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You make possible

How to choose the Correct Branch Device

Stefan Mansson
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Enterprise Routing Group
#isrguru

BRKRST-3404

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Barcelona | January 27-31, 2020

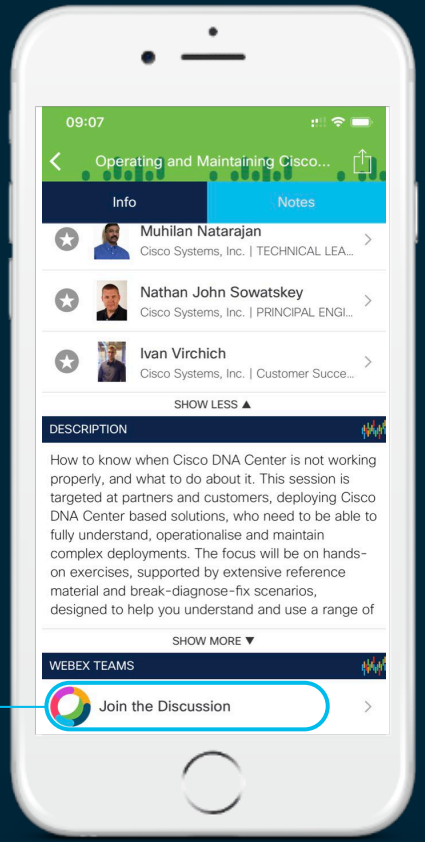
Cisco Webex Teams

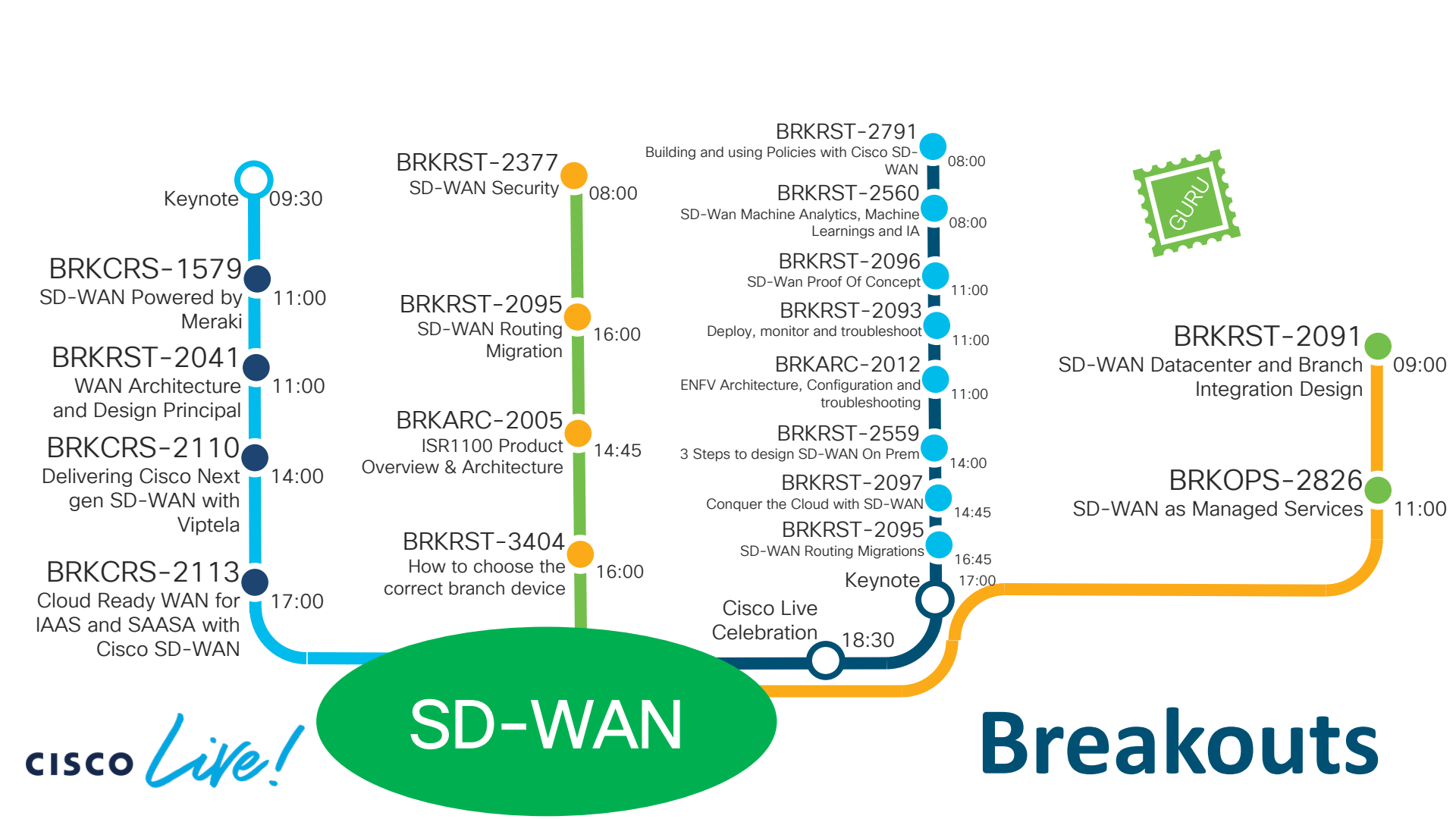
Questions?

Use Cisco Webex Teams to chat with the speaker after the session

How

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




Keynote 09:30
BRKCRS-1579
SD-WAN Powered by Meraki
11:00
BRKRST-2041
WAN Architecture and Design Principal
11:00
BRKCRS-2110
Delivering Cisco Next gen SD-WAN with Viptela
14:00
BRKCRS-2113
Cloud Ready WAN for IAAS and SAASA with Cisco SD-WAN
17:00
BRKRST-2377
SD-WAN Security
08:00
BRKRST-2095
SD-WAN Routing Migration
16:00
BRKARC-2005
ISR1100 Product Overview & Architecture
14:45
BRKRST-3404
How to choose the correct branch device
16:00
BRKRST-2791
Building and using Policies with Cisco SD-WAN
08:00
BRKRST-2560
SD-Wan Machine Analytics, Machine Learnings and IA
08:00
BRKRST-2096
SD-Wan Proof Of Concept
11:00
BRKRST-2093
Deploy, monitor and troubleshoot
11:00
BRKARC-2012
ENFV Architecture, Configuration and troubleshooting
11:00
BRKRST-2559
3 Steps to design SD-WAN On Prem
14:00
BRKRST-2097
Conquer the Cloud with SD-WAN
14:45
BRKRST-2095
SD-WAN Routing Migrations
16:45
Keynote
17:00
Cisco Live Celebration
18:30
GURU
BRKRST-2091
SD-WAN Datacenter and Branch Integration Design
09:00
BRKOPS-2826
SD-WAN as Managed Services
11:00
SD-WAN
Breakouts
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Agenda

- WAN drivers that will impact your CPE
- Before you start looking for new CPE - Ask yourself this...
- Performance collaterals – Are you comparing apples to apples?
- At some point your CPE will get attacked. Has it got an adequate threat defense?
- ISR & ASR1K HW Architecture – Why do you need to know?
- We just added 25 new ISR1100 models. - Which one to choose?
- Cisco SD-WAN
  - Viptela OS or IOS XE
  - Cisco ISR 1100 with Viptela OS
  - Choosing CPE for SDWAN Security – Don't paint yourself into a corner
- Will a virtualized CPE be a good fit?
- Useful Troubleshooting & Monitoring tips

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For your refererence - Might or might not be elaborated on

Stefan Mansson

Sr. Technical Marketing Engineer – SDWAN & Branch Routing

35 years in Network Business

30 years with Cisco Branch Routers and Routing Solutions

10 years as Cisco consultant @ Swedish Gold Partner

20 years @ Cisco, based in 5 countries

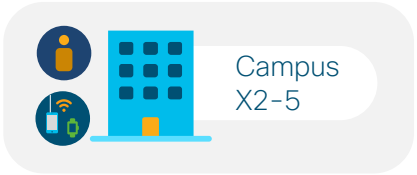
CCIE # 3516 22 years since -98

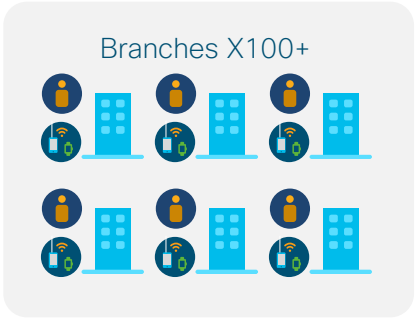
CCSI # 20145 Cisco Instructor 23 years since -97

Things that will impact your choice of CPE

Cloudification – Changing WAN traffic patterns

Internet Becoming Business Critical





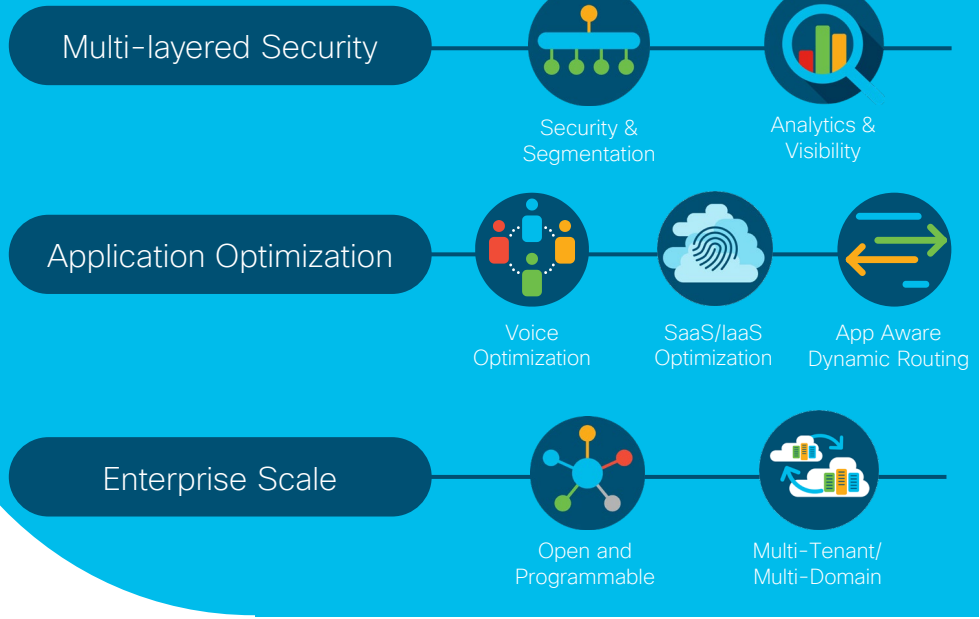
More users, things and applications, everywhere

More Advanced WAN Capabilities Required

Required basic WAN capabilities

- Circuit Load Balancing
- Direct Internet Access
- Centralized Management & Orchestration
- Circuit Cost Savings

Extended WAN capabilities



All that cool stuff aside...

Down to The Basics

Ask yourself this:

Things to ask yourself

How much WAN bandwidth do I actually require

- Will my traffic utilize the offered bandwidth I'll be paying for?
- What does my traffic pattern look like?

For the Services I intend to run…

- …do I understand the impact these services will have?
  - Are they impacting Throughput …or only DRAM usage? …or maybe both?

How will my chosen platform scale?

- Can I upgrade interfaces and DRAM after the fact?
  - Do I need to?
- Will my platform accommodate eventual changes to the WAN environment ?

Do I fully understand the collaterals and data I'm being fed?

- Can I really apply what I'm reading to my environment?
- How do I compare this data from one vendor to another?
  - …or even from one Cisco platform to another?
    - Is it tested the same way?

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Understanding Router Performance

Are you comparing apples to apples?

Beware of Misperceptions

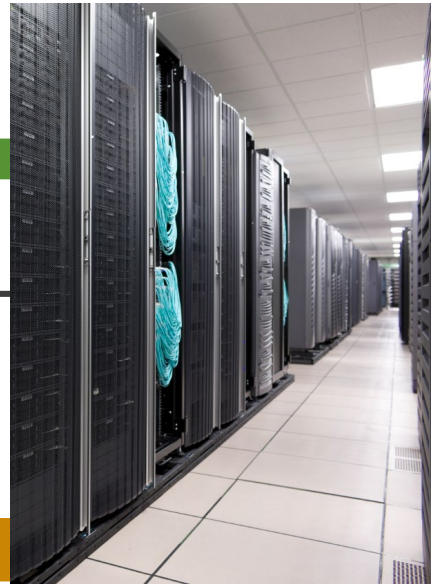
So...my 4331 will do 2Gbps. Is that Bidirectional?

Is this 2Gbps Bidirectional?

1Gbps UP

+

1Gbps DOWN



2Gbps UP

+

2Gbps DOWN

?????

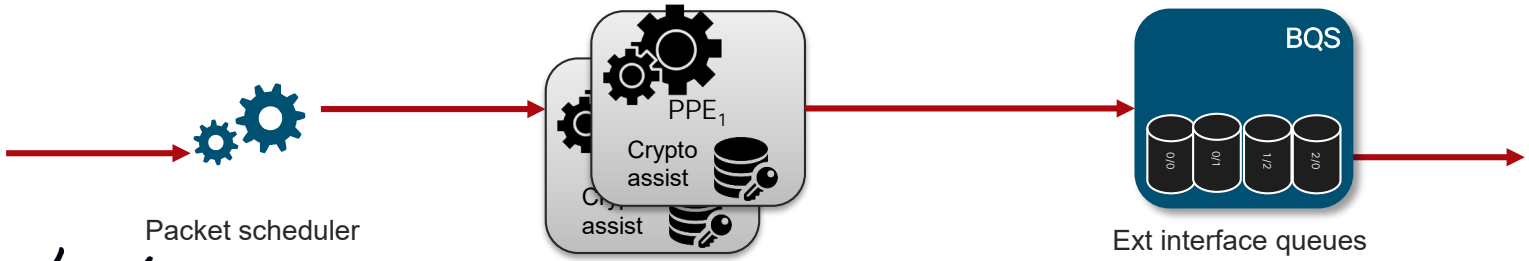
...or is this 2Gbps Bidirectional?

Why Cisco Uses the Term ”Aggregated”

Ehh...Wrong!!!

”Reported performance numbers should be cut in half to show true throughput”

- Our performance numbers represents total performance capacity – regardless of direction
- A Forwarding mechanism doesn’t distinguish between Up or Down
- Total forwarded traffic is hence the ”Aggregated” throughput
- Plus...today’s cloudification changes traffic into unidirectional patterns



Measuring Throughput – RFC 2544

RFC 2544 NDR Methodology

- Automated test employing a binary search for a no drop throughput rate
- All traffic the router can forward for a service is reported
- Reported performance number represents just below drop rate

Why we run RFC 2544

- Fully automated & repeatable test process
- Measures throughput identically on all tested platforms
- A drop is a drop – when it's dropping packets, the limit has been reached
  - Regardless of vendor or architecture

Beware of Misperceptions

Traffic Profiles

Performance Report # X

Cisco 4451

Basic L4 FW: 3.8 Gbps

Performance Report # Y

Cisco 4451

Basic L4 FW: 2.025 Gbps

Hmm....

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So...Which One is Correct?

They both are, it depends....

...on the traffic profile

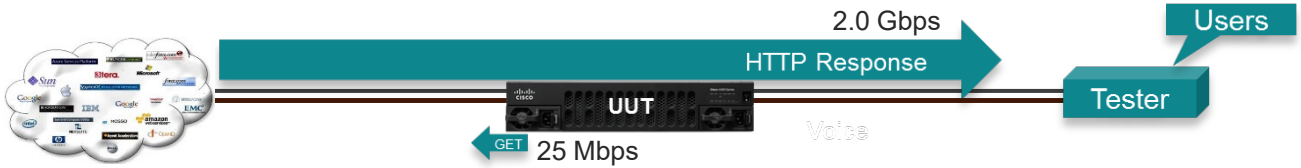
Stateless

- 1.9Gbps up + 1.9Gbps down

Cloud Based HTTP

- 0.025 up + 2.0 down*

  * 1 Gbps/Inbound port x 2 ports



Beware of Misperceptions

Test Methodologies

Max throughput
2.8Gbps +

Cisco 1941
Recommended 25-40Mbps

Cisco 3945E
Recommended 350-500Mbps

Max throughput
8Gbps +

Believe it or not: All are actually perfectly accurate test results

1. No services enabled
2. Same IPv4 destination for all packets
3. Stateless UDP with ONLY maximised L2 frame size

Beware of Misperceptions

Test Methodologies

Max throughput
2.8Gbps +

Cisco 1941
Recommended 25-40Mbps

Cisco 3945E
Recommended 350-500Mbps

Max throughput
8Gbps +

But will this ever work in a real environment?

Believe it or not: All c… …ctly accurate test results

1. No s…
2. …v4 destination for all packets
3. Stateless UDP with ONLY maximised L2 frame size

As we would say in North Carolina

Not just no…

Skewing performance with Packet sizes

Test case: SD-WAN w. IPSec + DPI + QoS + FNF

Report #1	Report #2	Report #3
246 Mbps	1.4 Gbps	5 Gbps

Confused yet?

SD-WAN w. Heavy features	Mbps			PPS		
Platform	64	IMIX	1400	64	IMIX	1400
4461	**246**	**1,389**	**5,052**	454,200	446,700	444,700

Packet Per Second = Indisputable routing capacity = #1 source of truth

Skewing performance with Packet sizes

Packet Per Second = Indisputable routing capacity = #1 source of truth

ISR 4461		@ 1400 byte	@ IMIX (avg 362)	@ 64 byte
Test Combo #1	Mbps	5,052	1,329	239
	Kpps	444	446	454
Test Combo #2	Mbps	4,461	1,139	246
	Kpps	385	391	410
Test Combo #3	Mbps	3,845	1,092	221
	Kpps	338	362	374

Would you look at that....

same packet count

Choose a CPE

with Adequate Performance

ISR 4000 Performance

What performance levels are you looking for?

Platform	Shaped Factory Default	Shaped Performance License	In the wild Boost License
4461	1.5 Gbps	3 Gbps	10 Gbps* @ 60-70% CPU
4451	1 Gbps	2 Gbps @ 19% CPU	4 Gbps* @ 35% CPU
4431	500 Mbps	1 Gbps @ 18% CPU	4 Gbps* @ 62% CPU
4351	200 Mbps	400 Mbps @ 17% CPU	2 Gbps* @ 45% CPU
4331	100 Mbps	300 Mbps @ 16% CPU	2 Gbps* @ 53% CPU
4321	50Mbps	100 Mbps @ 8% CPU	2 Gbps* @ 68% CPU
4221	35 Mbps	75 Mbps @ 8% CPU	1.4 Gbps @ 94% CPU

IP Routing @ IMIX

Tested with 2 onboard ports on 4300 = 2 Gbps
Tested with 4 onboard ports on 4400 = 4 Gbps

Clocked interface speed was the limit.

Room for higher throughput with more interfaces or additional services with maintained throughput

IPSec 256 AES with IMIX in Boost

- 4331 - 550 Mbps = 2 x throughput compared to 300 Mbps Perf license
- 4451 - 1.6 Gbps = Same throughput as with 2 Gbps Perf license
- 4461 - 7 Gbps

CPE Comparison @ IMIX (Avg 362bytes)

ASR1K Series
@ IMIX

ASR1002-HX
20Gbs SD-WAN

ASR1001-HX
12Gbs SD-WAN

ASR1001-X
5Gbs SD-WAN

ISR 1100-4&6G Series – Viptela OS
@ IMIX

ISR1100-6G
300Mbps SD-WAN

ISR1100-4G
100Mbps SD-WAN

ISR Series
ISR4000
ISR1100
@ IMIX

ISR 4461
4.2Gbps SD-WAN

ISR 4351
1.2Gbps SD-WAN

ISR 4331
440Mbps SD-WAN

ISR1161-8P
207Mbps SD-WAN

vEdge Series - Viptela OS
@ IMIX

vEdge 5000
4.7Gbps SDWAN

vEdge 2000
2.5Gbps SD-WAN

vEdge 1000
300Mbps SD-WAN

vEdge 100
100Mbps SD-WAN

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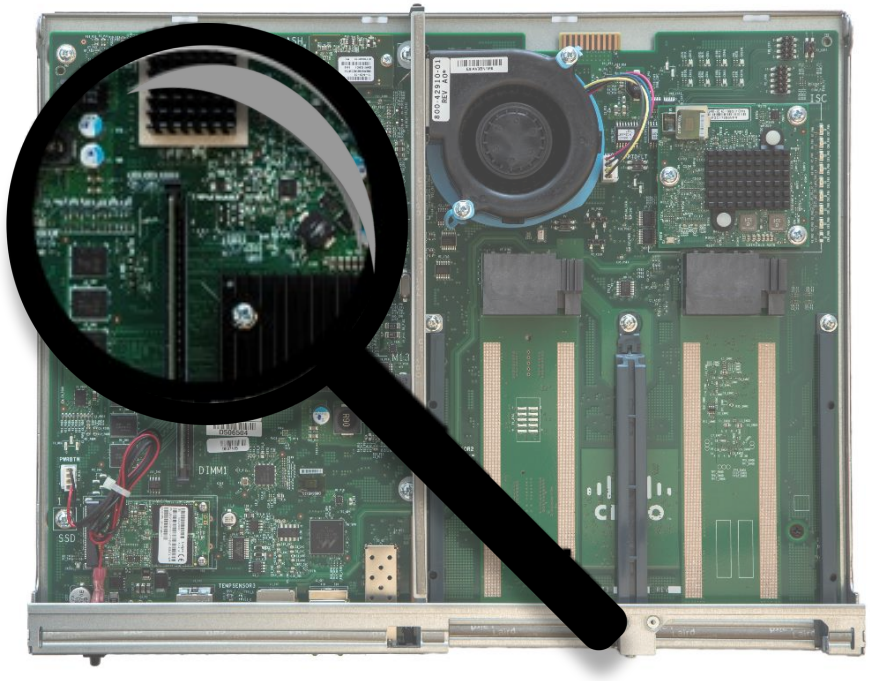
A look at the ISR & ASR1K HW Architecture

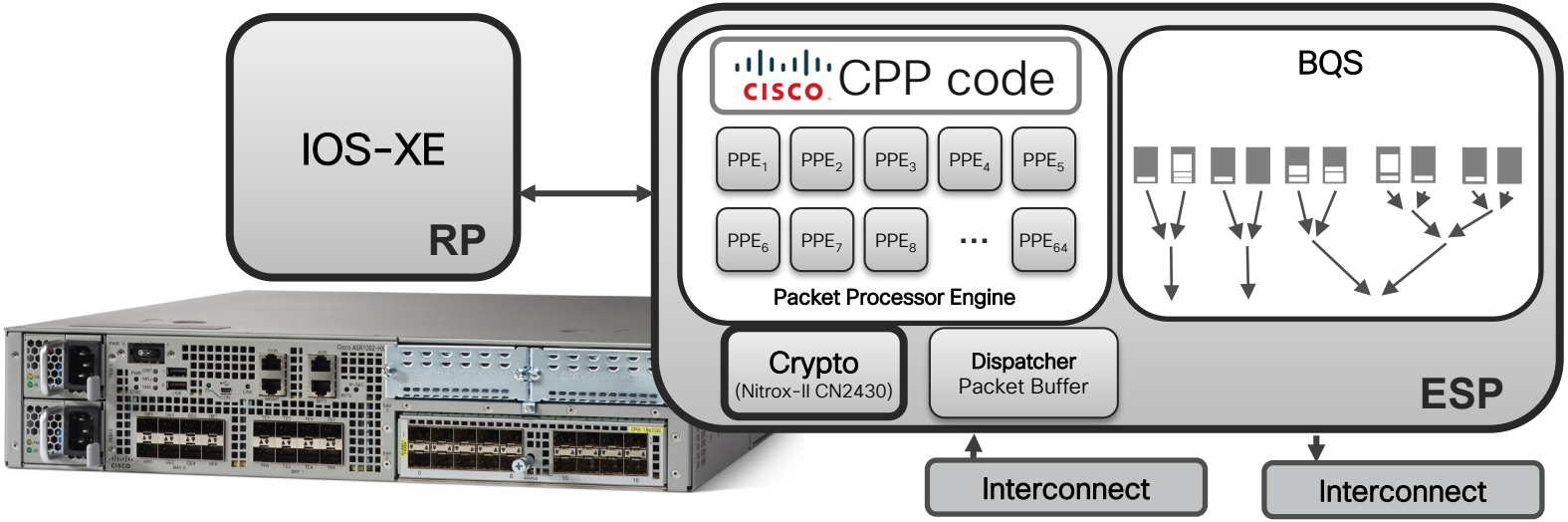


ASR1K – King of Distributed Architecture

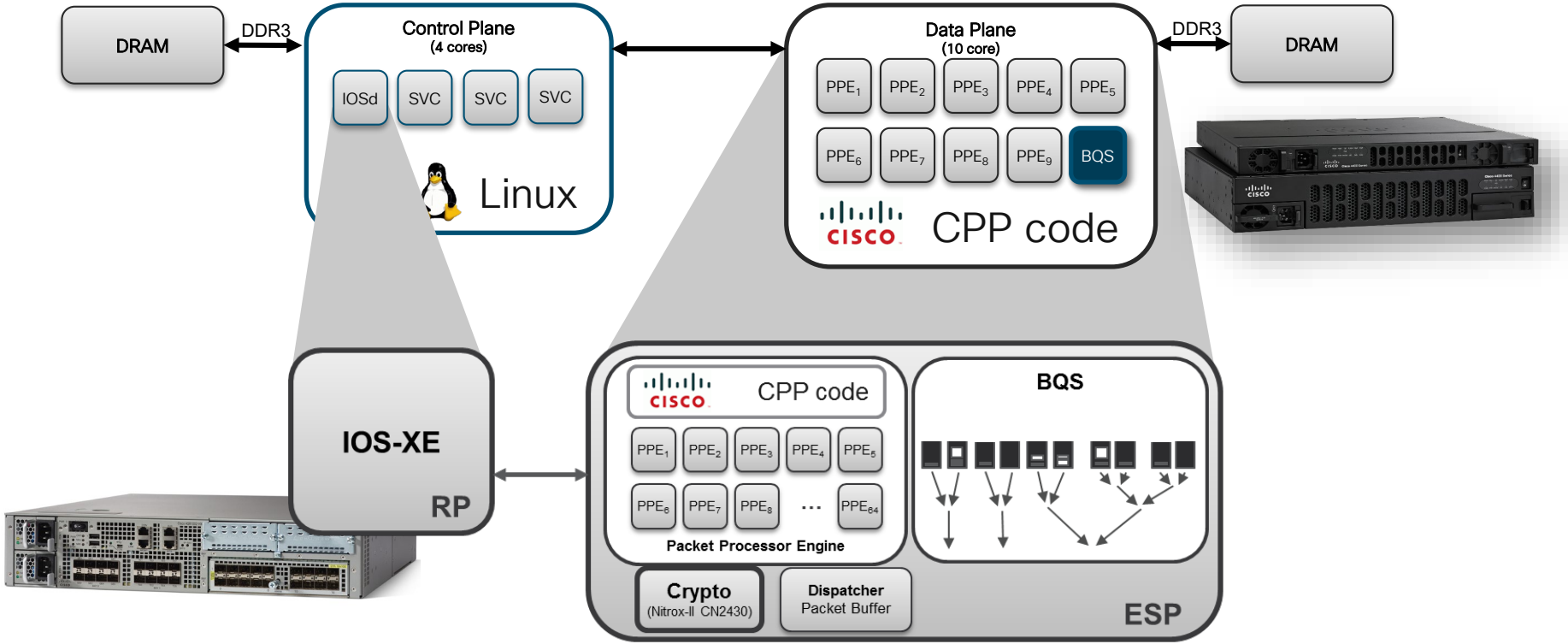
Route Processor (RP)

- Where IOS XE lives
- Tells QFP what services to bolt on to packet
- RP and ESP work autonomously from each other

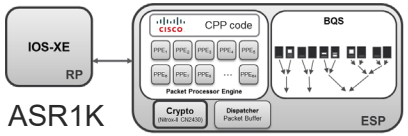
- Embedded Service Processor (ESP)
  - Takes marching orders from RP
  - Superfast QFP packet forwarding in parallel threads
  - Distributes forwarding workload



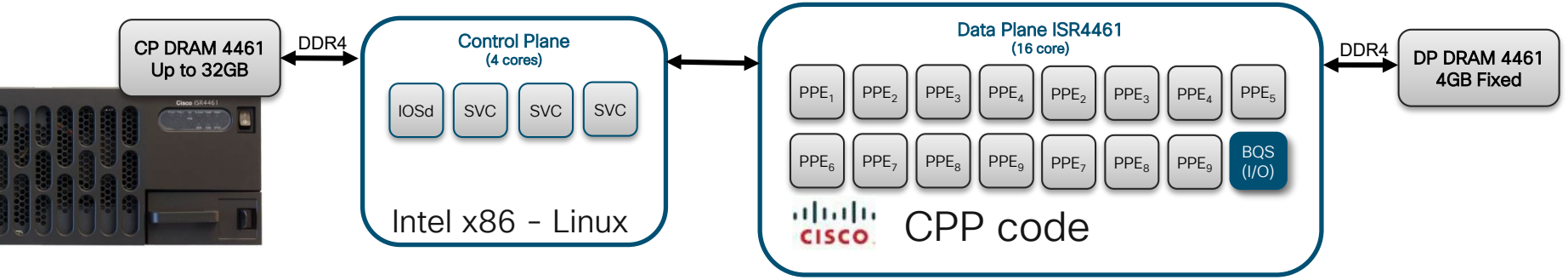
ISR4k vs. ASR1k architecture



ISR4400 Architecture



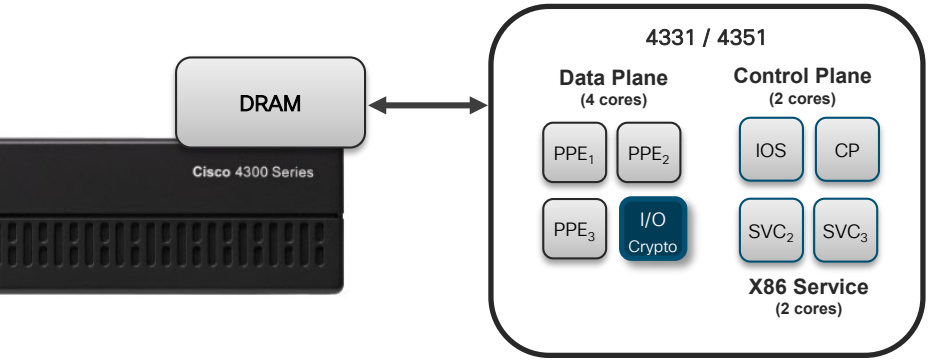
SD-WAN
LTE Advanced
Modularity

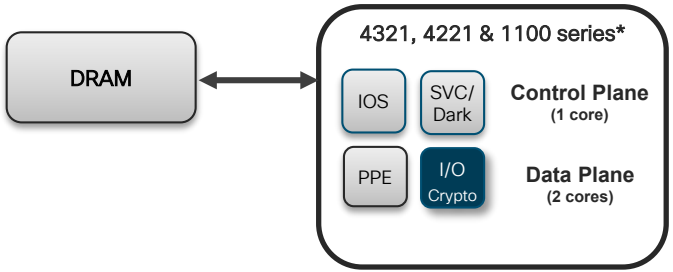


- Same physical processing separation as on ASR1K
- Control Plane 4-core Intel X86 architecture
- Data Plane 6, 10 or 16-core Cavium SoC architecture
- Data Plane run by same Cisco micro code as on ASR1K
- Dedicated forwarding, crypto and scheduling resources

ISR4300, ISR4200 & ISR1100 architecture

SD-WAN
LTE Advanced
Modularity – 42/4300





* ISR1100 Series has crypto assist on separate entity

- Unified architecture – Single socket CPU
- Multiple CPU cores providing the distributed architecture
- Control & Dataplane cores run by Linux 3.10
- Dedicated forwarding, crypto and scheduling resources
- 1100 & 4200: Service Core only supported on 8GB SKUs

Cloudification, DIA, IaaS and SaaS...

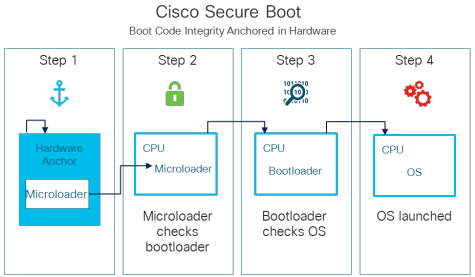
...it's no longer a matter of **if** your CPE will be attacked...

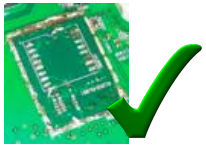
Turn Your Branch into a Bastion

ISR Built-in Cyber Threat Defense

Boot integrity visibility – Protects against...

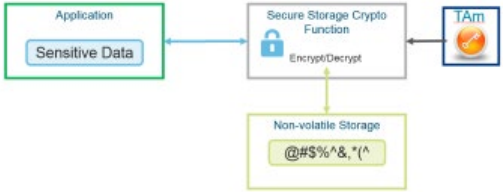
- Attacker compromises the code that is supposed to protect against compromised code





Secure NVRAM Storage – Protects against...

- Attacker steals device - Uses forensic techniques to obtain secrets & credentials from non-volatile RAM



Simplified REAL Factory Reset

- Resets all writable file systems, licenses, ROMMON variables, User credentials etc..

Secure Guest Shell

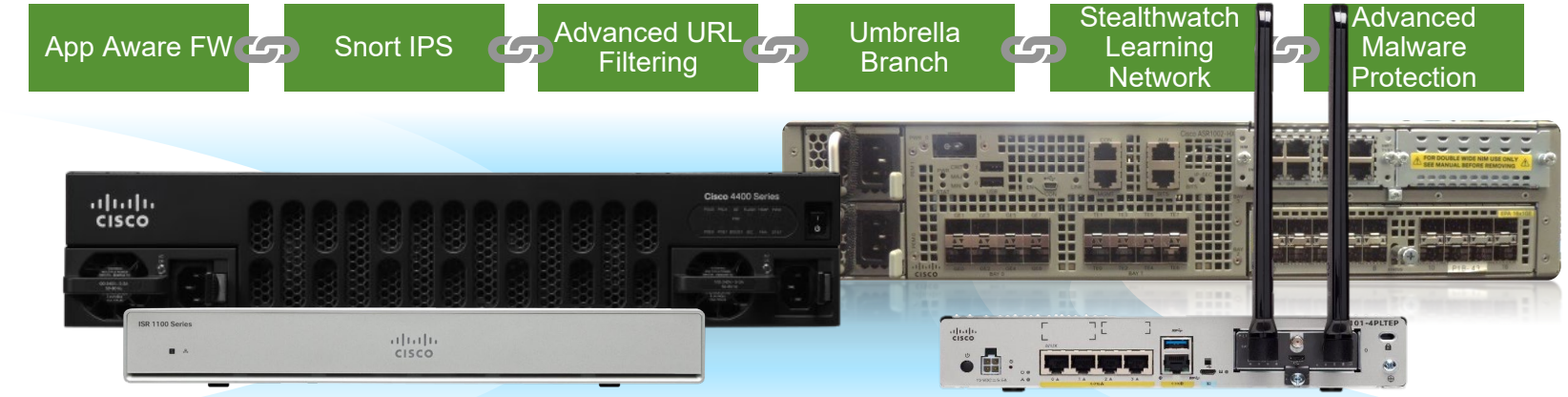
- Prevents Open Container hosted applications and their users from manipulating underlying Linux system on ISR4k & 1100

...and much more

Your Bastion Against Cyber Attacks

Tools for Protecting Your Branch Assets

App Aware FW — Snort IPS — Advanced URL Filtering — Umbrella Branch — Stealthwatch Learning Network — Advanced Malware Protection



Secure Boot — Hardware Trust Anchor — Counterfeit Protections — Runtime Defenses — OS Validation — Modern Crypto

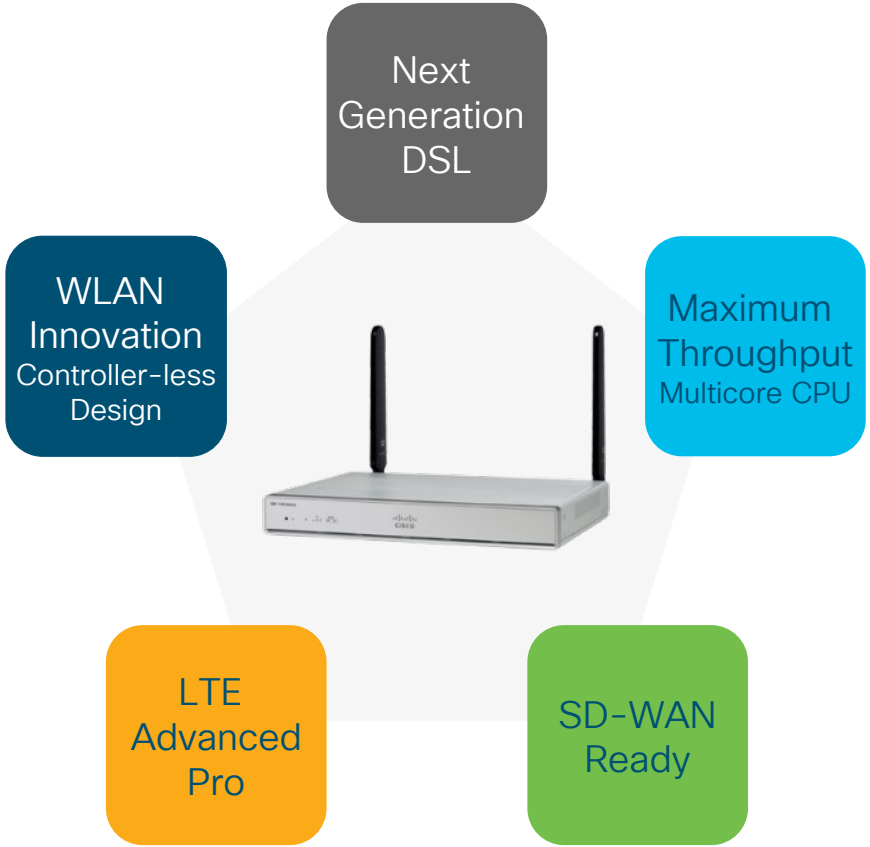
Architecture Protecting what's Protecting Your Branch Assets

All XE based ISR's & ASR's ships with built in Cyber Threat Resiliency

So, what's new on the CPE side?

Well, we just added 25 more ISR1100

+ an 1100 for IoT



Cisco 1000 Series Integrated Services Routers

An Entire Branch Rack in a box

WAN and Application Assurance

Cisco SD-WAN
Application visibility and link optimization
Analytics and assurance

Advanced Mobility

Gigabit Ethernet WAN
Gigabit Ethernet LAN Switch
DSL (G.fast),
LTE Advanced Pro (Cat 4/6/18)
802.11ac wave2 WLAN with Mobility Express
Manages 50 APs and up to 1000 users
Support for the new Catalyst 91xx 802.11ax APs

High Performance

Multi-core hardware architecture
WAN-WAN and LAN-WAN
VPN and security

Comprehensive Security

Branch threat defense
Trustworthy
Ent. FW App aware, IPS, URL-F
AMP & TG
DNS/web- layer security on SD-WAN

Platform

Cisco 1000 Integrated Services Router

Connectivity

Ethernet WAN	LAN Switch	802.11ac WLAN	xDSL	LTE Advanced Pro

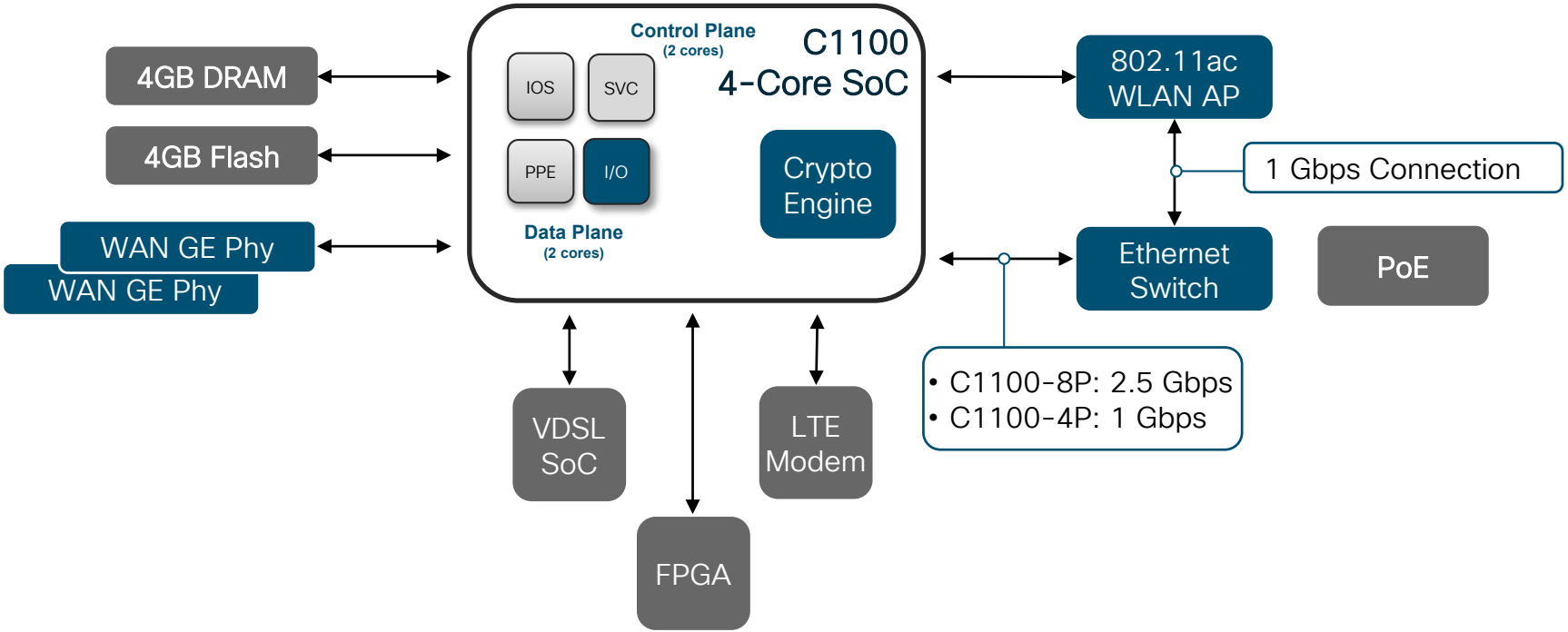
Manageability

vManage

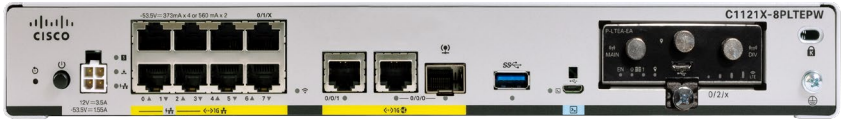
DNA Center

WebUI

C1100 Hardware Diagram



Cisco ISR 1100 Expansion



- Multi-layered security SD-WAN capable (X-SKUs)
- ISR 1161 is the fastest model in the ISR 1000 Series – 30% faster processor
- Smaller formfactor for space-constrained deployments
- Investment Protection with PIM slot [LTE CAT4/6/18 support]

4 Arm SOC Marvel Armada	ISR 1121	ISR 1126	ISR 1127	ISR 1128	ISR 1161 Highest Perf. 1100
10 SKUs : Ethernet (with and without LTE Pluggable)	●				●
8 SKUs : Ethernet + Wi-Fi + LTEP (802.11ac wave-2)	●				
7 SKUs : DSL (with LTEP)		●	●	●	
25 Total SKUs	14	2	4	1	4

ISR 1100 Portfolio

For your refererence

New!

	C1161X-8P *	C112xX-8P *	C1111X-8P *	C111x-4P	C1101-4P	C1109-4P	C1109-2P
Crypto	480 Mbps	350 Mbps		250 Mbps		200 Mbps	
Cisco SD-WAN	Yes						
SD-WAN Security	Yes			No			
LTE	CAT18/CAT6/ CAT4	CAT18/CAT6/ CAT4	No	CAT6	CAT18/CAT6/ CAT4	CAT18/CAT6/ CAT4	CAT4
Wi-Fi	No	Yes	No	Yes			No
DSL	No	Yes	No	Yes	No		
PoE	Yes				No		

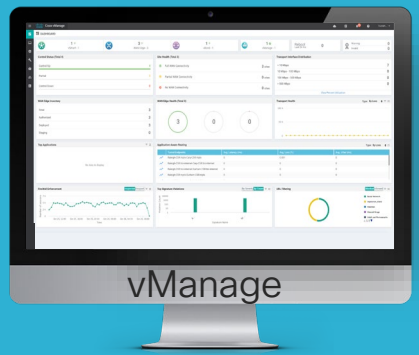
* 4GB DRAM/FLASH variants available – Supports only Ent. FW App aware, DNS/web-layer security on SD-WAN

Extend Enterprise to the IoT Edge

Cisco

IR1101

Integrated
Services Router Rugged



SDWAN – Simplicity at scale from the enterprise to the IoT edge

Increase visibility and control, saving time and resources from the enterprise to the edge.

Save time and reduce workloads as you scale

Intelligent monitoring of failover and policy management

Ensure mission critical infrastructure is uninterrupted

Prioritization of data and control traffic

Automate complex security setup from enterprise to edge

Secure segmentation and Cisco Umbrella

Cost savings with intent-based mgmt. tailored to SLA's

Multiple active paths (MPLS/Ethernet/LTE)

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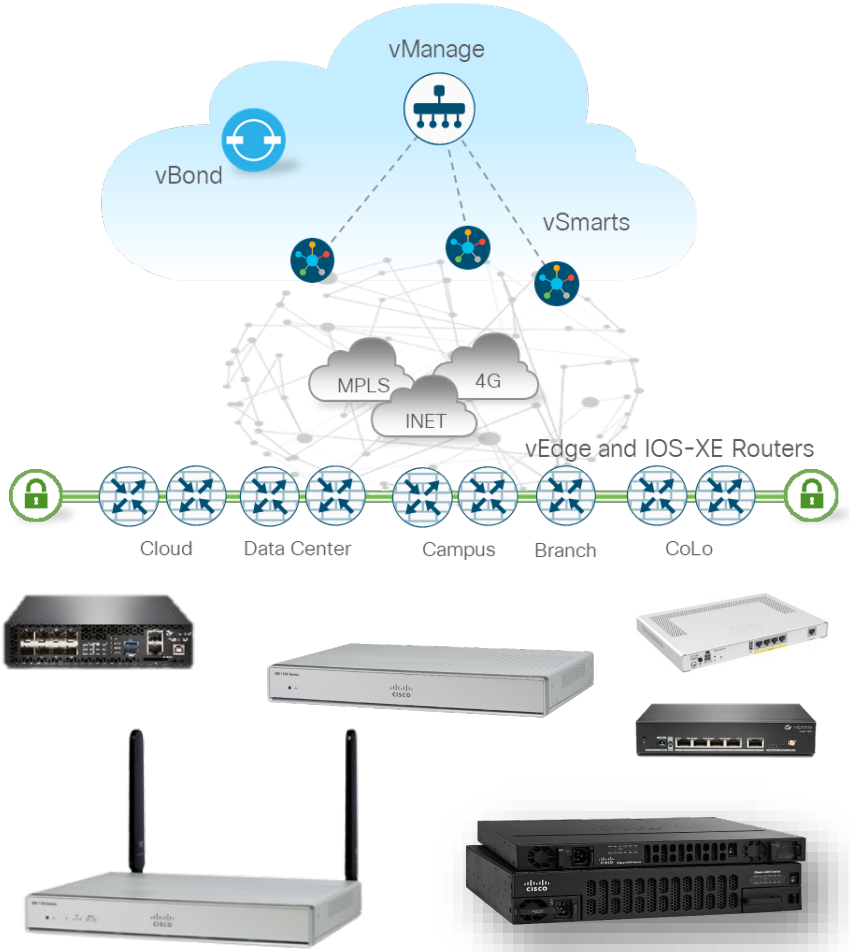
SDWAN CPEs

Viptela OS

or

IOS-XE?



SD-WAN Cloud Edge Portfolio with New Platforms

Branch

Aggregation

IOS-XE / XE SD-WAN

ISR 1000

- Integrated wired and wireless access
- LTE Advanced Pro
- VDSL2,ADSL2/2+

NEW

ISR1120 / 1160
(New 25 SKUs)

- High Performance
- WWAN pluggable flexibility
- PIM: 4G LTE CAT4/6/18

ISR 4000

- WAN and voice module flexibility
- Compute with UCS E
- Container Architecture
- Slot Modularity, RPS
- 1GE, 10GE options

ASR 1000

- High-performance service with hardware assist
- Modular ASR 1K is not supported

Viptela OS

NEW

ISR1100-4G

4 GE WAN ports

ISR1100-4GLTE

4G LTE (CAT4)

ISR1100-6G

6 WAN ports (4GE and 2 SFP)

vEdge 100

4 GE RJ45 WAN ports

vEdge 1000

8 GE SFP WAN ports

vEdge 2000

RPS, PIM options

vEdge5000

Modularity, RPS

Virtualized

vEdge Cloud

- Software Router Platform
- Can be deployed in private, public, and hybrid cloud

Cisco ENCS

- Service chaining virtual functions
- Options for WAN connectivity
- Open for 3rd party services & apps
- NFVIS Hypervisor

CSR 1000V

- Extend Enterprise routing, security & management to Cloud
- Cisco DNA virtualization

SDWAN Platform choice – Viptela or IOS-XE code

Viptela code

vEdge series & ISR1100-4G/6G

- Super robust
- Support for all the standard SDWAN features
- Provides some features not yet supported by IOS-XE code
- Less Security options than IOS-XE
- Cisco HW available with ISR1100-4G/6G,
- vEdge Cloud scales well

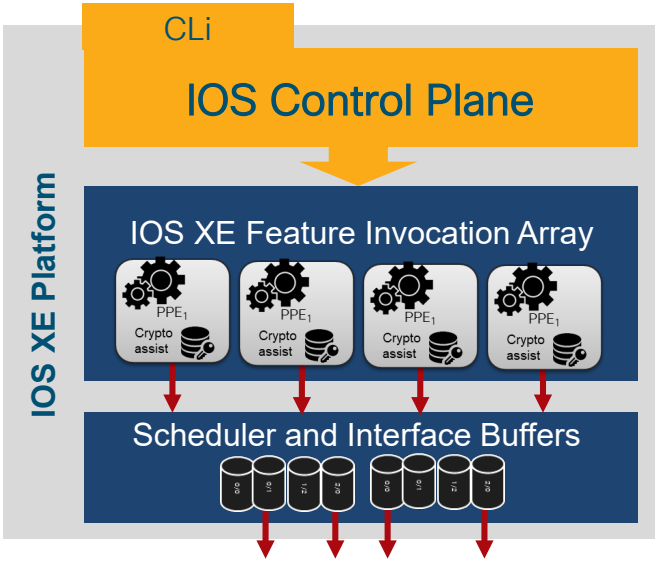
Cisco IOS-XE

ISR1100/4000 & ASR1000 Fixed

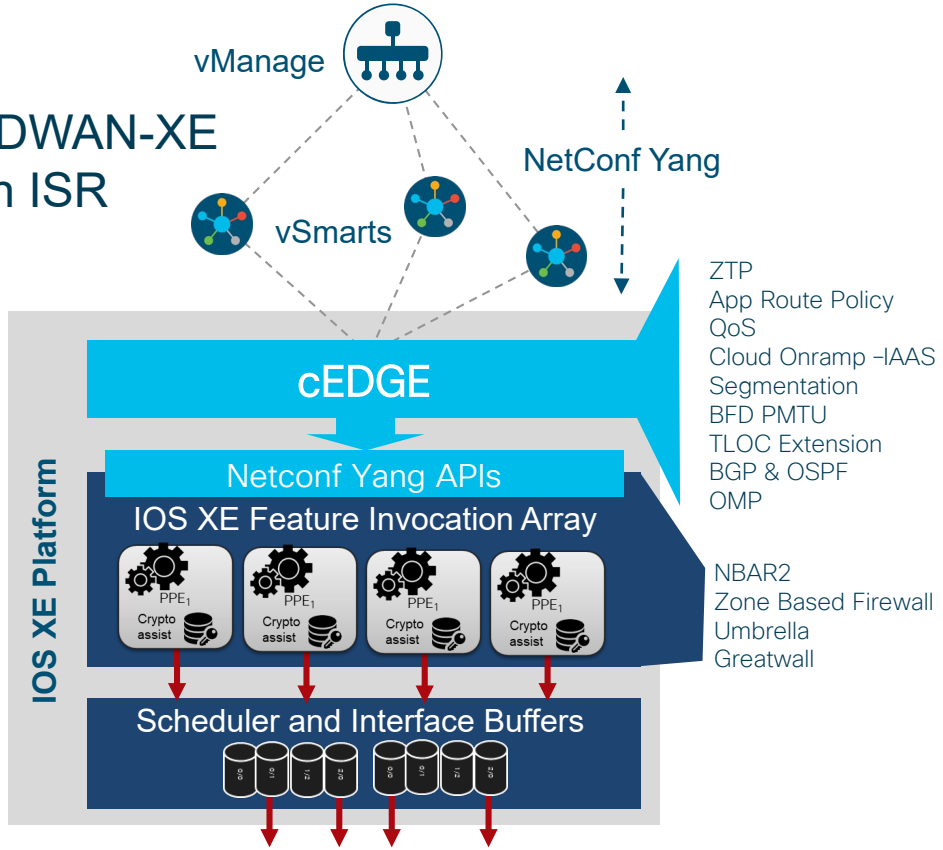
- Support for Cisco's well known Branch Services
- Very Comprehensive Security support
- Built-in Threat Defense
- Comprehensive WAN support
- Reuse existing Branch platforms
- Cisco HW
- Higher scale with Cisco CSR1000v

Cisco SD-WAN How it's implemented on IOS-XE

Traditional
WAN on ISR



SDWAN-XE
on ISR

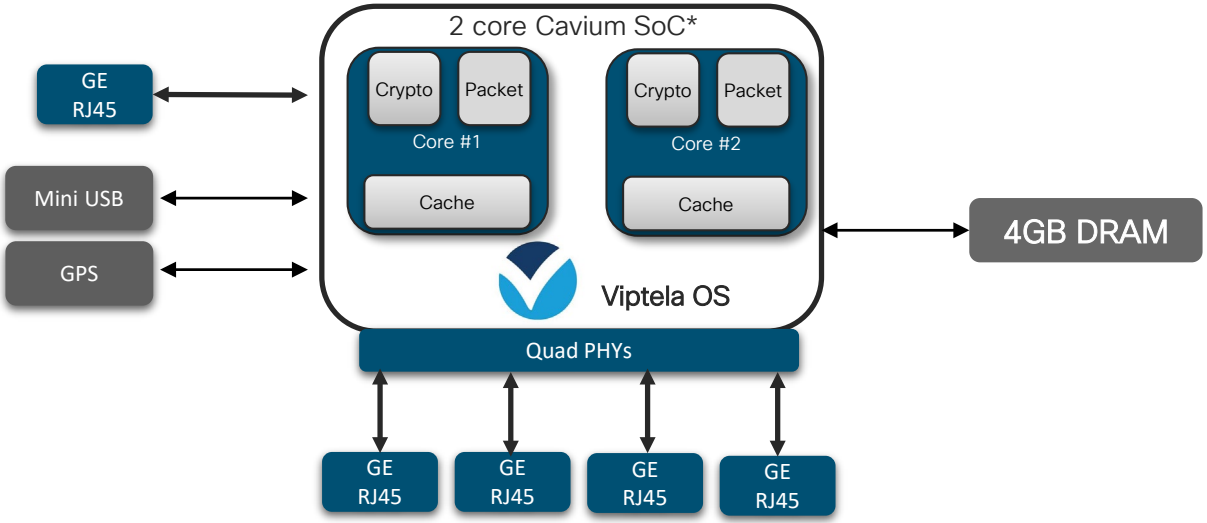


Sample SDWAN feature roadmap
19.2/16.12 (July 2019) Key features

SD-WAN Core/Infra	Pairwise Key Support	vEdge & IOS-XE SD-WAN	SD-WAN Core/Infra
	Loopback for WAN/TLOC Support	IOS-XE SD-WAN	
	NAT64 DIA	IOS-XE SD-WAN	
	CoS Rewrite rule & QoS for sub interfaces	IOS-XE SD-WAN	
App-QoE	Packet Duplication	IOS-XE SD-WAN	App-QoE
	TCP Optimization	IOS-XE SD-WAN	
Security	Self Zone Policy	IOS-XE SD-WAN	Security
	HSL Logging	IOS-XE SD-WAN	
X-Domain	ACI – SD-WAN Integration	IOS-XE SD-WAN	X-Domain
Colo	Service chain and VNF features	vEdge & IOS-XE SD-WAN	Colo

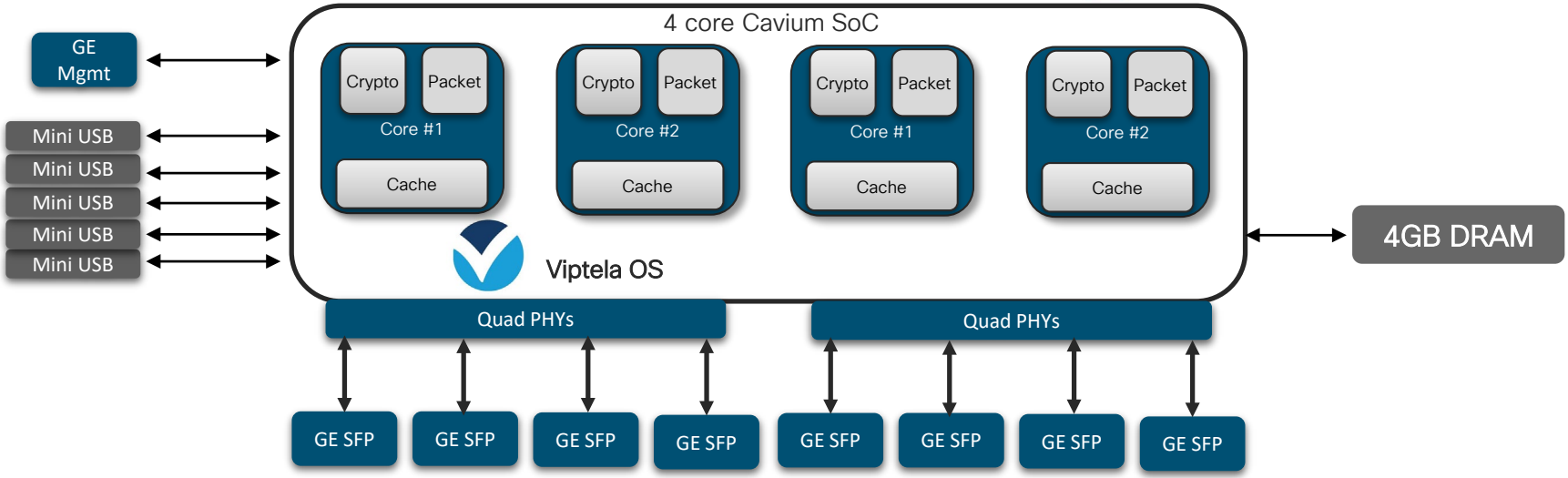
Some of the roadmapped features in IOS-XE already supported by vEdge

vEdge 100



* System on Chip (SoC)

vEdge 1000



* System on Chip (SoC)

vEdge Platform Overview

	vEdge 100	vEdge 1000	vEdge 2000	vEdge 5000
				
CPU	Cavium 7020 2-cores @800MHz	Cavium 6130 4-cores @1.0GHz	Cavium 6880 32-cores @1.2GHz	Intel Haswell-EP 14-cores @2.2GHz
I/O	5x 10/100/1000 Mbps RJ-45	8x 1G SFP	4x 1G SFP, 2x PIM* PIM: 2x10G SFP, 8x 1G SFP	4x NIM* NIM: 8x1G Copper, 8x1G SFP, 4x10G SFP
Memory	2GB DDR3	4GB DDR3	8GB DDR3	32GB DDR4
4G LTE	vEdge 100: N/A vEdge 100m & 100wm: 1x port	N/A	N/A	N/A
Flash	4GB	8GB	8GB	120GB
Throughput @ IMIX	112Mbps	345Mbps	2.5Gbps	4.7Gbps
Tunnel Scale	250	1500	6000	6000
Route Scale	25k	128k	128k	256k

* PIM: Pluggable Interface Module, NIM: Network Interface Module – not same NIM as ISR4000

ISR 1100 for Viptela OS

Cisco ISR1100-4G/6G

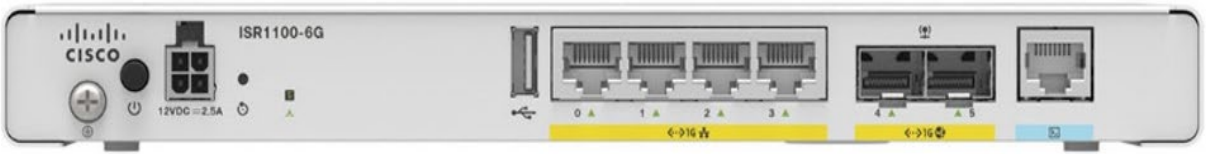
Powered by Viptela OS

Simple to manage with Cisco SD-WAN

Delivering essential WAN and multi-cloud capability of the Cisco SD-WAN.

ISR 1100-4G & ISR 1100-6G

ISR1100 routers for SD-WAN with Viptela OS



Robust Performance

- Multicore x86 architecture
- Dedicated core for control plane
- Integrated LTE modem option*

SD-WAN Support

- Powered by Viptela OS
- Central management w/ vManage
- Feature parity with vEdge platforms

Branch Optimized

- Compact form factor
- Unmatched prize/performance
- Fiber Uplinks**

Investment Protection

Planned for future IOS-XE support

* ISR1100-4GLTE models only
** ISR1100-6G only

Platform Evolution for vEdge

Powered by Viptela OS 19.2

vEdge Series

vEdge 100B

vEdge 100M

vEdge 1000

Next-Generation vEdge

ISR 1100-4G

- 4 Ethernet WAN ports

ISR 1100-4GLTExx*

** xx = LTE domain*

- 4 Ethernet WAN ports
- Integrated LTE (CAT4)

ISR 1100-6G

- 6 WAN ports (4GE and 2 SFP)

ISR1100-4/6G Performance and Scale

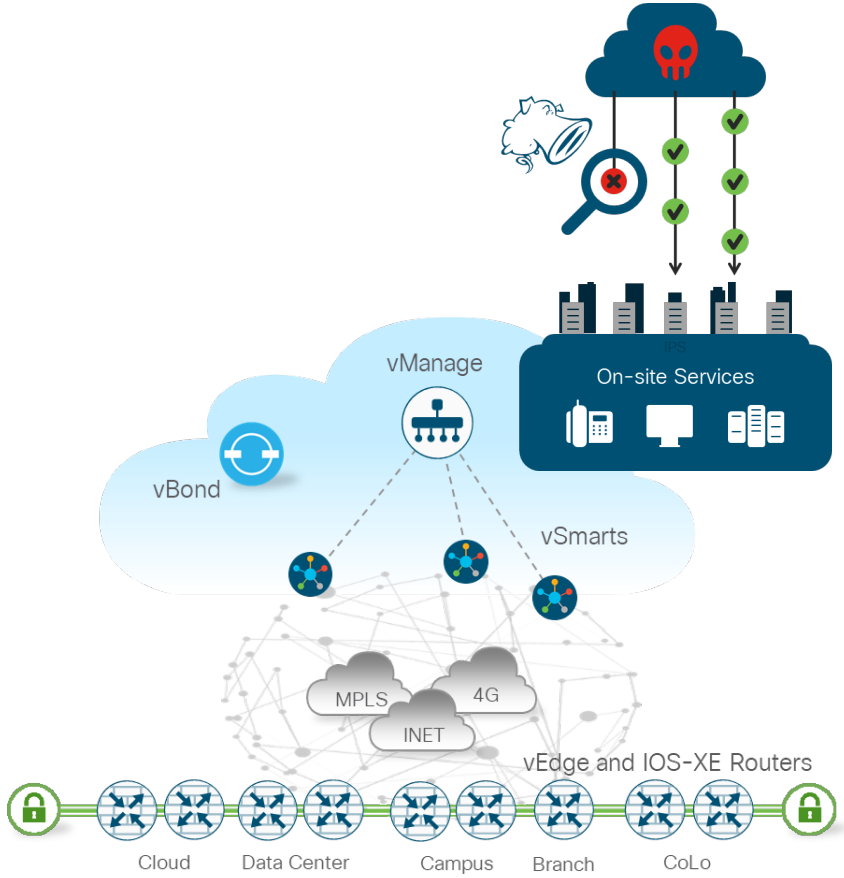
For your refererence

	ISR1100-6G	ISR1100-4G(LTE)
SDWAN: IPSec+QoS+DPI+CFLOWD+NAT Perf., 1400B / IMIX	845 / 301 Mbps (vEdge 1000 @ IMIX – 345Mbps)	449 / 125 Mbps (vEdge 100 @ IMIX – 112Mbps)
SD-WAN Tunnel	1500	247*
IPv4 Routes	128,000	10,000*
VPNs	64	64
CFLOWD	65,000	8,000

* Release 19.2 Planned to be improved.

Choosing CPE for SDWAN Security

Capabilities & Requirements



Cisco SDWAN Security – Platform Support

All Services

ISR 4000

ISR 1100

CSR 1000v

ENCS 5400

App Aware FW and
DNS/web-layer security

ASR 1000

DNS/web-layer security

vEdge & ISR1100-4/6G

URL-Filtering
Onboard, using 82+ web categories

Intrusion Protection System
Onboard IPS engine powered by TALOS

Adv. Malware Protection
File Reputation and Sandboxing

Enterprise Firewall
+1400 layer 7 apps classified

Simplified Cloud Security
Cisco Umbrella

SD-WAN Security Support Viptela OS platforms

Platforms/Features	Ent FW	DPI	DNS/web-layer Monitoring **
ISR1100*, vEdge100, 1000, 2000 and 5000	Y	Qosmos	Y

* ISR1100 4G & 6G models with **– Viptela OS** only

- Support for IOS-XE planned for 2nd half CY20

* * Need Umbrella Subscription for enforcement

SD-WAN Security IOS-XE Routers – 16.10.1



Platforms/Features	Ent App Aware FW	IPS/IDS	URL Filtering	DNS/web-layer Monitoring *
Cisco - CSR	Y	Y	Y	Y
Cisco – ENCS (ISRv)	Y	Y	Y	Y
Cisco – ISR4K (4451, 4431, 4351, 4331, 4321, 4221-X)	Y	Y	Y	Y
Cisco – ISR1K	Y	Y**	Y**	Y
Cisco - ASR1K 1001-HX, 1002-HX, 1001-X, 1002-X)	Y	N/A	N/A	Y

* Need Umbrella Subscription for enforcement

Ent FW App Aware and DNS/web-layer security will work with default 4 GB DRAM

** 1100**X** 8GB DRAM models only

Security App Hosting Profile and Resources

Platforms	Total No of CP Cores	Total No of CP Cores for Security	Default Profile with 8 GB DRAM	High Profile with 16 GB of DRAM
4321/4221/ 1100-X	2	1	1	-
4331	4	2	2	2
4351	4	2	2	2
4431	4	2	2	2
4451 / 4461	4	2	2	2

IPS / URL-F App Hosting Profile	Security Profile Features	Memory requirement	Platform Supported
Default	IPS + URLF (Cloud Lookup only)	8GB Bootflash 8GB Memory (X-SKUs only for 1100)	ISR1-X/4221/4321 4331/4351/44xx CSR/ISRv - 4/8 vCPU
High	IPS + URLF (On-box DB + Cloud Lookup)	16GB Bootflash & 16GB Memory	4331/4351/44xx CSR/ISRv - 4/8 vCPU

Ent FW App Aware and DNS/web-layer security will work with default 4 GB DRAM

SD-WAN Security ISR4K/1K Throughput

1024K Object Size - 780B

	ISR4461 (Mbps)	ISR4451-X (Mbps)	ISR4431 (Mbps)	ISR4351 (Mbps)	ISR4331 (Mbps)	ISR4321 (Mbps)	ISR4221 (Mbps)	C1111X-8P (Mbps)
100%DIA(NAT+FW+DPI)	2490	1029	714	530	440	230	178	240
100%DIA(NAT+FW+DPI+IPS+URLF)	680	310	166*	205	170	83	62	75
100%DIA(NAT+FW+DPI+IPS+AMP+TG)	504	259	144*	195	165	81	60	71

* Security features like IPS/URLF/AMP/TG run in the service plane core
* ISR 4431 service plane core clock rate @1.0GHz, while ISR 4351 service plane core clock rate @2.4GHz, and 4331 service plane core clock rate @2.0GHz, therefore lower throughput.

When to choose what CPE

Pure Play SDWAN

Transport Independence,
Voice Optimization,
Cloud Management & Analytics

Integrated Services SDWAN

Interface Flexibility,
Rich Application Optimization Services*
Multi-Domain Integrations*

VRF and Tunnel Scale, Throughput

IOS-XE: ISR , ASR

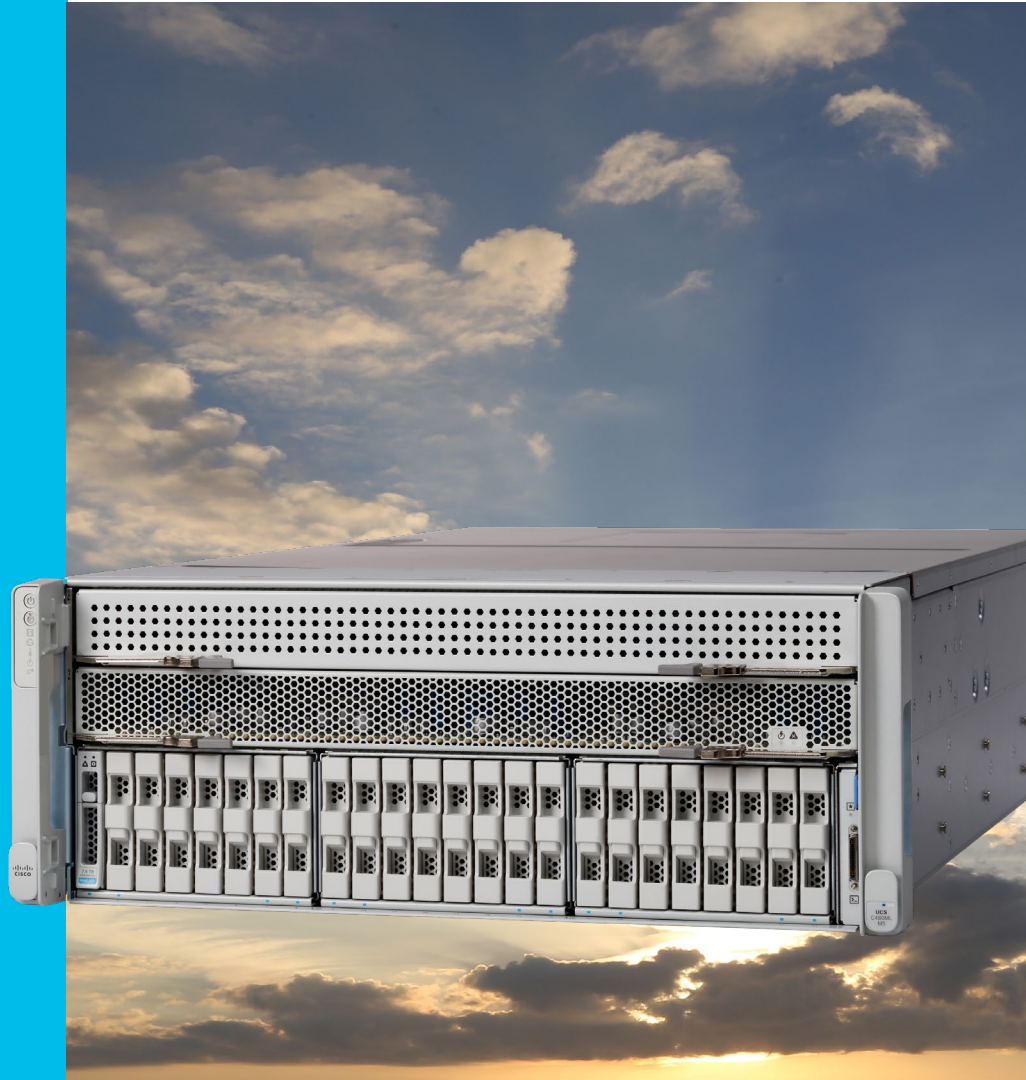
Viptela OS: ISR1100-4G, ISR 1100-6G, vEdge 2000

Cloud Security	Voice Optimization	TCP Flow Optimization
Integrated Voice*	Cloud onramp for Colocation	Multi-Domain*
On Prem Security	Adv. Cloud Security	AppQoE * Caching, DRE

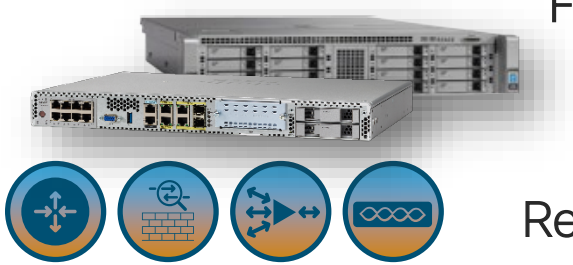
App-Aware Routing, Full Mesh, Dynamic Routing	CloudOnRamp for IaaS and SaaS	vManage: Multi-tenant | Cloud | on-prem	vAnalytics

* Roadmap

Maybe virtualized Branch CPEs would be a good fit?



What's so cool about Virtualizing a Branch CPE?



Full Service Elasticity

- Deploy in minutes – Rack & Stack a remote branch in 2 min
- Deploy as needed

Reduce number of network elements

- Less HW to handle – Install, Service contract etc.
- Smaller attack surface – Less cables and buttons

Reduce on-site visits
Eliminate Truck rolls

- No need to add HW when adding a new Network service

Best-of-breed network

- Install whatever vendors you prefer on the same HW Platform
- Stitch installed services (VNFs) together with virtual patch cables

Simplify Performance Upgrades

- Add more cores to an App in minutes

ENCS 5000 Series

Enterprise Network Compute System

SD-WAN
LTE Advanced
Modularity
RAID Storage
SDWAN Security

ENCS 5100 Series

ENCS 5400 Series

ENCS 54xx - XE-SDWAN & vEdge Cloud
ENCS 5104 - vEdge Cloud only

ENCS 5104
4Core (ISRv+1VNF)

ENCS 5412
12Core(ISRv+5VNF)

ENCS 5408
8Core(ISRv+3VNF)

ENCS 5406
6Core(ISRv+2VNF)

Virtualized Services | Open for 3rd party apps | NFVIS Hypervisor | 500Mbps SD-WAN

Cisco Cloud Services Router (CSR) 1000V

Our Virtualized Go-To Platform for Cisco SD-WAN

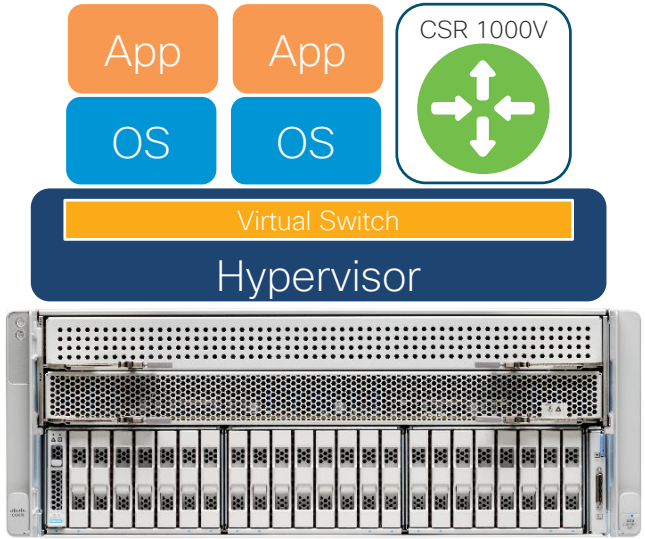
SD-WAN
RAID Storage
SD-WAN Security

Software
Same exact IOS XE software as ASR1000 and ISR's

Infrastructure Agnostic
Runs on x86 platforms

Supported Hypervisors:
VMware ESXi, RHEL Linux KVM, Suse Linux KVM, Citrix Xen, Microsoft Hyper-V, Cisco NFVIS and CSP2100

Supported Cloud Platforms:
Amazon Web Services, Microsoft Azure, Google Cloud Platform



Performance Elasticity
Available licenses range from 10 Mbps to 10 Gbps

CPU footprint ranges from 1vCPU and up

Programmability
NetConf/Yang, RESTConf, Guest Shell and SSH/Telnet

License Options
Term based 3 or 5 year

Enterprise-class networking with rapid deployment and flexibility

Virtualizing my CPE – Stuff to keep in mind

- Fully flexible Branch rack when virtualizing multiple appliances
  - *Do I then also understand that Flexibility doesn't equal Simplicity or Lower cost?*
- Flexible and Fast spin-up of new services
- Tight integration of Network services through service chaining
  - *Each VNF'd service will still be managed by its own management tool*
- New paradigm for maintenance, config & troubleshooting
  - *Make sure staff receives adequate training to work in a non-Cli, Linux based Hypervisor environment*

Monitoring & Troubleshooting

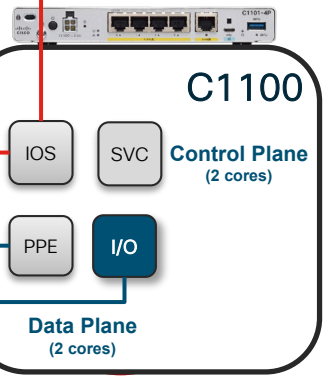
Monitoring CPU Resources

This cmd:
IOSd processor only

```
C1101#sh processes cpu
CPU utilization for five seconds: 3% one minute: 3%; five minutes: 3%
```

Same as sh process cpu

```
C1101#sh processes cpu platform sorted
CPU utilization for five seconds: 18%, one minute: 18%, five minutes: 18%
Core 0: CPU utilization for five seconds:  3%, one minute:  3%, five minutes:  3%
Core 1: CPU utilization for five seconds:  2%, one minute:  3%, five minutes:  3%
Core 2: CPU utilization for five seconds:  8%, one minute:  7%, five minutes:  7%
Core 3: CPU utilization for five seconds: 60%, one minute: 61%, five minutes: 61%
  Pid    PPid    5Sec    1Min    5Min  Status      Size  Name
-----------------------------------------------------------------------------
19866   18993   74%     74%     74%   S      699367424  qfp-ucode-tsn
22816   22582   1%      1%      1%    S       27967488  ngiolite
13314   12505   1%      1%      1%    S     1752436736  linux_iosd-imag
23760   23754   0%      0%      0%    S      144998400  nginx
```



High load % for scheduler
(I/O) core = Normal

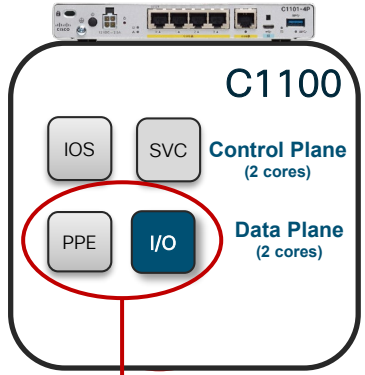
"Looking for work" process.
High % = Normal

Monitoring PPE (Data Plane) Forwarding state

Show summary of Dataplane load in Packets & Percentage

Also good for checking if an ISR 4000 Boost license will make any difference

```
C1101#show platform hardware qfp active datapath utilization
 CPP 0: Subdev 0                5 secs     1 min     5 min     60 min
Input:  Priority      (pps)          0         0         0          0
                      (bps)          0         0         0          0
   Non-Priority       (pps)         13        10        10          9
                      (bps)       8952     13976     15136       9824
          Total       (pps)         13        10        10          9
                      (bps)       8952     13976     15136       9824
Output: Priority      (pps)          0         0         0          0
                      (bps)          0         0         0          0
   Non-Priority       (pps)          1         3         3          2
                      (bps)       2088     15184     15208      15176
          Total       (pps)          1         3         3          2
                      (bps)       2088     15184     15208      15176
Processing: Load (pct)               1         1         1          1
```



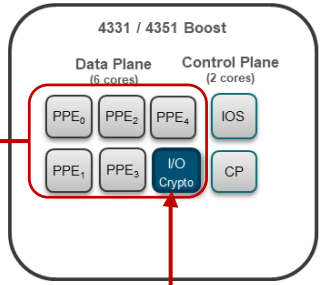
Taken from my idling lab router, hence the low%

Looking for bottlenecks

show platform hardware qfp active datapath infra sw-cio

- For PPE cores, look at % used for packet processing (PP)
- For I/O assigned core look at % used for In-Out packet scheduling (RX/TX) + % used for crypto operation, where applicable

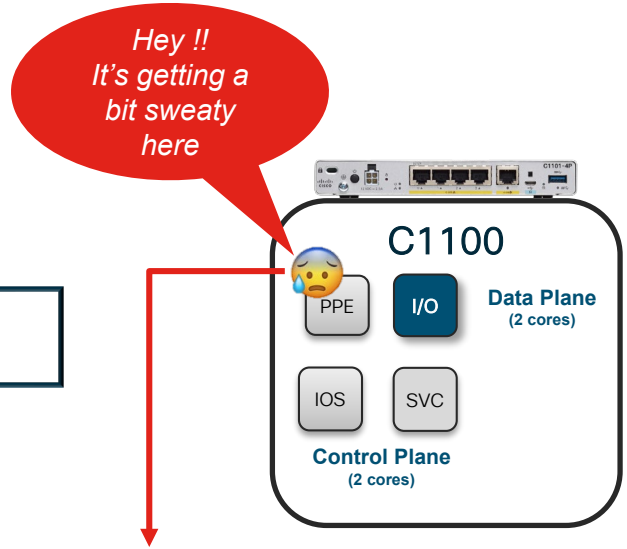

```
stefs_Sword# show platform hardware qfp active datapath infra sw-cio

  Core Utilization
-----------------
       ID:      0      1      2      3      4      5
    % PP:  42.15  41.55  41.76  41.71  41.97   0.00
    % RX:   0.00   0.00   0.00   0.00   0.00  43.02
    % TM:   0.00   0.00   0.00   0.00   0.00  30.00
% CRYPTO:   0.00   0.00   0.00   0.00   0.00  26.98
  % IDLE:  57.85  58.45  58.24  58.29  58.03   0.00
```



Uh-oh ! Core 5 (I/O) out of capacity

Well..Whaddaya know...
Crypto maxed it out

Use the Early Warning System



Warn me when my data plane load exceeds 90%

```
C1101(config)# platform qfp utilisation monitor load 90
```

When traffic exceeds 90% load

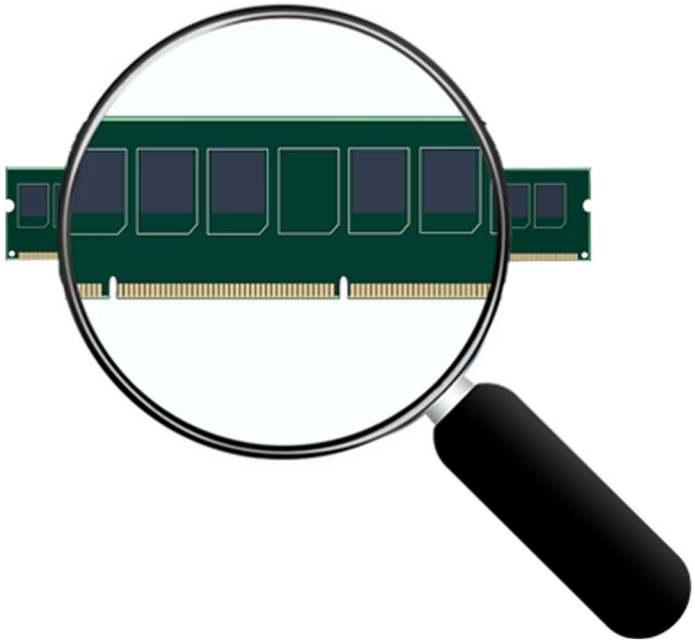
```
Jan 29 03:28:03.647: %IOSXE_QFP-2-LOAD_EXCEED: Slot: 0, QFP:0, Load 93% exceeds the setting threshold.
```

After traffic is falling back under the limit:

```
Jan 29 01:57:33.591: %IOSXE_QFP-2-LOAD_RECOVER: Slot: 0, QFP:0, Load 54% recovered.
```

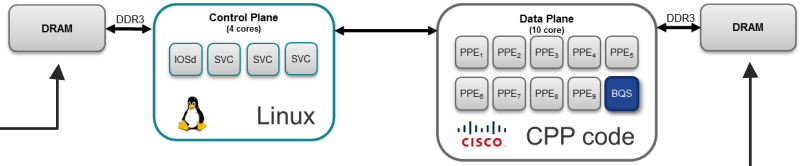

Did You bring enough Memory to the Party?

Monitoring Your Memory resources



Control Plane & Data Plane memory

Which one does what?



Control Plane Memory

- Used for IOS daemon & Underlying Linux on ISR4k & 1K
  - Holds IOS as well as Databases (RIBs, VLAN etc.)
  - Holds Linux + The entire architecture on 4300/4200 & 1100
  - Linux memalloc grows IOS memalloc due to information replication into other processes

Data Plane Memory (4400) / Memory partition (42/4300)

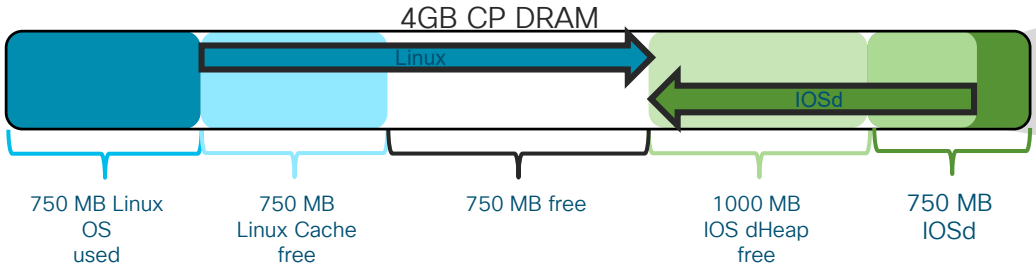
- Used exclusively for data plane services
  - Packet Buffering
  - CPP Dataplane internal Microcode – Runs forwarding process
  - Forwarding process EX Memory (EXMEM) – Fixed size partition
    - FIA (Feature Invocation Array) ... Data plane entity that bolts on services to packets
    - Grows when scalable features are configured (MPLS FIB, NAT Table, ZBFW etc.).

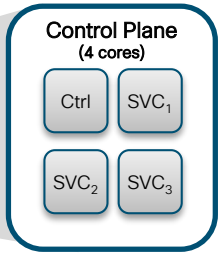
How Memory is allocated – 4451 & 4431

4451/4431: 4GB default CP DRAM + 2GB fixed DP DRAM

Control Plane

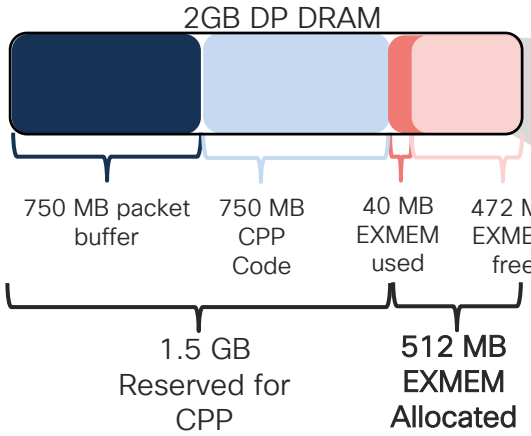
CP: **Floating** memory allocations: Linux & IOSd

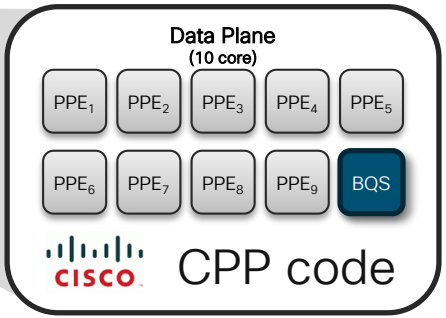




Data Plane

DP: **Fixed** memory allocations: CPP, Packet buffer, EXMEM

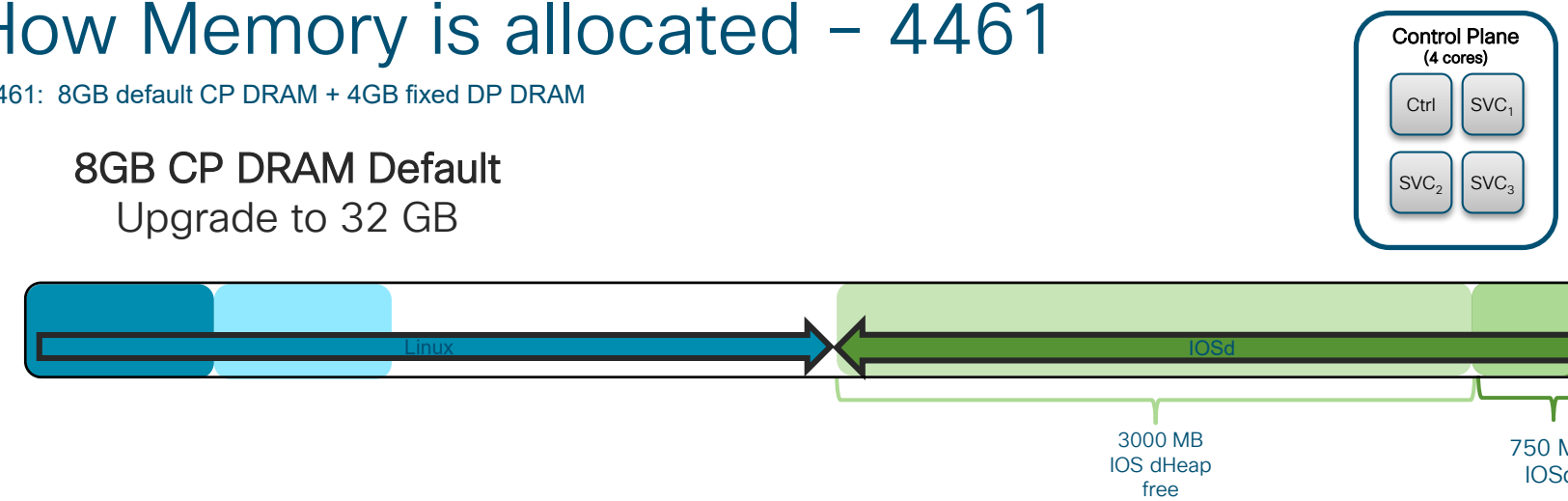




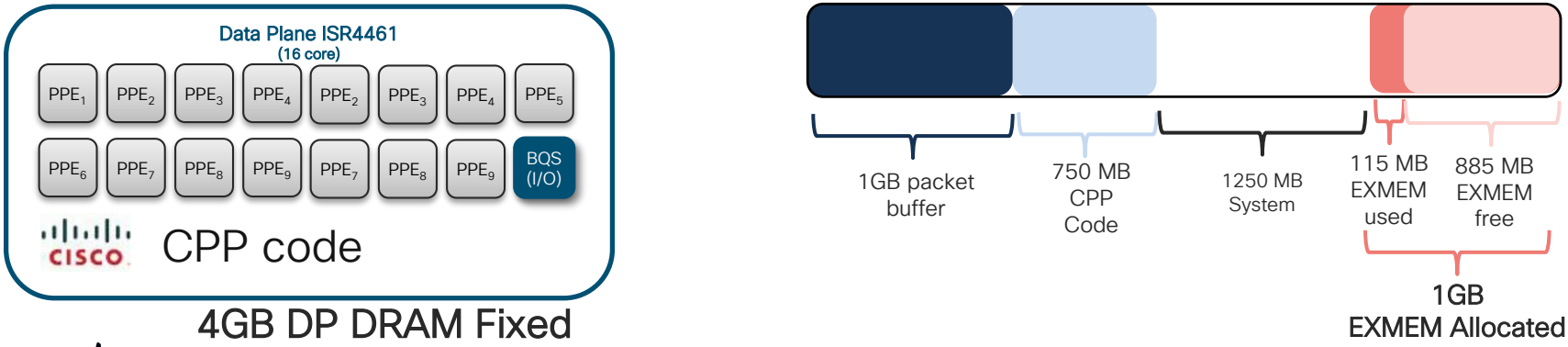
How Memory is allocated – 4461

4461: 8GB default CP DRAM + 4GB fixed DP DRAM

Control Plane



Data Plane

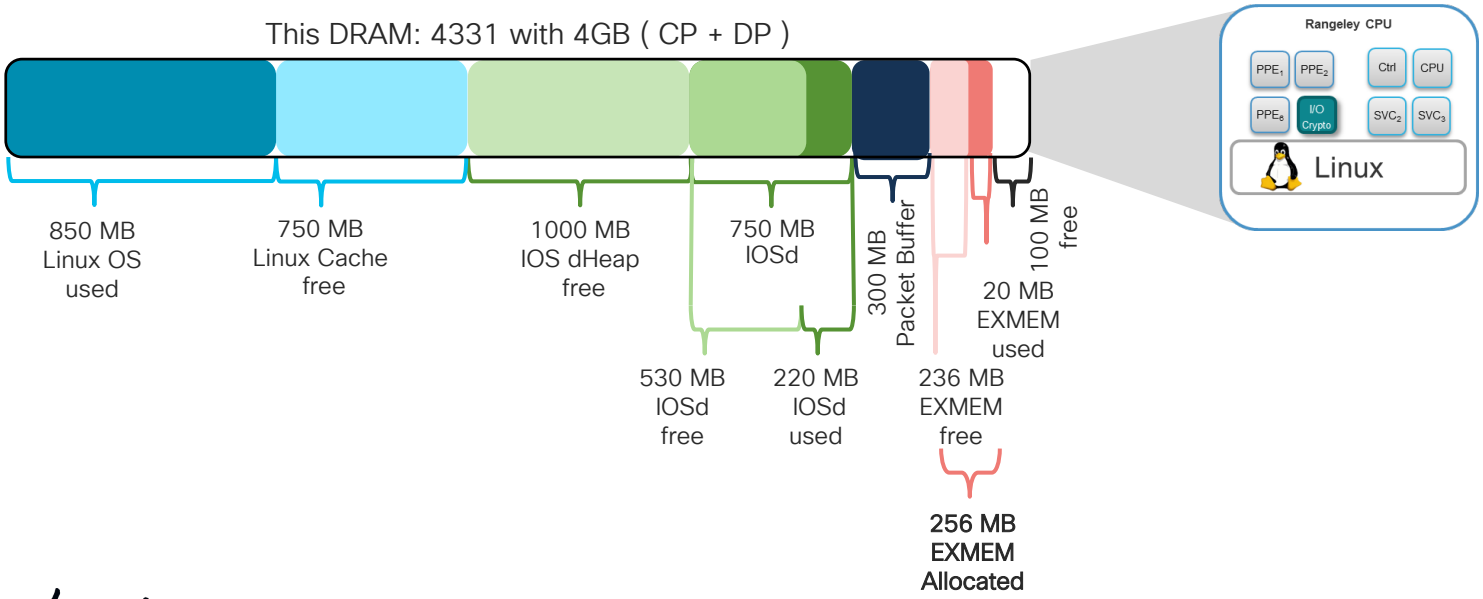


How Memory is allocated – 4200, 4300 & 1100

Shared memory allocations for CP & DP

CP: **Floating** memory allocations Linux & IOSd

DP: **Fixed** memory allocations for Packet buffer & EXMEM (no CPP code on 4300)



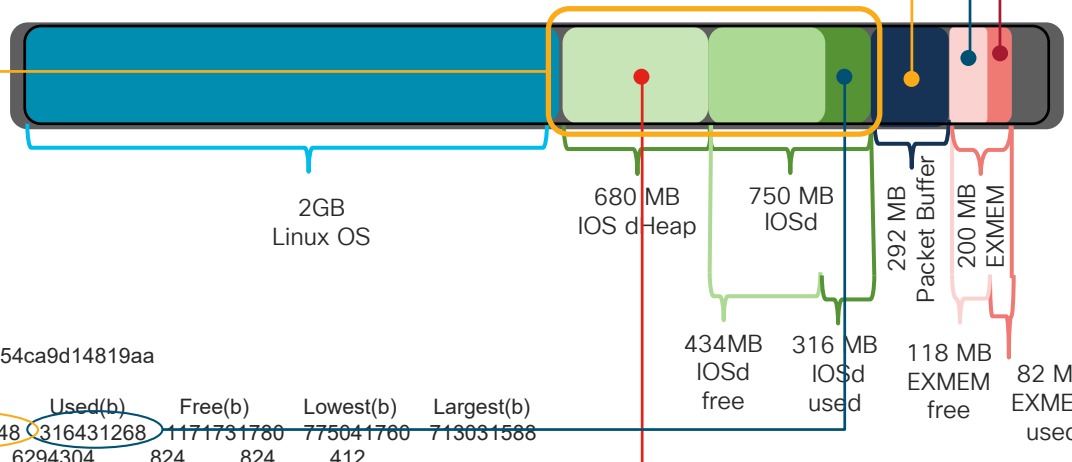
Monitoring C1100 4GB DRAM

C1101#**show platform hardware qfp active infrastructure exmem statistics**
QFP exmem statistics

Type: Name: DRAM, QFP: 0
 Total: 201326592
 InUse: 82447360
 Free: 118879232
 Lowest free water mark: 118878208
Type: Name: IRAM, QFP: 0
 Total: 2097152
 InUse: 211968
 Free: 1885184
 Lowest free water mark: 1885184

C1101#**sh memory platform information**
Memory (kB)
 Physical : 3758800
 Total : 3758800
 Used : 2397200
 Free : 1361600
 Active : 2241576
 Inactive : 709888

Buffers (kB) : 292612



C1101#**sh memory**
Tracekey : 1#55a11728f207abb2b0754ca9d14819aa

	Head	Total(b)	Used(b)	Free(b)	Lowest(b)	Largest(b)
Processor	7F52DE3010	1488163048	316431268	1171731780	775041760	713031588
lsmpi_io	7F521821A8	6295128	6294304	824	824	412

Dynamic heap limit(MB) 680 Use(MB) 0

Monitoring Your DRAM usage – 4300, 4GB Default

IPv4 BGP Routes	show platform resources		show memory			show platform software status control-processor brief	show platform hardware qfp active infrastructure exmem statistics	
	Reserved CP	Reserved DP	Total used	Total Free	Heap Used	committed	InUse	Free
0	3773MB(97%)	22MB(8%)	229MB	1498MB	0MB	2302MB (58%)	23MB	244MB
100000	3830MB(99%)	49MB(18%)	366MB	1362MB	0MB	2457MB (62%)	50MB	218MB
200000	3830MB(99%)	59MB(22%)	507MB	1220MB	0MB	2609MB (66%)	60MB	207MB
300000	3830MB(99%)	67MB(25%)	641MB	1087MB	0MB	2762MB (70%)	69MB	199MB
400000	3829MB(99%)	77MB(29%)	782MB	946MB	112MB	3030MB (77%)	79MB	188MB
500000	3828MB(99%)	86MB(33%)	919MB	808MB	240MB	3313MB (84%)	88MB	179MB
600000	3828MB(99%)	96MB(36%)	1056MB	671MB	368MB	**3648MB (91%)**	98MB	170MB

Takeaway from this table: 1 x Internet RIB (600k+ prefixes) = More than 91% Committed = Upgrade to 8GB needed

EXMEM / QFP (data plane) memory

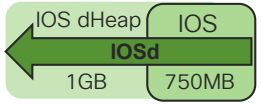
- Marginally impacted by Control plane tasks
- EXMEM will increase with complex configurations (no actual traffic needed)

To closely monitor when using databases like large RIBs:

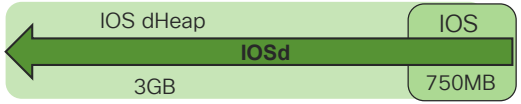
- **Committed memory:** IOS + Heap + Linux Memory earmarked for processes

What does an ISR DRAM Upgrade give me?

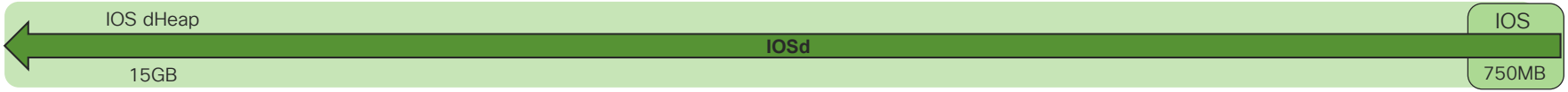
4GB DRAM Default
1.75 GB for IOS use



8GB DRAM Upgrade
3.75 GB for IOS use



16GB DRAM Upgrade
7.75 GB for IOS use



32GB DRAM Upgrade (ISR4461)
15.75 GB for IOS use

Memory Bottlenecks

There are 3 main possible memory bottlenecks:

1. IOSd Memory
   - Even including dHeap there is a limit to how big IOSd can grow
2. Linux Memory
   - Linux memory grows at about the same rate as IOSd memory
   - You can protect Linux by restricting IOS memory

     C1101(config)#platform memory set 1000 (750MB + 250MB = IOS + a limited HEAP of 250MB)
3. EXMEM (Data Plane memory)
   - Could in extreme cases pose a limitation as it can't be increased
     - Consider in those cases 4400 series with up to 5x the EXMEM size than C1100

Key Takeaways

- When choosing platform – Base it on your own business requirements
- Understand the collateral & be critical. Never take performance data at face value.
- All IOS-XE based platforms: Same architecture - Same characteristics
- 1100 Series – A network rack in a box
- ISR1100 Available with Viptela OS – Switch to IOS-XE in the future
- Viptela OS of IOS-XE platform – A matter of feature requirements
- Before deciding on SDWAN CPE – What are your Branch security requirements?

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