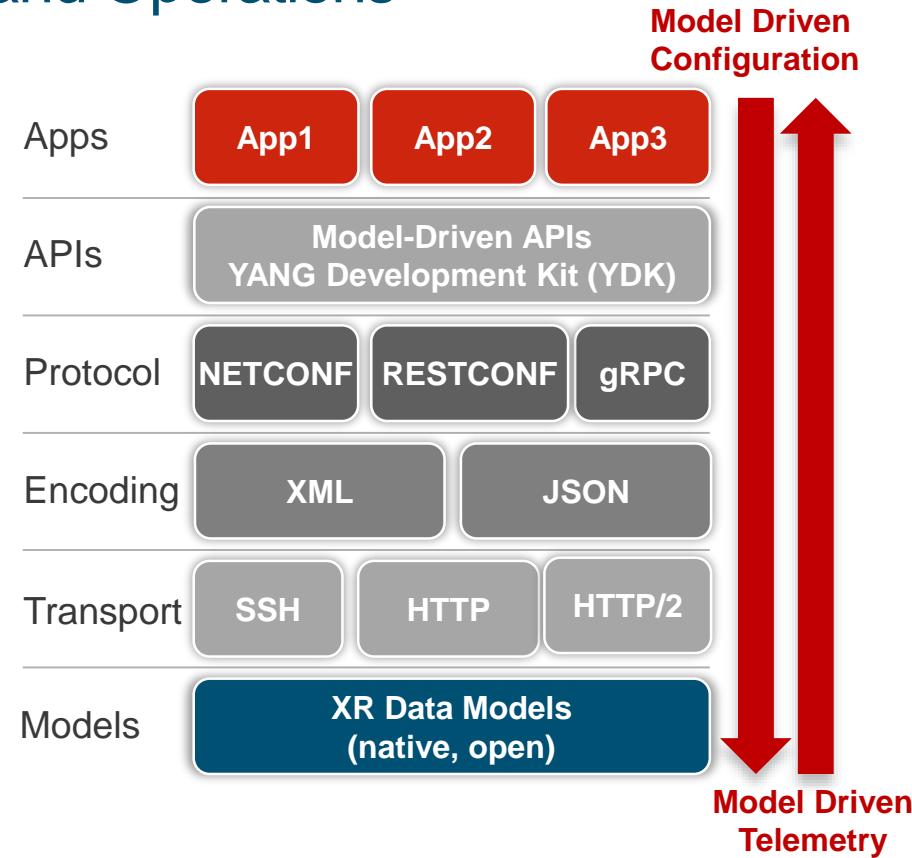
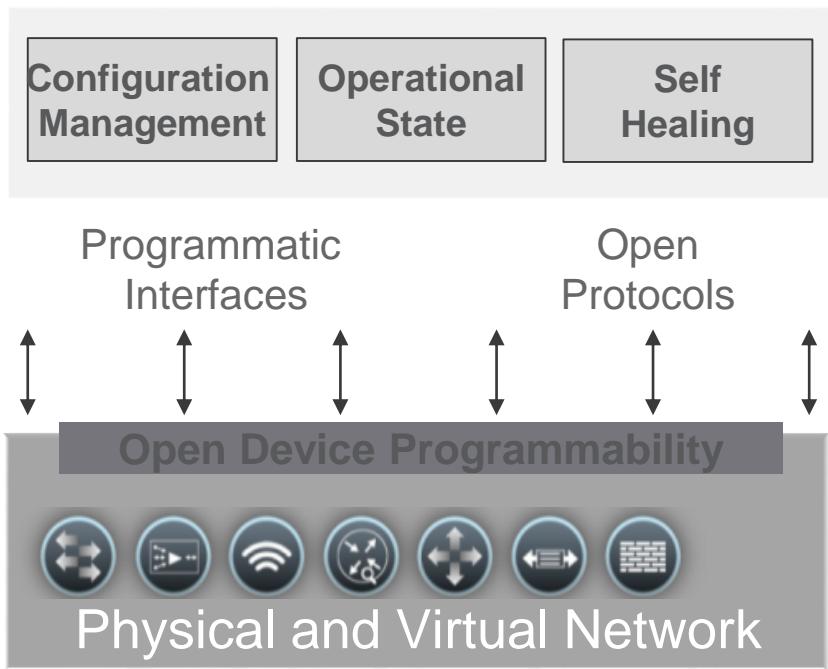
Fault Notification, Remediation

- Avoid unnecessary streaming with events triggering telemetry

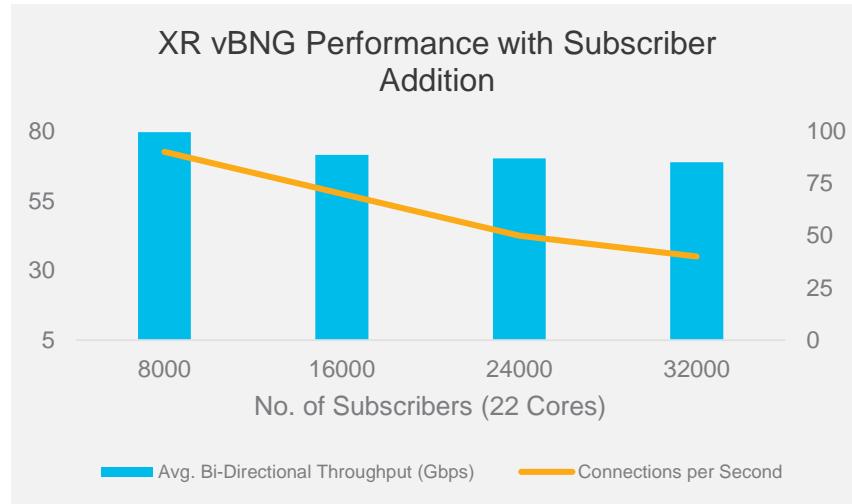
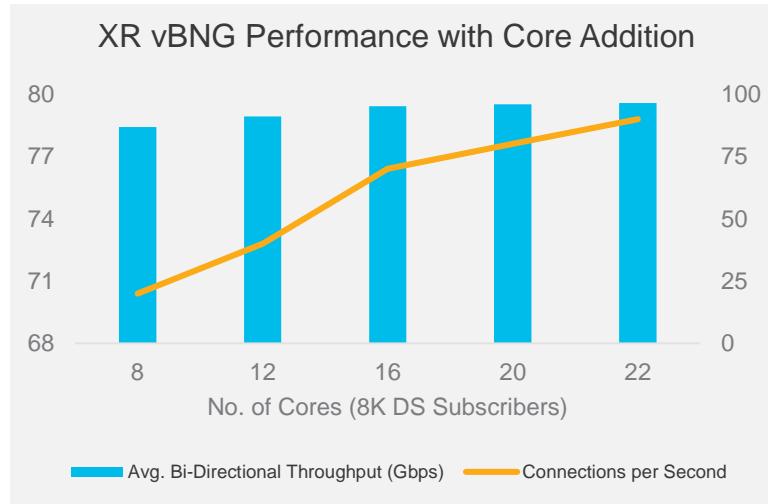
INTERESTING DATA ONLY

XRv9000 is Telemetry Ready

Automating Network Deployment and Operations



IOS XR v9000 BNG Performance and Scaling

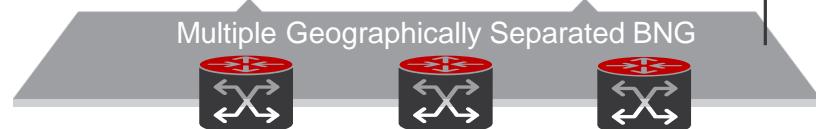


- All tests performed with Dual-Stack IPoE Subscribers with Bi-directional IPv4 IMIX Traffic (avg. pkt size 321 Bytes)
- Each Subscriber interface configured with 26 ACE's per ACL per subscriber and H-QoS with egress shaper and ingress policer
- Session and Service Accounting configured for 5-minute interval

CPU : Intel(R) Xeon(R) CPU E5-2697 v3 @ 2.60GHz
No CPU Pinning
NIC Used = Intel X510
No. of Ports : 8x10G with 2x10G Per NIC
No. Of Sockets – 2
Core Distribution: 1xCP,1xAP,nxDP for all test cases
RAM: 16G per NUMA, 32G per VM
All tests with performed with No Drop Rate – 0.00001% soaked for 3 hours

XR Geo-Redundancy Overview

Profitable Customer Experiences



Stateful Redundancy

BNG can be geographically spread out with only L3 connectivity for BNG Sync
Can be used for Physical/Virtual Deployments

1:1, M:1 and M:N Redundancy

Redundancy in case of

- Access Link Failures
- Line Card Failures
- RP Failures
- Chassis Failures
- Site Failures
- VM Failure

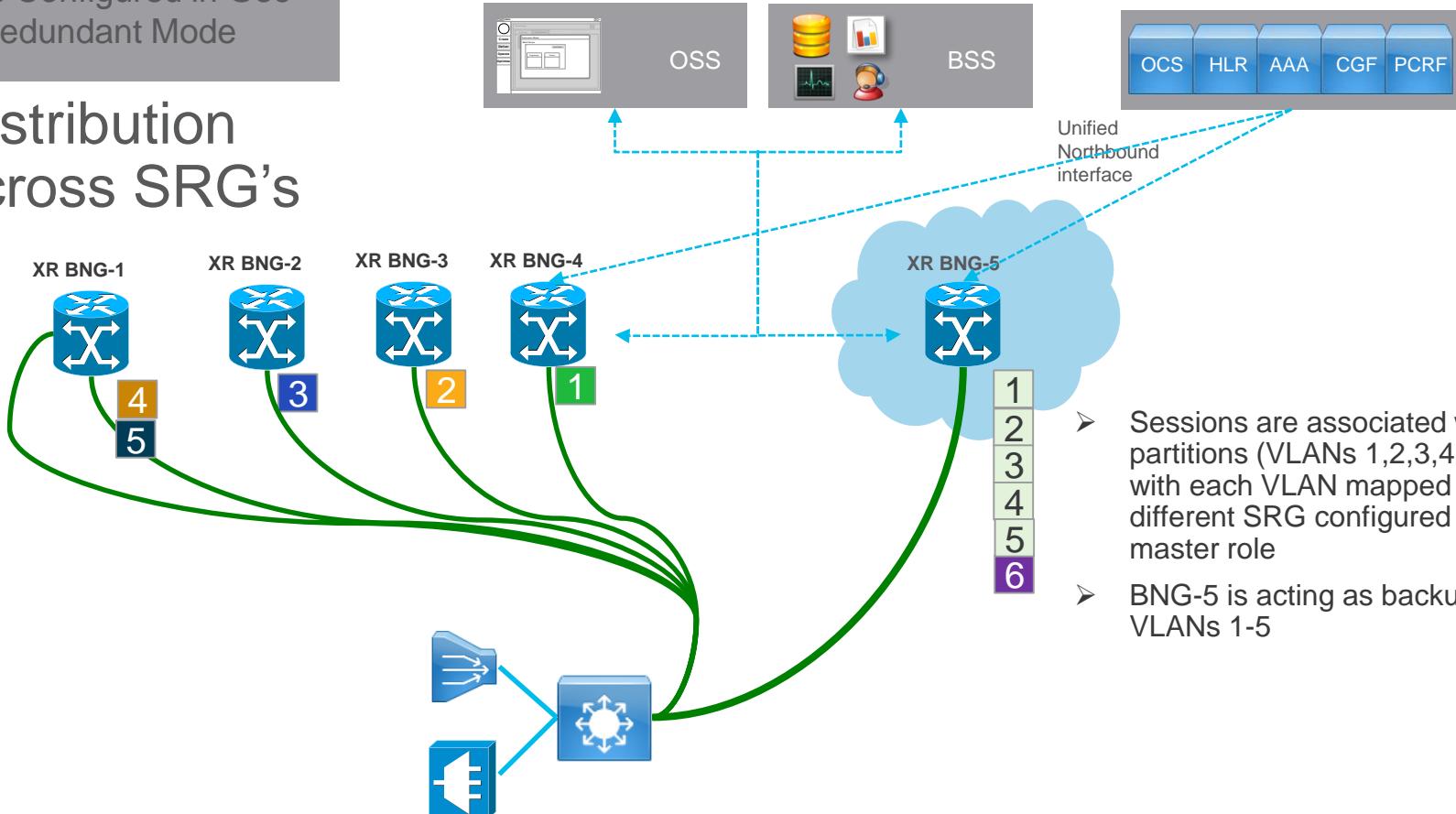
Multiple Technology Support

Access Nodes are dual/multi-homed for redundancy using a variety of technologies based on the SP network design and choices - MLAG, Dual Homed, Ring (G.8032), PWHE, etc...

Transparent Switching

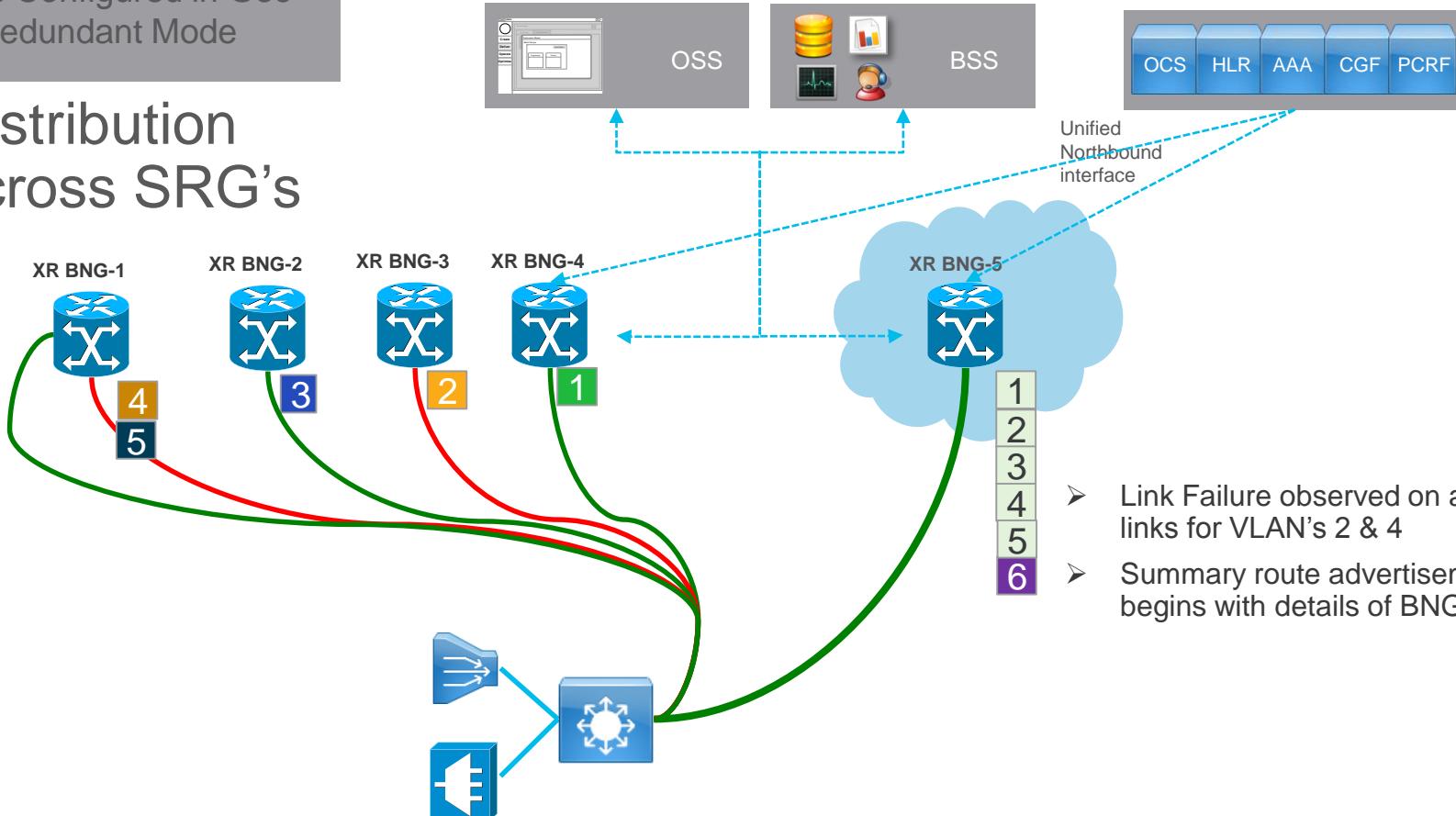
CPEs see one BNG Gateway

Distribution across SRG's



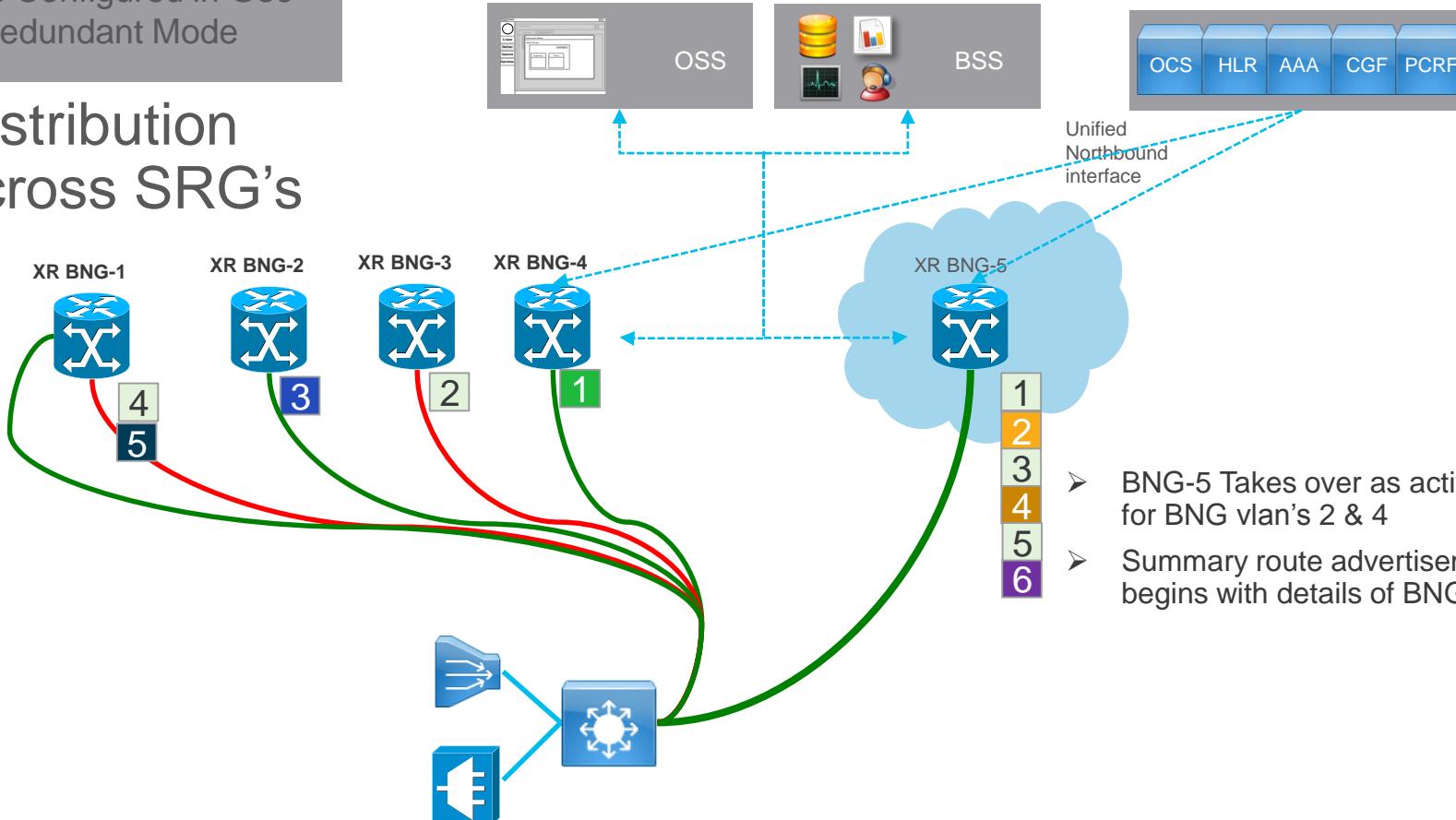
BNG's Configured in Geo-Redundant Mode

Distribution across SRG's



- Link Failure observed on access links for VLAN's 2 & 4
- Summary route advertisement begins with details of BNG-5

Distribution across SRG's



What does Mobile Local Loop achieve?

In many markets, wireline connectivity penetration is low or costly or time consuming.
There is a better connection of cellular networks and better bandwidth availability



Mobile Local Loop(MLL) solution enables faster time to market and easier customer acquisition, leveraging wireless access

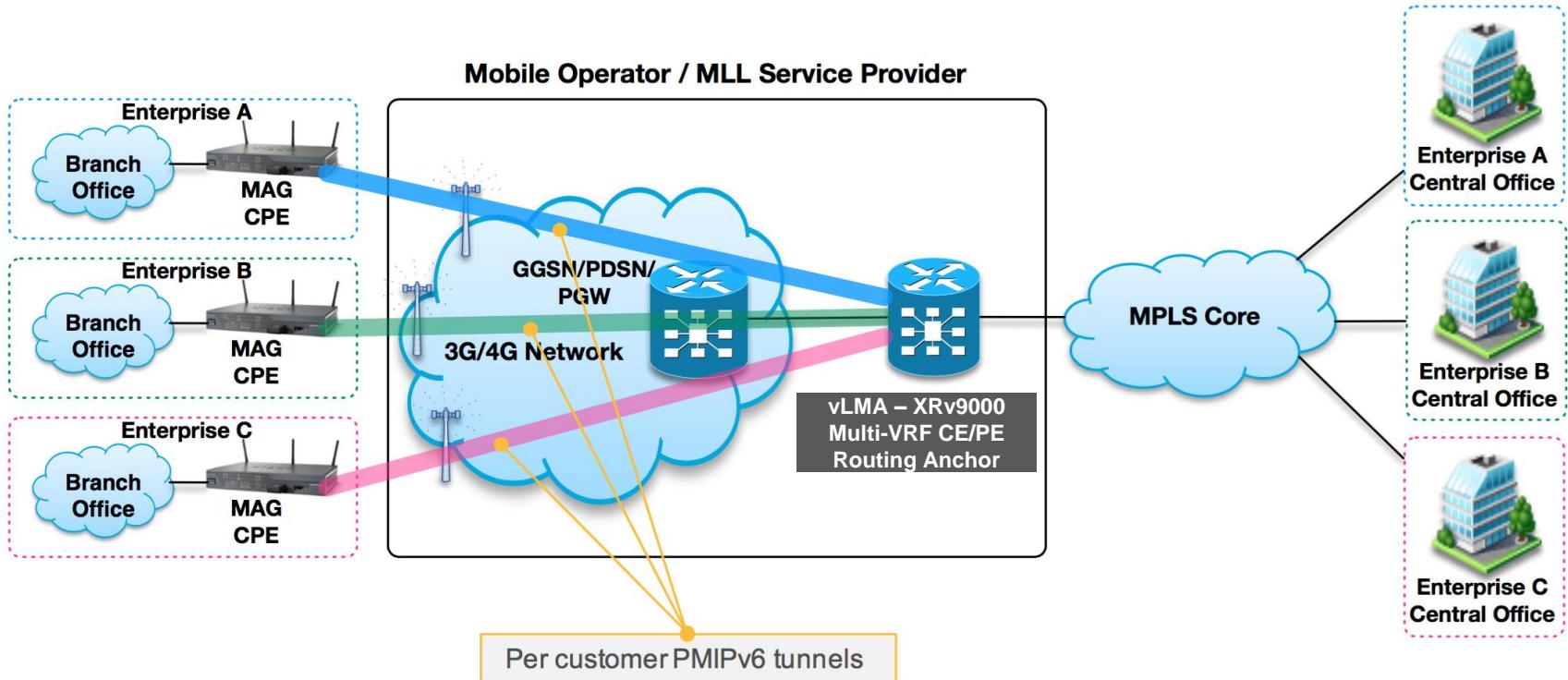
MPLS VPN connectivity over any wireless access; 2G,3G,4G WIFI

Ability to connect multiple customers with single CPE- Multi-tenancy

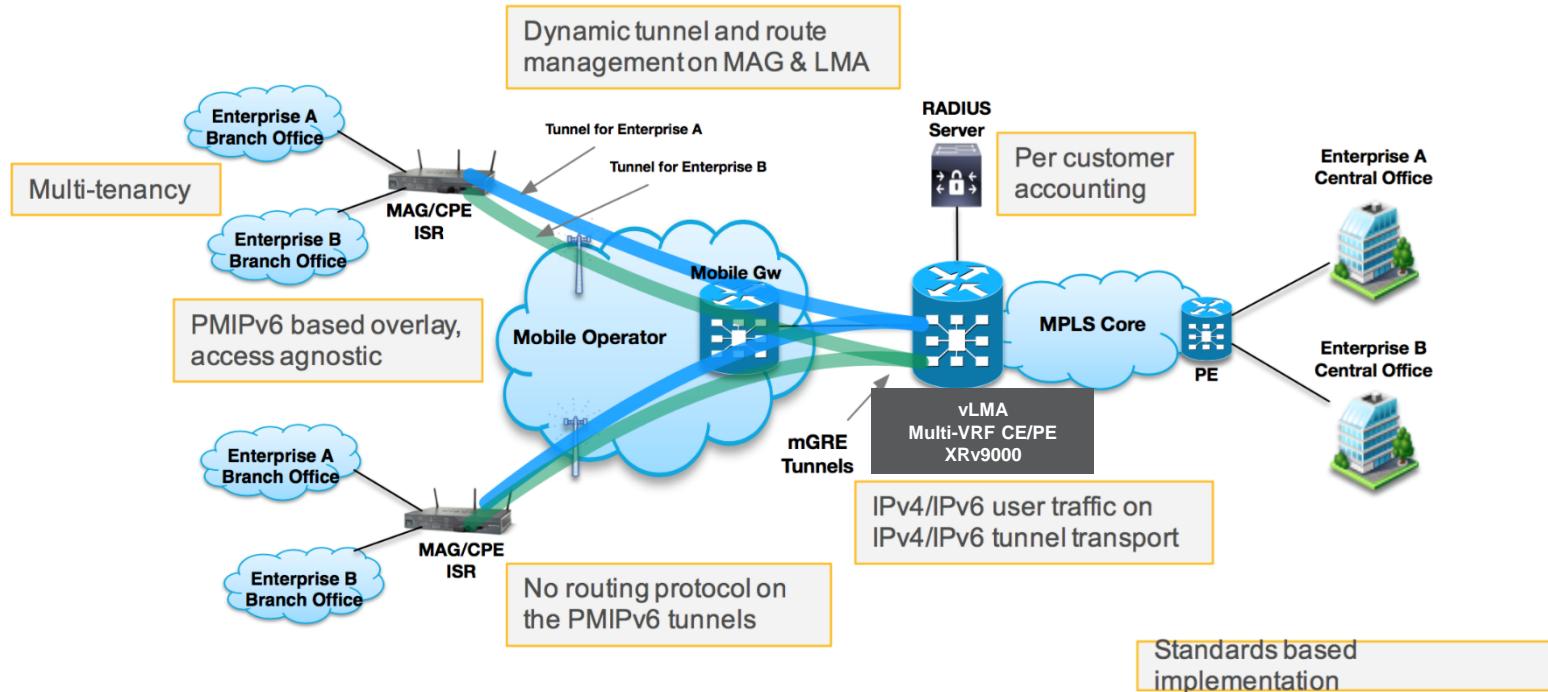
Separate billing capabilities per customer flow

No Routing complexity on MPLS CE- PE link

PMIPv6 in MPLS VPN wireless last mile



Mobile Local Loop Solution View



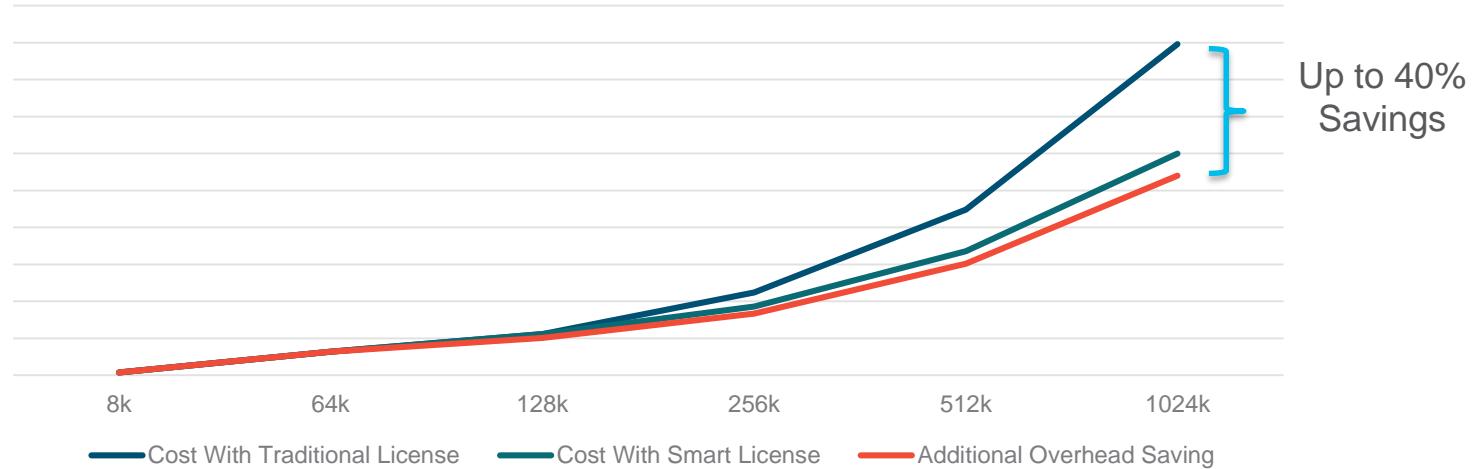
Smart Licenses can be shared across XR BNG's (Physical and Virtual)

Typical overhead of licenses per box ~15% *

Average overhead of licenses with Smart Licensing per network ~5%*

Option to right size purchase with Subscription based model (annual/tri-annual pricing)

Cost Savings with Smart Licensing



* Average of actual number of licenses procured v/s licenses consumed from live deployments with 8 customers in 5 countries

IOS-XR BNG Architecture Evolution

Physical BNG

Internet G/W
Walled Garden
CDN



AAA/PCRF



BNG

Moderate-High Density
Power Optimized
Multi-Service Termination
Inline MACSEC, NAT

Virtual BNG

Internet G/W
Walled Garden
CDN



Services



vBNG

Subscriber
Termination
Policy Enforcement
Authentication,
Authorization and
Accounting
Stateful Redundancy
Flexible Deployment
Options
Smart-Licensing
Subscriber Telemetry

Low-Moderate Density
Elastic Scaling Options
Service Replication ,Service Agility and Re-
use
Service-Chaining

Subscriber Visibility
Granular Subscriber Control
Optimized Network Resources
OSS/BSS Simplification

Managed BNG

Internet G/W
Walled Garden
CDN



Managed Services

Physical/ Virtual
BNG's



Summary

Summary of The Whole Presentation

- Cisco offers both IOS XE (CSR1000v) and IOS XR (XRv 9000) based vBNG solutions
- Both vBNG solutions include:
 - Cisco vBNG VNF: CSR 1000V and/or XRv 9000
 - NSO / ESC Orchestration Software
 - UCS Server Hardware and Setup Optimization
 - Smart Licensing, Monitoring and Operation Guidance

With Cisco vBNG solutions you can build



Scalable



Flexible



Cost-
Effective

Broadband Aggregation

Cisco Spark

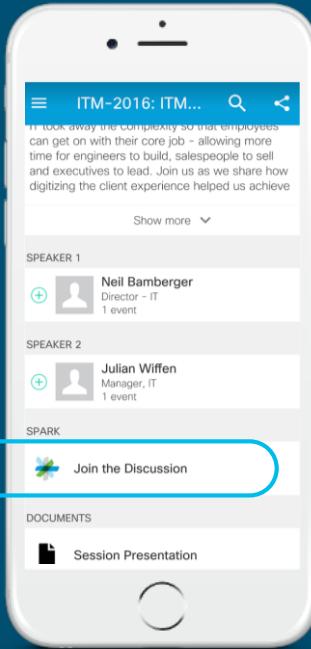


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2. Click “Join the Discussion” ——————
3. Install Spark or go directly to the space
4. Enter messages/questions in the space



cs.co/ciscolivebot#BRKSPG-2063

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- Complete 4 Session Evaluations & the Overall Conference Evaluation (available from Thursday) to receive your Cisco Live T-shirt
- All surveys can be completed via the Cisco Live Mobile App or the Communication Stations

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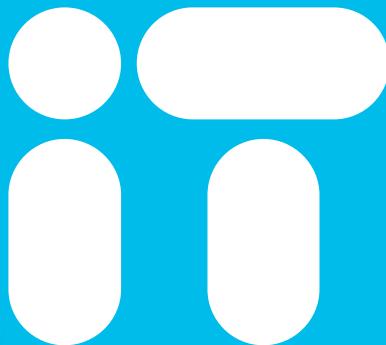
- Demos in the Cisco campus
- Walk-in Self-Paced Labs
- Tech Circle
- Meet the Engineer 1:1 meetings
- Related sessions



Thank you



You're



Cisco *live!*