

CISCO *Live!*

ALL IN

#CiscoLive

How to choose the Correct Branch Device

Stefan Mansson
Sr. Product Manager ISR4000 & Cat8000
CCIE #3516
@isrguru

BRKENT-2139

Cisco Webex App

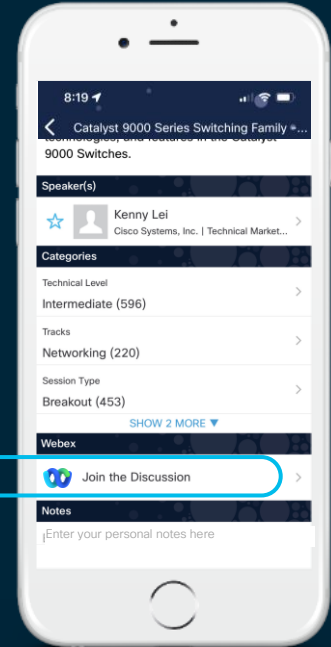
Questions?

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

How

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

Webex spaces will be moderated by the speaker until June 17, 2022.



<https://cicolive.ciscoevents.com/cicolivebot/#BRKENT-2139>



Agenda

- Basics - Looking for new CPEs?
 - Make sure you address your questions
- Can I trust published Performance Data?
 - Know what's hidden in Performance Data
 - Make sure you're comparing apples to apples
- Under the hood - Do I really need a refresh?
 - Learn to monitor CPU load and DRAM usage
 - ISR vs. Cat8k - Architectural differences to be aware of
 - Return of Investments - EoS announcements
- Cisco SD-WAN, Viptela OS or IOS XE?
 - Don't paint yourself into a corner
- Cat8k DNA licensing
 - How it's done in practice
 - Common misperceptions

Stefan Mansson



37 years in Network Business

32 years exclusively with Cisco Branch Routers and Routing Solutions



10 years as Cisco consultant @ Swedish Gold Partner



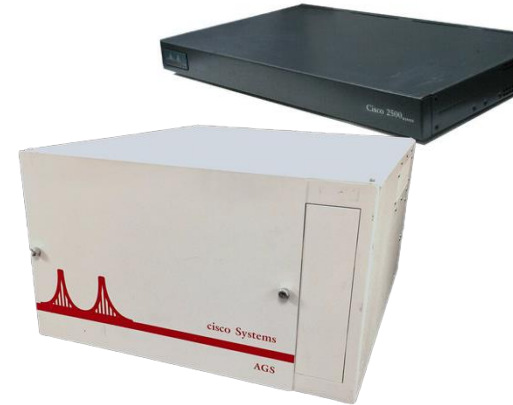
21 years @ Cisco, based in 5 countries



CCIE #3516 24 years, since -98



CCSI #20145 Cisco Instructor 23 years



The Basics

Before you start

How much WAN bandwidth do I actually require

- Is our traffic really utilizing the bandwidth we're paying for?
- What does my traffic pattern look like?



Do I fully understand performance data?

- How do I compare this data from one vendor to another?
- Is it tested the same way?



Do I really know the impact of my services?

- Are they impacting Throughput, DRAM, Storage?
- ...or all of them?



Is it time to refresh?

- How much load am I putting on my routers today?
- How much memory do they have left?
- How do I find out?

My org. is looking at Cisco SD-WAN

Should I recommend a solution based on Viptela OS or IOS XE?



What about lifespan?

- For my existing platforms and for the chosen replacement platforms
- How do I make sure I get full ROI ?
- Will Cat8000 routers work with my existing ISR4000?

Cat8k are using DNA licensing

Hmmm....that's new to me

How does DNA licensing work for my routers?



Are you comparing
Apples to Apples?

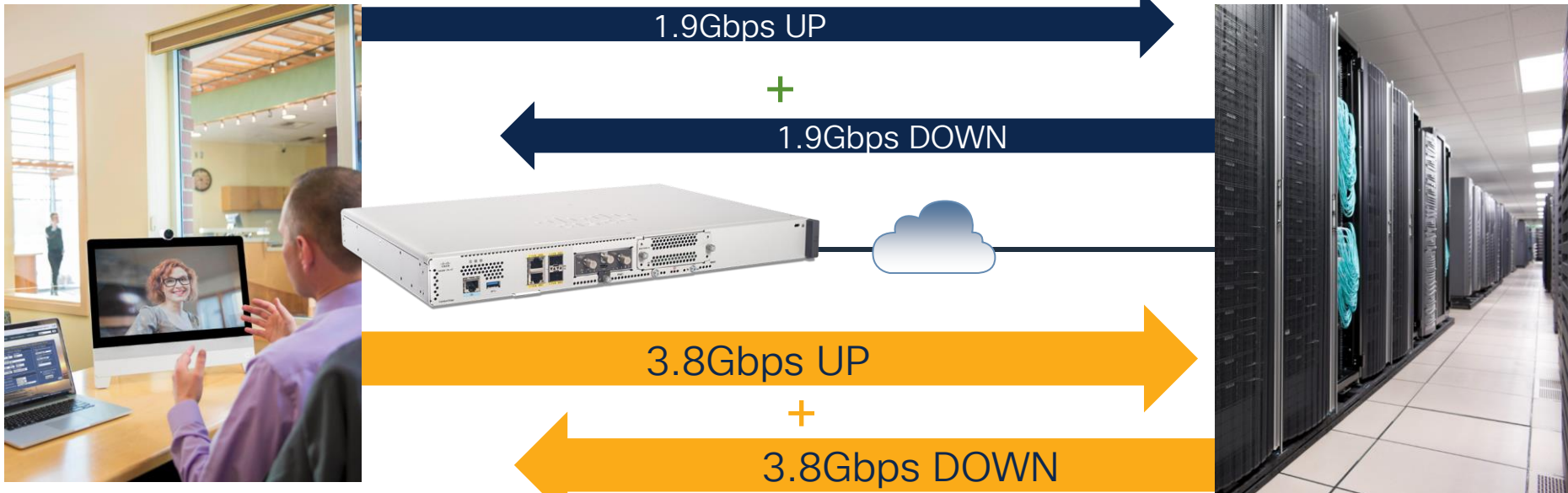
Understanding
Performance
Collaterals



Beware of Misperceptions

So...C8200 collateral says 3.8Gbps IP CEF....Is that Bidirectional?

Is this 3.8Gbps Bidirectional?



...or is this 3.8Gbps Bidirectional?

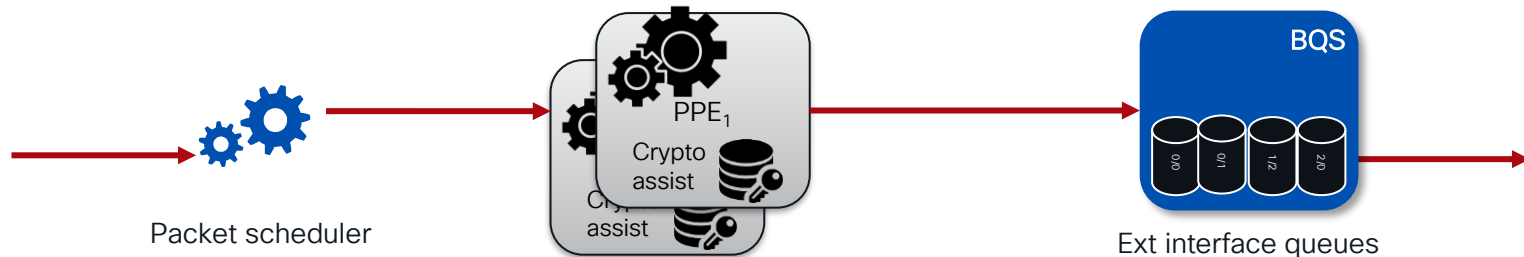
?????

Why Cisco Uses the Term "Aggregate"

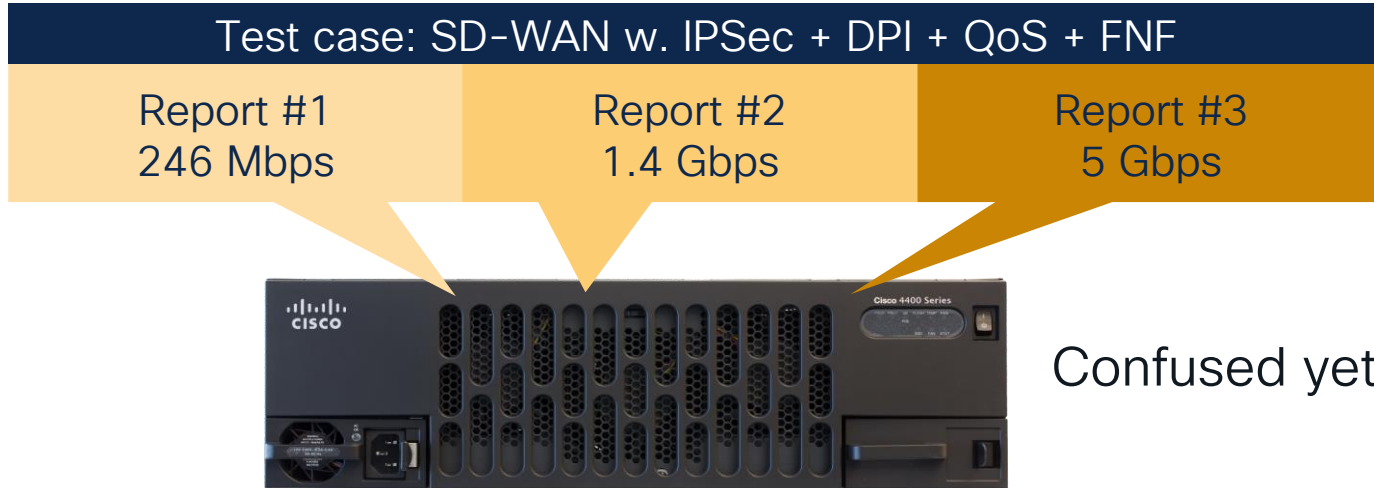
Ehh...Wrong!!!

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

- Aggregate = Total capacity of Forwarding engine, regardless of direction
- Forwarding engine doesn't distinguish between Up or Down.
- All measured using RFC 2544 NDR Methodology – Highest possible Non-drop rate



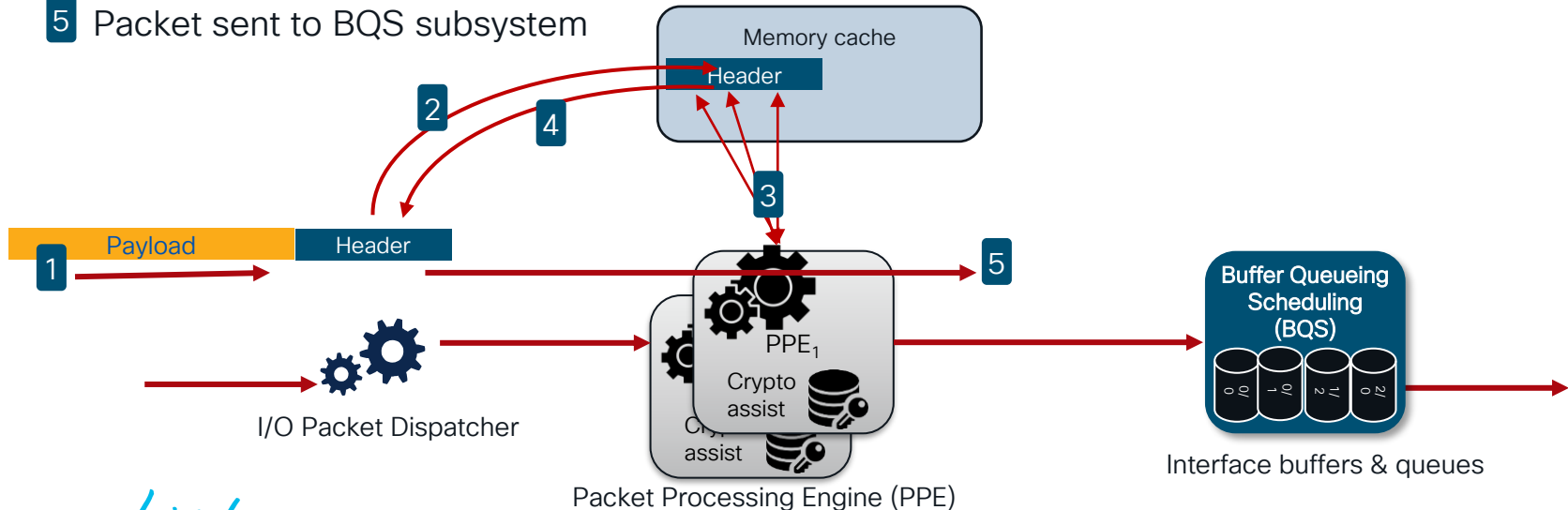
How packet sizes can skew performance data



SD-WAN w. Heavy features	Mbps		
Platform	64	IMIX	1400
4461	246	1,389	5,052

Cisco Express Forwarding process "CEF"

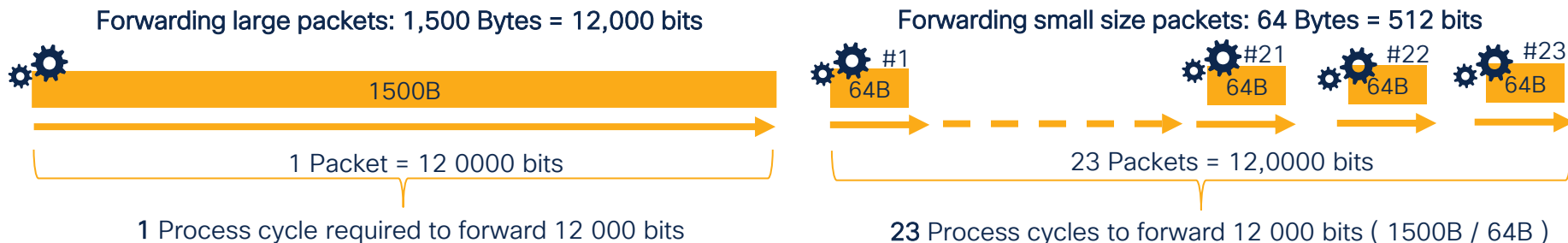
- 1 Packet comes in from Packet Dispatcher
- 2 Packet header copied to memory cache – Main Payload generally not copied.
- 3 PPE invokes Data Plane features based on header information
- 4 Header bolted back on to original packet waiting in buffer
- 5 Packet sent to BQS subsystem



Packet sizes can skew data

One process cycle = One packet served

Time to process each packet is more or less constant for same service



Example:

Performance for a given service: 100kpps

- **1500B packet size:** $100\,000 \text{ packets/sec} \times 12\,000 \text{ bits/packet} = 1\,200\,000\,000 \text{ bps} = 1\,200\text{Mbps}$
- **64B packet size:** $100\,000 \text{ packets/sec} \times 512\text{bits/packet} = 51\,200\,000 \text{ bps} = 51.2\text{Mbps}$

Although different in bps: Common denominator in both testresults: 100kpps

True Routing capacity = Number of packets per second served for a given service

How packet sizes can skew performance data

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

Report #1
246 Mbps

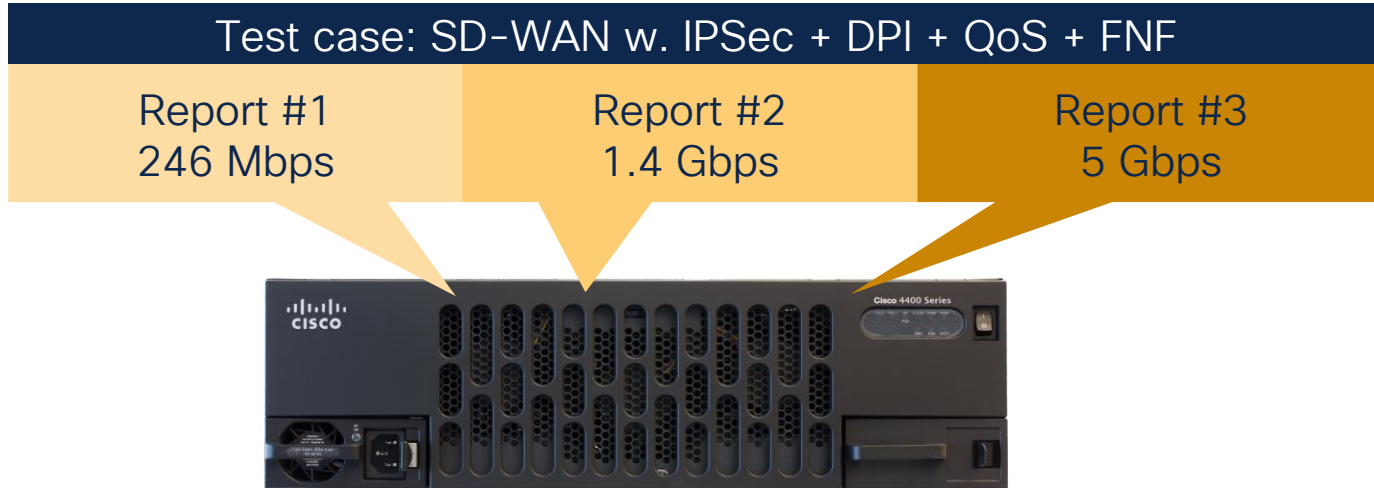
Report #2
1.4 Gbps

Report #3
5 Gbps



SD-WAN w. Heavy features	Mbps		
Platform	64	IMIX	1400
4461	246	1,389	5,052

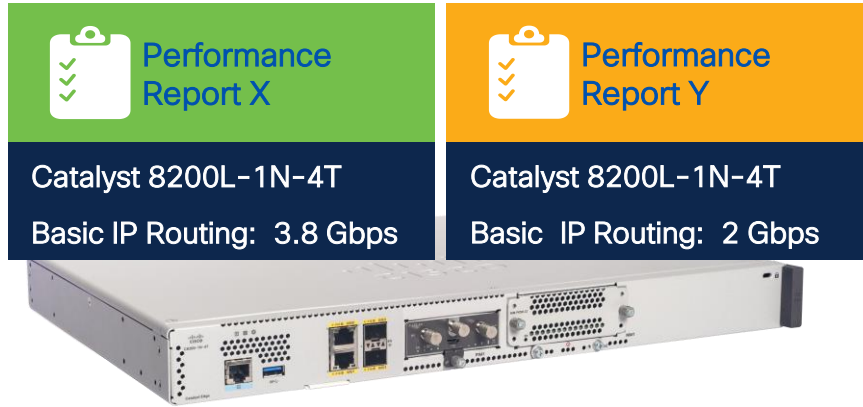
How packet sizes can skew performance data



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

Packet Per Second = Indisputable routing capacity

What about Traffic profiles?



Test setup Report X: Stateless traffic, tester to tester



Test setup Report Y: Stateful, 50 users downloading Cloud based content



Beware of
misleading data



Skewing performance data with packet sizes

Internal “drag race” test we once did with ISR G2 ...just for kicks & giggles



Believe it or not: All were perfectly accurate test results

- No services enabled
- Same IPv4 destination for all packets
- Stateless UDP with ONLY maximised L2 frame size

Awesome numbers, right? But...

Max throughput
2.8+ Gbps

Cisco 1941
Recommended 25-40Mbps

Cisco 3945E
Recommended 350-500Mbps

Max throughput
8+ Gbps



Will this ever hold in a real environment?

Believe it or not, these are perfectly accurate test results

- Jumbo frames enabled
- Same IPv4 destination for all packets
- Stateless UDP with ONLY maximised L2 frame size

Not just no...

Time to refresh your ISRs?

Easy...
...just take a look under
the hood and find out



Monitor your CPU Resources

Looks at the IOSd process only

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

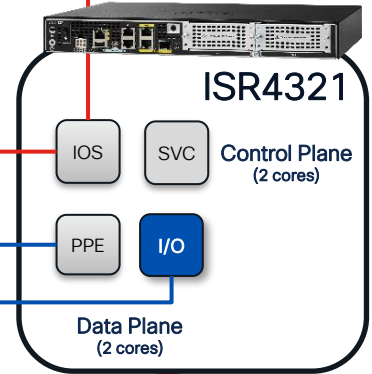
Shows individual load for all processors

```
Stefs_Dagger#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: 100%, one minute: 100%, five minutes: 100%
```

Pid	PPid	5Sec	1Min	5Min	Status	Size	Name
28331	25742	100%	100%	100%	S	1093480448	qfp-ucode-utah
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

“Looking for work” process.
High % up to 100% = Normal

Don't panic!
This is I/O scheduler core
100%, or very high = Normal



Monitor Data Plane Forwarding state

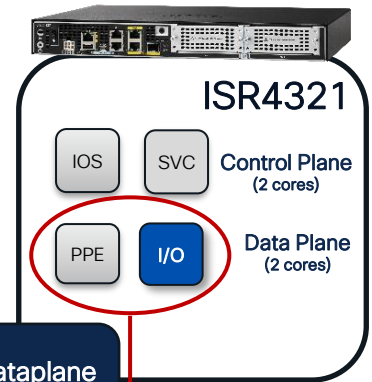
Show summary of Dataplane load in Packets & Percentage

Good for checking if a Boost license on your ISR4k will move the performance needle

...or if it's time for an upgrade to a C8k platform with a (MUCH) more powerful dataplane.

```
Stefs_Dagger#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)	4	2	2	2
(bps)	1792	896	896	896
Total (pps)	4	2	2	2
(bps)	1792	896	896	896
Output: Priority (pps)	0	0	0	0
(bps)	0	0	0	0
Non-Priority (pps)	4	2	2	2
(bps)	15392	7760	7760	7760
Total (pps)	4	2	2	2
(bps)	15392	7760	7760	7760
Processing: Load (pct)	1	1	1	1



Total load of your Dataplane
in % (pct)

Taken from my idling lab router, hence the low load

Look for bottlenecks in your installed routers

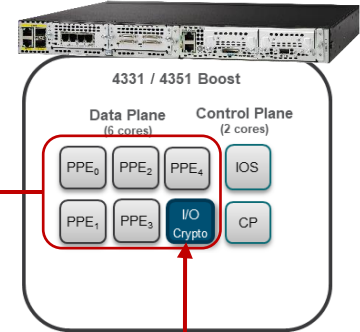
show platform hardware qfp active datapath infra sw-cio

- 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
```

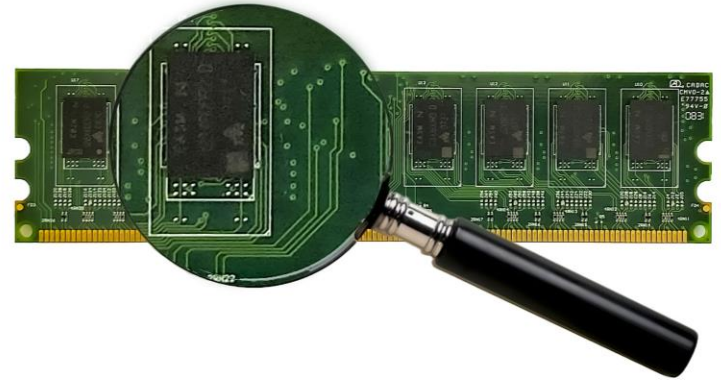
Core Utilization						
ID:	0	1	2	3	4	5
% PP:	42.15	41.55	41.76	41.71	41.97	0.00
% RX:	0.00	0.00	0.00	0.00	0.00	43.02
% TM:	0.00	0.00	0.00	0.00	0.00	30.00
% CRYPTO:	0.00	0.00	0.00	0.00	0.00	26.98
% IDLE:	57.85	58.45	58.24	58.29	58.03	0.00



Uh-oh ! I/O core out of capacity
No more packets being handled

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

Did You bring
enough Memory to
the Party?



Control Plane & Data Plane memory

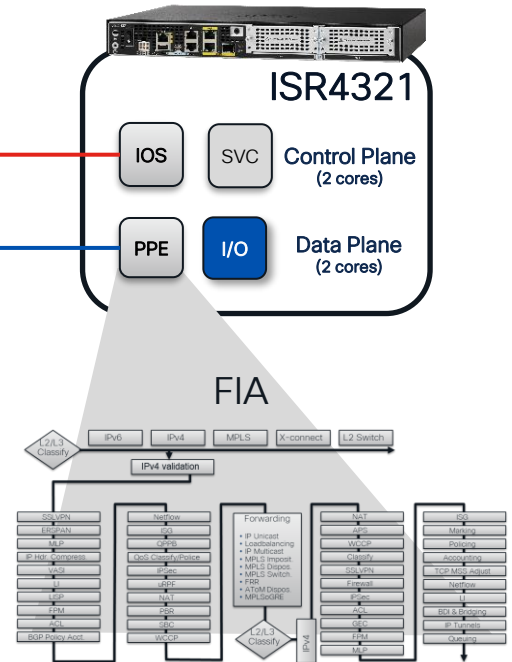
Which one shows what?

Control Plane Memory

- `#show memory` will only show you Control Plane memory
- Used for IOS daemon & Underlying Linux
 - Holds IOS as well as Databases (RIBs, VLAN etc.)
 - Linux kernel mem-alloc grows with IOS mem-alloc
- Control Plane memory is what you want to keep an eye on

Data Plane Memory – Fixed partition memory

- `#show platform hardware qfp active infrastructure exmem [variables]`
- Separate set of Cli cmds required to monitor
- Used exclusively for data plane services & Packet Buffering
- **Fixed size partitions – Will NOT change with a DRAM upgrade**
- Holds Dataplane Microcode – Runs forwarding process (FIA)
 - FIA (Feature Invocation Array) ... Adding services to packets
- Grows when scalable features are configured (MPLS FIB, NAT Table, ZBFW etc.).



Monitoring Memory – ISR4321, 8GB DRAM



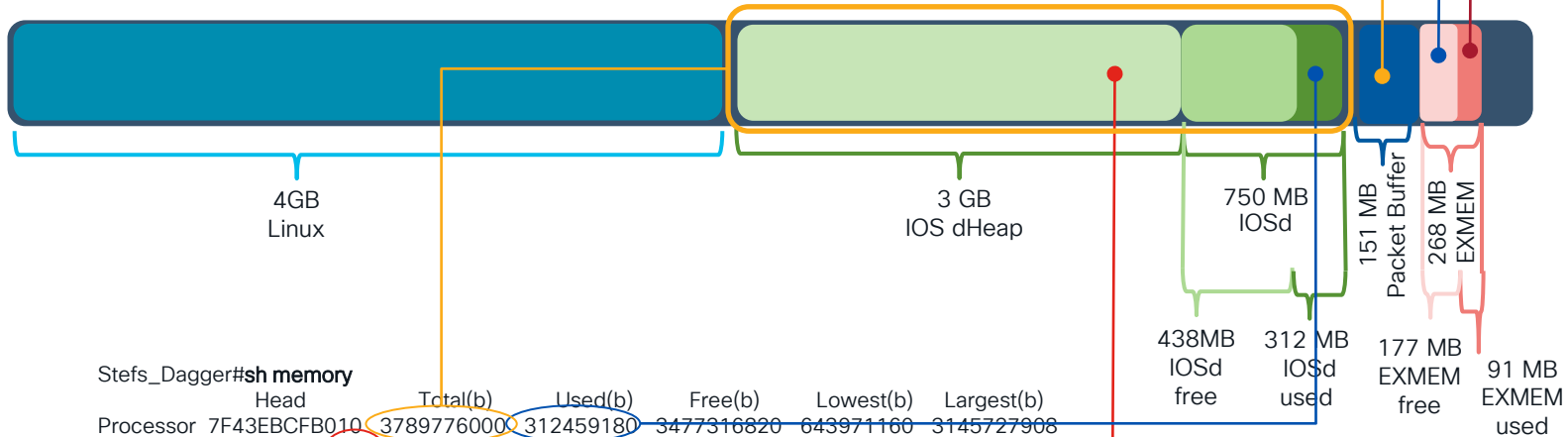
Stefs_Dagger#show memory platform information

```
Architecture : x86_64
Memory (kB)
Physical      : 8008036
Total        : 8008036
Used         : 2854172
Free         : 5153864
Active       : 1827884
Inactive     : 1434452
```

Stefs_Dagger#show platform hardware qfp active infrastructure exmem statistics
QFP exmem statistics

```
Type: Name: DRAM, QFP: 0
Total: 268435456
InUse: 90986496
Free: 177448960
Lowest free water mark: 177446912
```

Buffers (kB) : 151140



Stefs_Dagger#sh memory

Head	Total(b)	Used(b)	Free(b)	Lowest(b)	Largest(b)
Processor 7F43EBCFB010	3789776000	312459180	3477316820	643971160	3145727908
Dynamic heap limit(MB)	3000	Use(MB) 0			

Monitor DRAM usage – Example from a 4300, 4GB Default

IPv4 BGP Routes	show platform resources		show memory			show platform software status control-processor brief	show platform hardware qfp active infrastructure exmmem 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

1 x Internet RIB (600k+ prefixes) = 91% Committed Memory = Upgrade to at least 8GB ...NOW!

Committed Memory: IOS + Heap + Linux Memory earmarked for processes

Closely monitor this when using large databases like Internet RIBs

EXMEM / QFP (data plane) memory

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

Upgrading DRAM

How much can I use?

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
15.75 GB for IOS use

Memory Bottlenecks to be aware of

These are three 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)

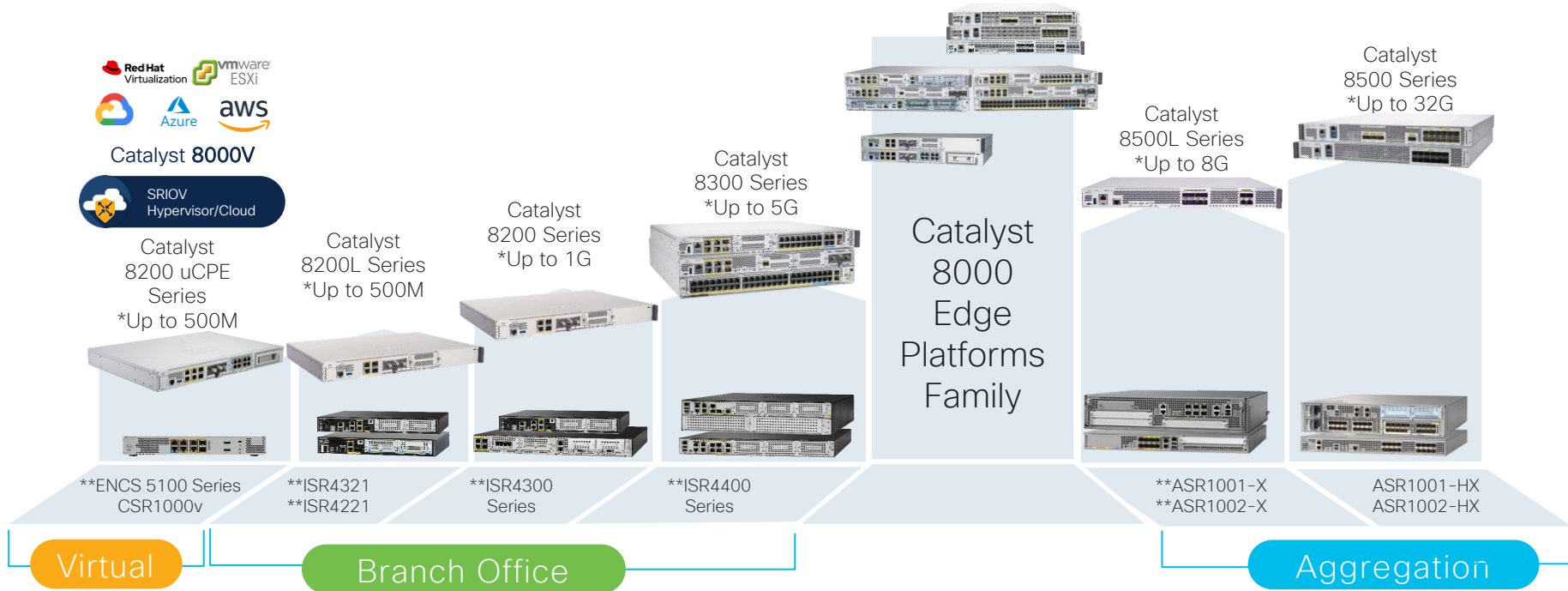
- Fixed in size
- Could in extreme cases pose a limitation as it can't be increased
 - 4400 series have up to 5x the EXMEM size than C1100

ISR4000/ASR1000 vs. Cat8000 Series



Cisco Catalyst Routing Portfolio

Which one suits your needs?



*Perf. Numbers are Base SDWAN, Aggregated IPsec IMIX
 ** Note: Platforms slotted for EoS

Upcoming End of Sale

ASR1001-X/1002-X

- EoS: August 1st, 2022
- End of New Service Attachment IOS 17.12 (August 2023)



Cisco ASR1001-X, ASR1002-X, ASR1000-6TGE, ASR1000-2T+20X1GE and associated miscellaneous ASR1000 SKUs.

ISR4000 Series

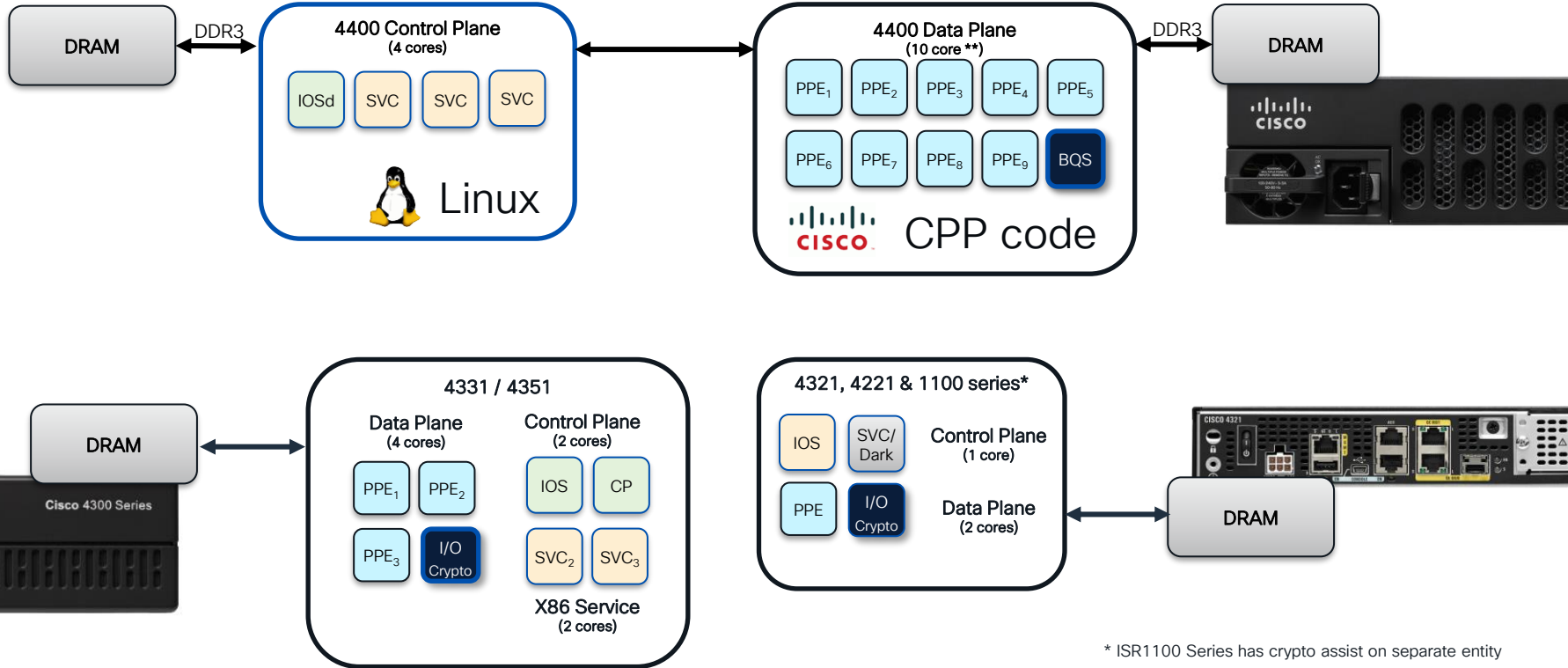
- EoS: August 1st, 2023
- End of New Service Attachment IOS 17.9 (August 2022)



Cisco ISR4221, 4321, 4331, 4431, 4451
Associated platform peripherals

ISR4461 & ISR4k modules not included in this EoS

ISR4400 vs. ISR4300/4200 architecture

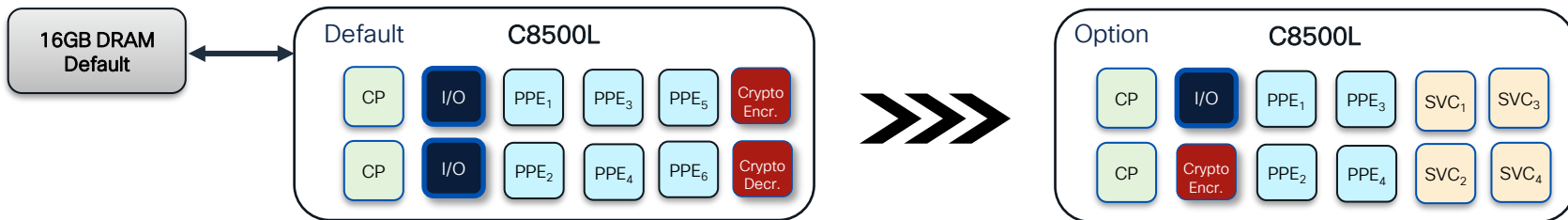


* ISR1100 Series has crypto assist on separate entity

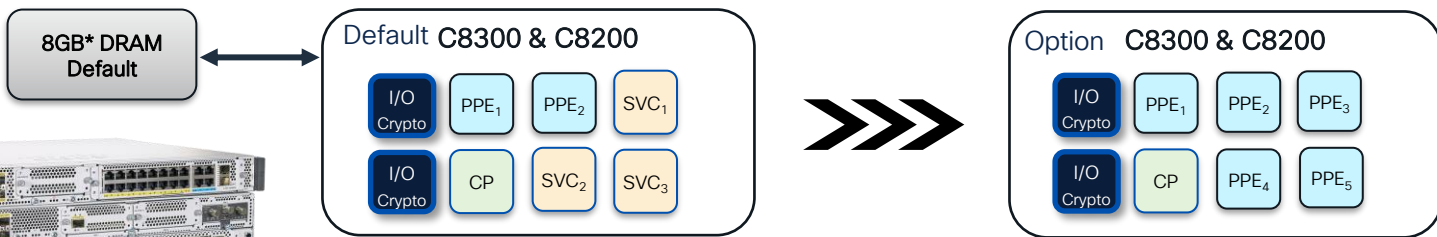
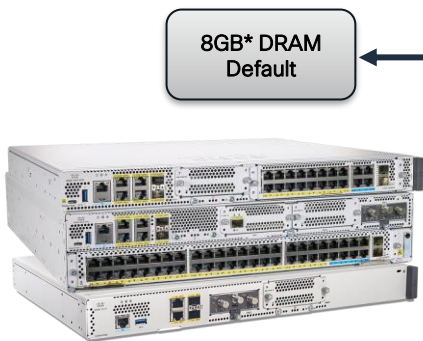
** ISR4431 - 6 Data plane cores

Catalyst C8500L, C8300, C8200 & C8200L

Single silicon x86 architecture with **Dynamic Core Allocation**



C8500L: 12-core x86 - Dual Scheduler & crypto / Advanced Flow based Forwarding
Up to 20Gbps CEF, 8Gbps SDWAN/IPSec

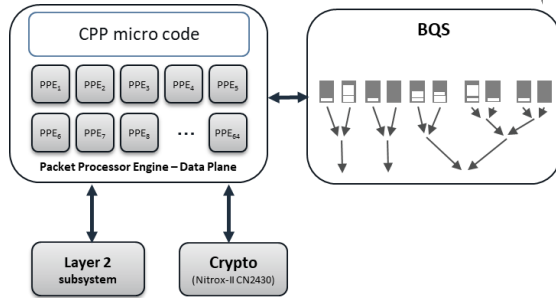


C8300, C8200: 8 & 12-core x86 - Dual Scheduler & crypto cores
C8200L: 4-core x86 - Single Scheduler & Crypto core
Up to 12 Gbps CEF, 5Gbps SDWAN/IPSec (C8300)

* C8300 & C8200.
C8200L 4GB default

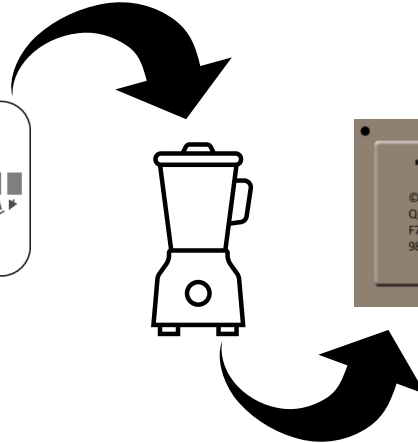
ASR1K vs. C8500 Architecture

ASR1K

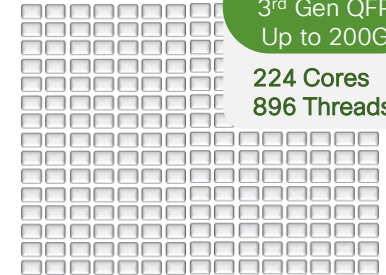


QFP2.0
2nd Gen QFP
Up to 60G

64 Cores
256 Threads



C8500



QFP3.0
3rd Gen QFP
Up to 200G

224 Cores
896 Threads



224 Four-thread cores with 896 Packets in parallel
Embedded Network processor and Crypto engines
Up to 200Gbps of IMIX throughput
Up to 65Gbps crypto in IMIX (137Gbps with large packet size)

Choosing SDWAN CPE

Viptela OS or
IOS XE?



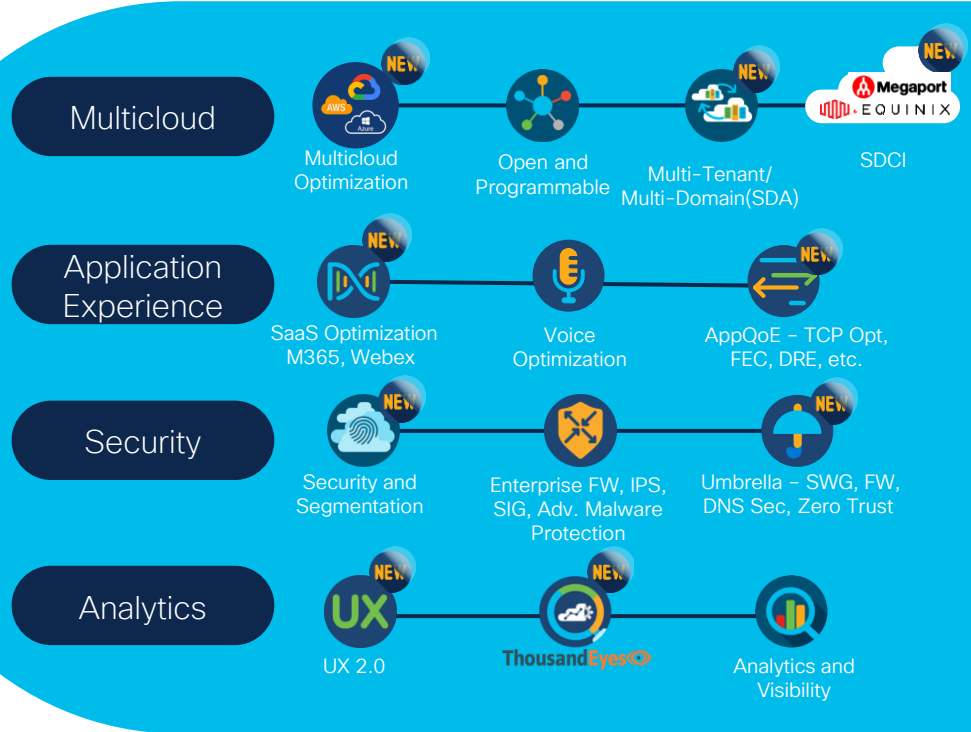
Cisco SD-WAN – Leading With Innovation

Viptela Base Architecture

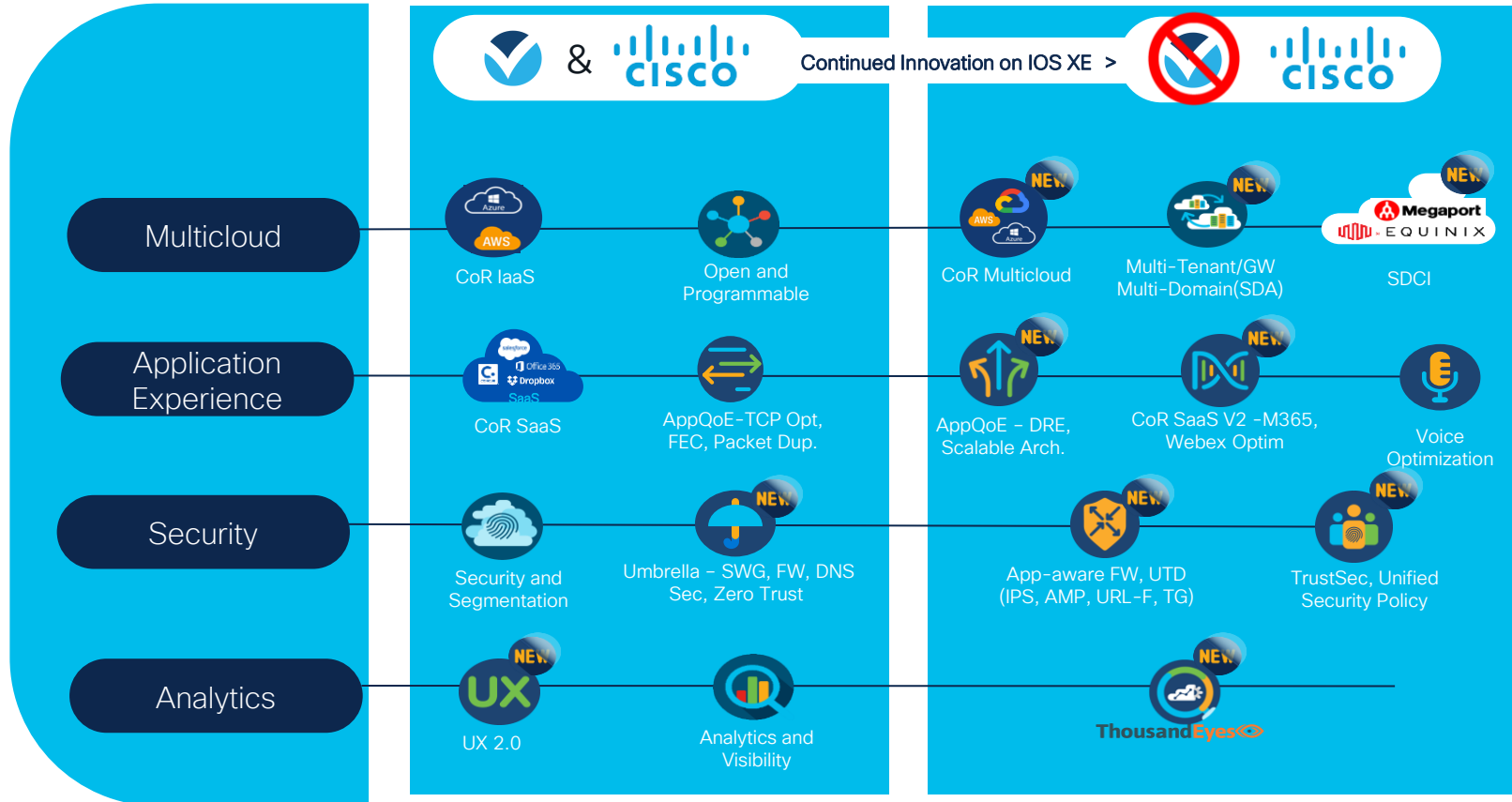
- Transport agnostic with hub-spoke and mesh architectures
- Direct internet access
- Centralized management and orchestration
- Circuit cost savings



Extended Capabilities and Innovations



SD-WAN Innovations continuing in IOS XE



Discontinuation of vEdge & Viptela OS



vEdge 2000 / 5000

- EoS: January, 2023

Viptela OS

- 20.9 Last Viptela release



Cat8k DNA Licensing



DNA licensing
matters to you

Consistency & Simplicity

Performance, flexibility
and investment protection

Portable between your HW

Software support included
on all Subscriptions

Cisco DNA Essentials

Cisco DNA Advantage

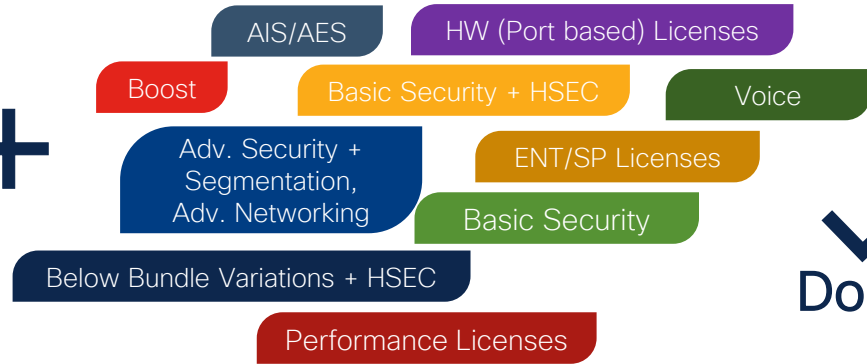
Cisco DNA Premier

ISR4k vs. Cat8000 DNA licensing model

Traditional Routing = Perpetual DNA entitlement

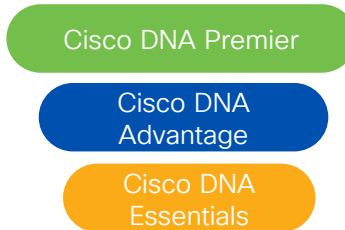
ISR4k/ASR1K

1. Buy HW
2. Choose Feature pack
3. Choose Performance/Port license
4. Done

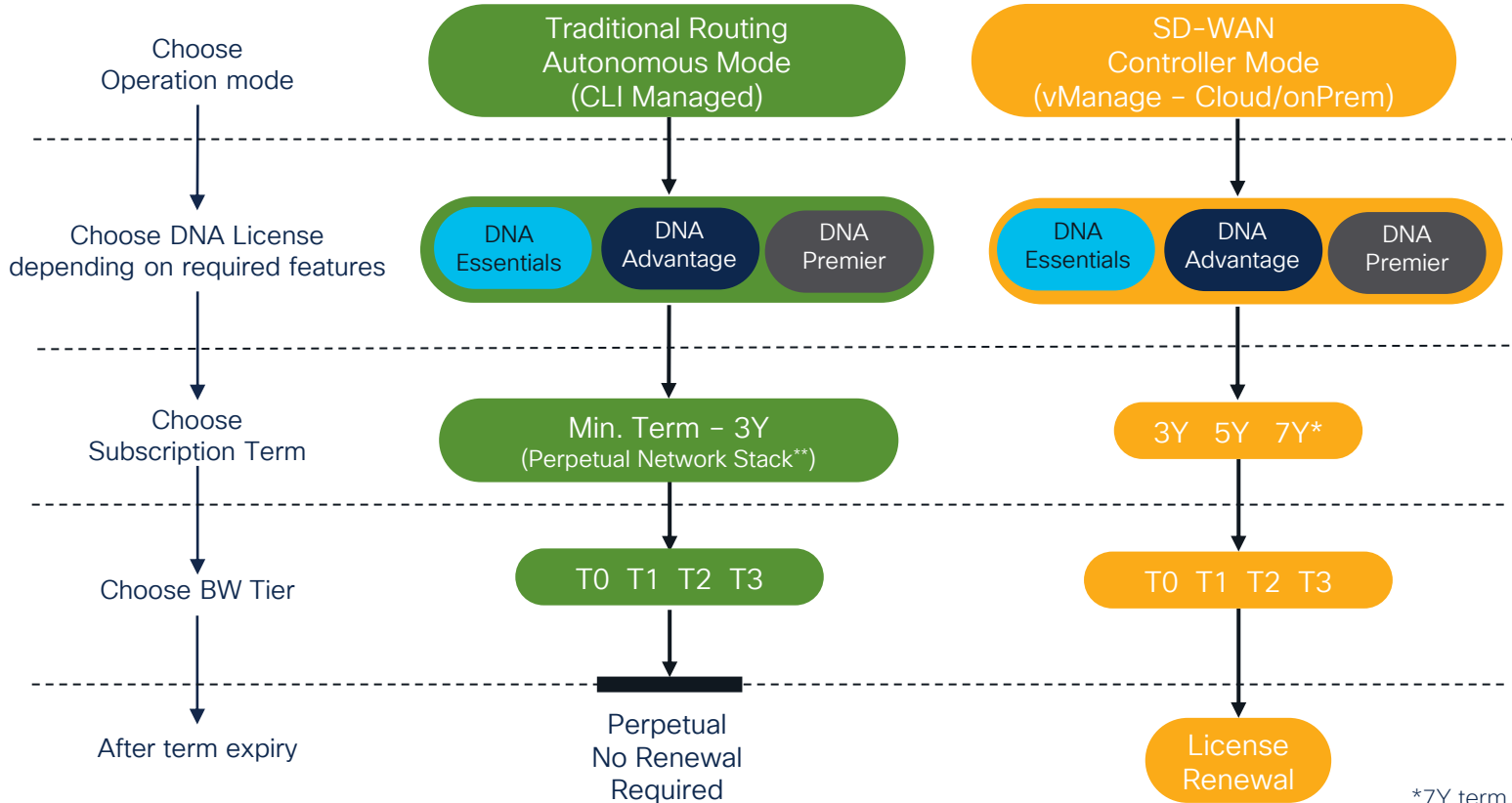


Cat8000

1. Buy HW
2. Choose DNA Subscripton (Feature pack)
3. Done



DNA License model – Catalyst 8K platforms



*7Y term in Advantage only
**Not applicable for C8000V

Choosing BW tier

Calculating BW Tier = Aggregated SD-WAN or IPsec traffic, divided by 2

Aggr. Throughput / BW tier	Catalyst 8000 BW Tiers
Unlimited ↑ From 2001 Mbps Aggr.	T3 10Gbps Select HSEC option
Up to 2000 Mbps Aggr. ↑ From 401 Mbps Aggr.	T2 1Gbps Select HSEC option
Up to 400Mbps Aggr. ↑ From 51 Mbps Aggr.	T1 200Mbps
Up to 50 Mbps Aggr. ↑	T0 25Mbps

BW tier compliant examples

T3 - Adv. & Prem. only

C8500-12X4QC - Autonomous Mode
T3 = Only BW tier for C8500-12X & 12X4QC
Regardless of throughput, encryption or SD-WAN

C8500L- Autonomous Mode

T2 = Starting BW tier for C8500L

C8300-2N2S-4T2X - SD-WAN

Running an estimated aggr. of 2 Gbps, Transport side

C8300-2N2S-6T - Autonomous Mode

I'm running aggr. 350 Mbps IPsec + 9 Gbps unencrypted traffic

C8300-2N2S-4T2X - Autonomous Mode

I'm running 11 Gbps of unencrypted traffic

Key Takeaways

No two businesses are alike

Know what your own traffic patterns really looks like

Set your own throughput requirements

Not what marketing collateral is telling you

Never take performance data at face value

Enough said!

Know the workload of your platforms

Make sure your investment is “On the Money” ...for years

ASR1k / ISR4k vs. Cat8k series

No learning curve involved, just a ton more throughput

EoS of ASR100x-X & ISR4000 coming up

A matter of future proofing your investment

SDWAN: Viptela OS or IOS-XE

vEdge & Viptela OS EoS. Don't paint yourself into a corner.

C8k DNA Licensing

Simplicity, flexibility and actually, easier than it looks

Technical Session Surveys

- Attendees who fill out a minimum of four session surveys and the overall event survey will get Cisco Live branded socks!
- Attendees will also earn 100 points in the Cisco Live Game for every survey completed.
- These points help you get on the leaderboard and increase your chances of winning daily and grand prizes.



Cisco Learning and Certifications

From technology training and team development to Cisco certifications and learning plans, let us help you empower your business and career. www.cisco.com/go/certs

**Pay for Learning with
Cisco Learning Credits**

(CLCs) are prepaid training vouchers redeemed directly with Cisco.

Learn

Cisco U.

IT learning hub that guides teams and learners toward their goals

Cisco Digital Learning

Subscription-based product, technology, and certification training

Cisco Modeling Labs

Network simulation platform for design, testing, and troubleshooting

Cisco Learning Network

Resource community portal for certifications and learning

Train

Cisco Training Bootcamps

Intensive team & individual automation and technology training programs

Cisco Learning Partner Program

Authorized training partners supporting Cisco technology and career certifications

Cisco Instructor-led and Virtual Instructor-led training

Accelerated curriculum of product, technology, and certification courses

Certify

Cisco Certifications and Specialist Certifications

Award-winning certification program empowers students and IT Professionals to advance their technical careers

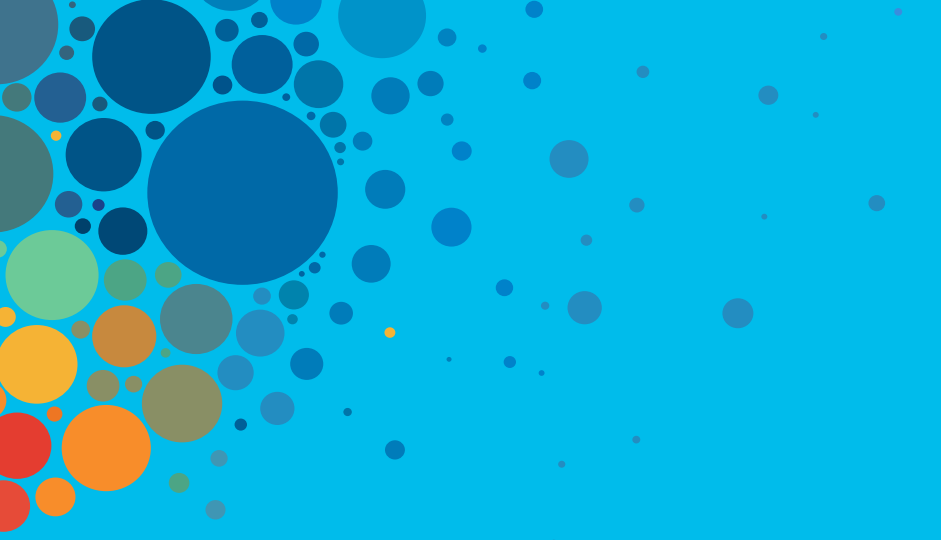
Cisco Guided Study Groups

180-day certification prep program with learning and support

Cisco Continuing Education Program

Recertification training options for Cisco certified individuals

Here at the event? Visit us at **The Learning and Certifications lounge at the World of Solutions**



Continue your education

- Visit the Cisco Showcase for related demos
- Book your one-on-one Meet the Engineer meeting
- Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs
- Visit the On-Demand Library for more sessions at www.CiscoLive.com/on-demand



The bridge to possible

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