



*TOMORROW  
starts here.*

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# Cisco Catalyst 4500E Switch Architecture

BRKARC-3445

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# Abstract

Catalyst 4500E is the leading platform for Cisco's Campus Access layer. The latest Supervisor 8-E and the previous Supervisor 7-E and its lighter cousin, the 7L-E are the heart and soul of this platform. In this session we will take a close look at the ASIC and System Architecture, walk with the Unicast and Multicast packets as they traverse the system. We will also talk about some of the differentiating features like Flexible NetFlow and Wireshark on IOS XE that enable application visibility from the access layer and help in capturing and viewing application packets on the switch itself. We will also discuss some of the High Availability and Resiliency features like SSO/NSF and ISSU. This session will also cover the latest line cards and their architecture. The session is for network designers and network operation engineers who have or are considering deploying Cisco Catalyst 4500 Series Switches in enterprise networks. At least a basic knowledge of routing protocols as well as traditional campus design is recommended.

# Agenda

- Catalyst 4500E & X Overview
- System Architecture
  - Supervisor Architecture
  - Unicast Packet Walks
- High Availability
- Latest Introductions...





# Introduction & Overview

# Catalyst 4500E



## MARKET LEADERSHIP

- 110M+ Ports Sold
- 800K+ Systems
- 70%+ Modular PoE/PoE+ Port share

## Key Benefits

Wired and Wireless Convergence

POE/POE+/UPOE Scale

VSS/ISSU - Resiliency for Business Continuity

Security With .1x, TrustSec and MacSec

Application Visibility and Control

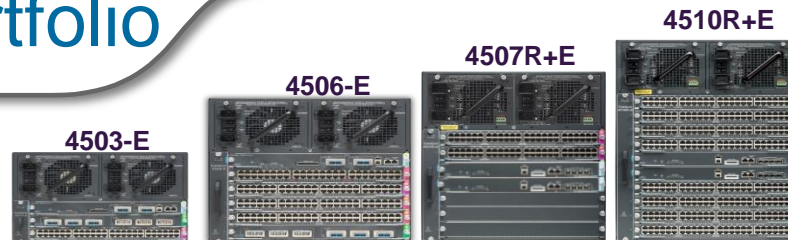


Catalyst 4500 Chassis

# Catalyst 4500E Campus Portfolio

## Four Chassis Options

7 and 10 Slot with Sup Redundancy



## Supervisors

Wireless Convergence vs Traditional  
928G Wired, 20G Wireless



## Port Scale: Access and Collapse Agg

384 10/100/1000 POE/UPOE,  
96 SFP+ , 192 SFP



POE: WS-X4748-UPOE+EE



10GE: WS-X4712-SFP+E



Data: WS-X4748-RJ45-E



1GE: WS-X47xx-SFP-E

## Power Supply

Maximize UPOE/POE+/POE delivery  
Fully Loaded 10-Slot with POE



PWR-C45-1300ACV



PWR-C45-2800ACV



PWR-C45-4200ACV



PWR-C45-6000ACV



PWR-C45-9000ACV



# Catalyst 4500E Chassis Types

## Redundant Sups



### 4507R+E

2 Supervisors

5 Line Cards

240 Ports of 10/100/1000

11 Rack Unit Height

Supervisor 6LE, 6E, 7LE, 7E, 8E

Dual Power Supplies

### 4510R+E

2 Supervisors

8 Line Cards

384 Ports of 10/100/1000

14 Rack Unit Height

Supervisor 6E, 7E, 8E

## No Sup Redundancy



### 4503-E

1 Supervisor

2 Line Cards

96 Ports of 10/100/1000

7 Rack Unit Height

Supervisor 6LE, 6E, 7LE, 7E, 8E

Dual Power Supplies

### 4506-E

1 Supervisor

5 Line Cards

240 Ports of 10/100/1000

10 Rack Unit Height

Supervisor 6LE, 6E, 7LE, 7E, 8E

Dual Power Supplies

# Per Slot Bandwidth in 10 and 7 Slot Chassis

24G
24G
24G
24G
Supervisor 6-E
Supervisor 6-E
24G
6G
6G
6G

**WS-C4510R-E\***

24G
24G
24G
24G
Supervisor 7-E
Supervisor 7-E
24G
24G
24G
24G

**WS-C4510R-E\***

48G
48G
48G
48G
Supervisor 8-E/7-E
Supervisor 8-E/7-E
48G
48G
48G
48G

**WS-C4510R+E**

24G
24G
Supervisor 6-E/6L-E
Supervisor 6-E/6L-E
24G
24G
24G

\* EoS **WS-C4507R-E\***

24G
24G
Supervisor 7-E/7L-E
Supervisor 7-E/7L-E
24G
24G
24G

**WS-C4507R-E\***

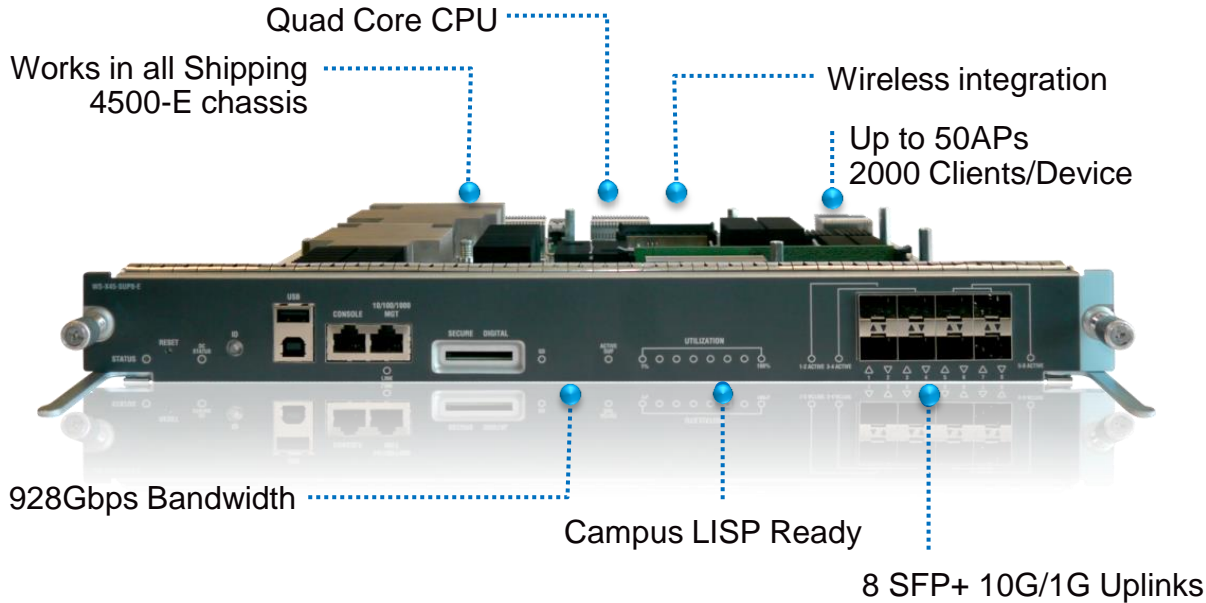
48G
48G
Supervisor 8-E/7-E/7L-E
Supervisor 8-E/7-E/7L-E
48G
48G
48G

**WS-C4507R+E**



# Catalyst 4500 Supervisors

# Supervisor 8-E on Catalyst 4500



## Scale

- 20G Wireless Termination\*
- 100% more Uplink Bandwidth
- Programmable Uplinks\*

## App Visibility

- Flexible NetFlow Wireless
- Wireshark Hosted Application
- MediaTrace for Video Deployment

## Lower TCO

- Investment Protection to UA Arch
- In Service Software Upgrade
- Life Cycle

\* Roadmap

# Catalyst 4500E Series Supervisors

## Optimized for Large Enterprise Campus Deployments 8E and 7E



Supervisor Engine 8-E

**928Gbps Switching Capacity**

### Scalability

- 4 x 1G/10G Uplinks (+4 with 8E)
- 384 10/100/1000 ports (+8 with 8E)
- 3,6,7 and 10 slot chassis
- 96 10G LC Fiber ports (+4 with 8E)
- 192 1G LC Fiber ports
- 256K Routes
- 128K ACL/QoS

## Optimized for Small/Medium Sized Campus Deployments



Supervisor Engine 7L-E

**520Gbps Switching Capacity**

### Scalability

- 2 x10G or 4 x 1G Uplinks
- 240 10/100/10000 ports
- 3,6 and 7 slot chassis
- 60 10G LC Fiber ports
- 120 1G LC Fiber ports
- 64K Routes
- 64K ACL/QoS

### Platform Innovations

- 48G/slot
- Flexible NetFlow
- UPOE
- Hosted Applications
- VRF-Lite, EVN
- In Service Software Upgrade
- VSS
- Cisco TrustSec\*
- Medianet

\* Roadmap SGT

# Sup8-E and SUP7-E Comparison

Features	SUP7-E	SUP8-E
Bandwidth	848 Gbps	<b>928 Gbps</b>
Native Wireless Controller Support Over IOS-XE	No	<b>Yes</b> (HW Ready, SW 2HCY14)
Uplinks	4 x 10 Gbps	<b>8 x 10 Gbps</b>
DRAM	2G	<b>4G</b>
Bootflash	1G	<b>2G</b>
Buffers	32 MB	32 MB
Routes	256K	256K
Security and QoS Entries	128K	128K
Campus LISP Readiness	No	<b>Yes</b>
Multi-Core CPU	1.5 Ghz Dual Core	<b>2 Ghz Quad Core</b>
Blue Beacon for Serviceability	No	<b>Yes</b>
Operating System	IOS-XE	IOS-XE



Catalyst 4500 Line Cards

# Cisco Catalyst 4500E —10/100/1000 Line Cards

## PoE Linecards



**WS-X4648-RJ45V+E**

- E-Series (**24G/slot**) 48p 10/100/1000 RJ45
- 30W/ port (**IEEE802.3at** standard PoEP) on up to **24** ports
- Re-use existing chassis, power supplies
- PoE policing and monitoring
- EnergyWise
- Jumbo frame support



**WS-X4748-UPOE+E**

- E-Series (**48G/ slot**) 48p 10/100/1000 RJ45
- 30W/ port (**IEEE802.3at** standard PoEP) on **48** ports
- **IEEE 802.1AE MACSec** on all ports
- **60W on 24 ports**, 1500W line card budget
- EnergyWise
- Jumbo frame support

## Data



**WS-X4648-RJ45-E**

- E-Series (**24G/slot**) 48p 10/100/1000 RJ45
- E-series Supervisors only
- Jumbo frame support



**WS-X4748-RJ45V-E**

- E-Series (**48G/ slot**) 48p 10/100/1000 RJ45
- **Energy Efficient Ethernet (EEE) 802.3az**
- **IEEE 802.1AE MACSec** on all ports
- Jumbo Frame support

**24G (E-Series)**

**48G (E-Series)**



# Catalyst 4500E:Fiber Line-Cards Portfolio

## 10G Fiber Line Card

96 10G SFP+

TrustSec and MACSec



WS-X4712-SFP+E

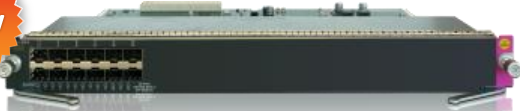


WS-X4606-X2-E

## 1G Fiber Line Card

384 1G SFP, Line rate

TrustSec and MACSec



WS-X4712-SFP-E



WS-X4724-SFP-E



WS-X4612-SFP-E/ WS-X4624-SFP-E



WS-X4748-SFP-E

## FTTx Fiber Line Card

400 1G CSFP/SFP

TrustSec and MACSec



WS-X4748-SFP-E



WS-X4640-CSFP-E



WS-X4448-GB-SFP



Catalyst 4500 Power Supplies

# Catalyst 4500E 4200W Power Supply



Voltage	Inputs	Redundancy Mode	Max PoE (15W) Devices	Max PoEP (30W) Devices	Max UPOE (60W) Devices
110 V	Single	Redundant	54	27	13
		Combined	98	50	25
	Dual	Redundant	109	56	28
		Combined	198	102	51
220 V	Single	Redundant	109	56	28
		Combined	198	102	51
	Dual	Redundant	218	112	56
		Combined	384	204	90

# Catalyst 4500E 6000W Power Supply



Voltage	Inputs	Redundancy Mode	Max PoE (15W) Devices	Max PoEP (30W) Devices	Max UPOE (60W) Devices
110 V	Single	Redundant	54	27	13
		Combined	98	50	25
	Dual	Redundant	109	56	28
		Combined	198	102	50
220 V	Single	Redundant	141	72	36
		Combined	257	132	65
	Dual	Redundant	283	145	70
		Combined	384	262	120

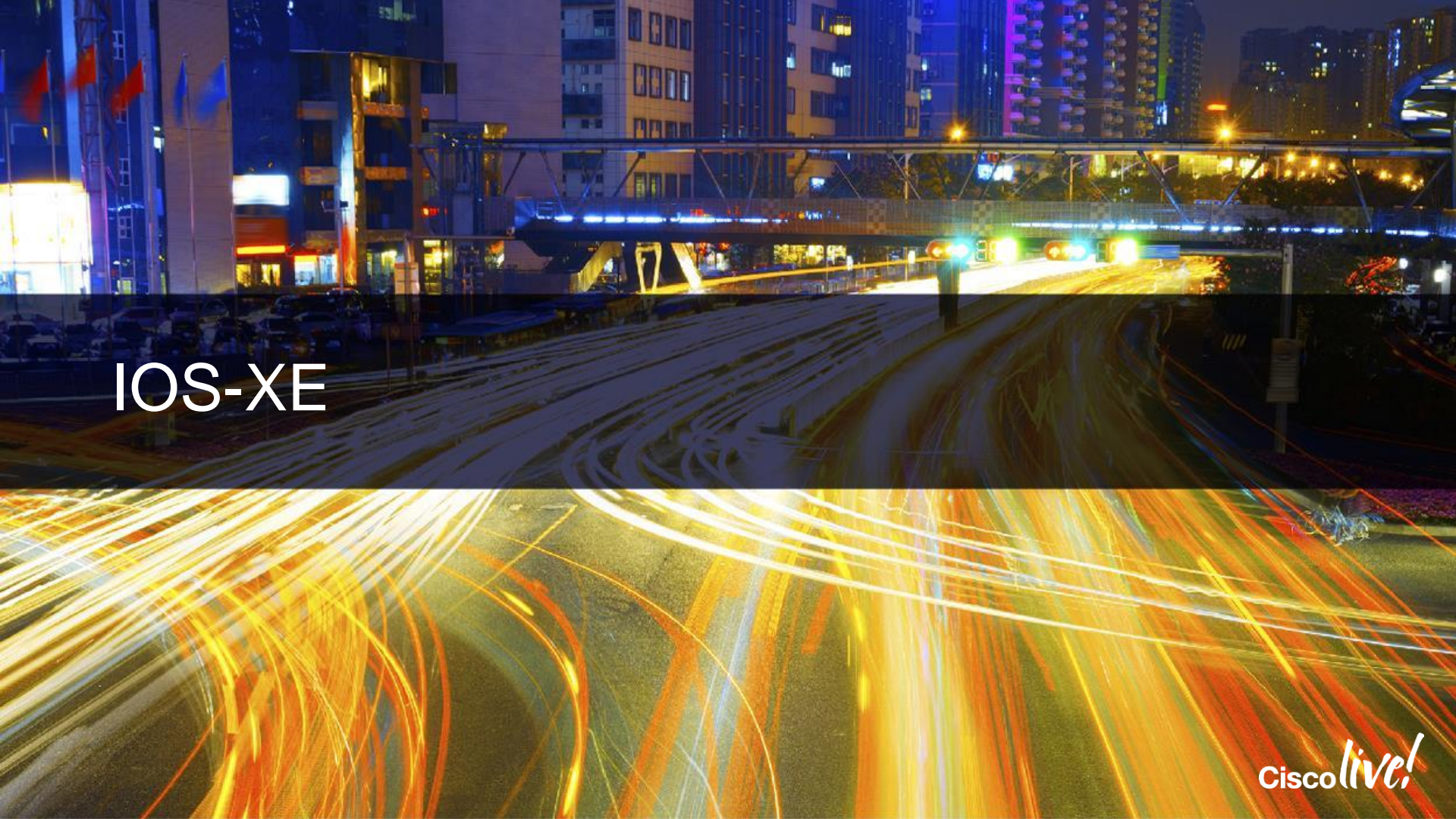
# Catalyst 4500E 9000W Power Supply



For Your Reference



Voltage	Inputs	Redundancy Mode	Max PoE (15W) Devices	Max PoEP (30W) Devices	Max UPOE (60W) Devices
110 V	Single	Redundant	62	31	15
		Combined	88	44	22
	Dual	Redundant	126	62	31
		Combined	210	102	51
	Triple	Redundant	152	76	38
		Combined	262	128	64
220 V	Single	Redundant	116	58	29
		Combined	236	118	59
	Dual	Redundant	306	153	76
		Combined	384	240	120
	Triple	Redundant	384	232	116
		Combined	384	232	116



IOS-XE

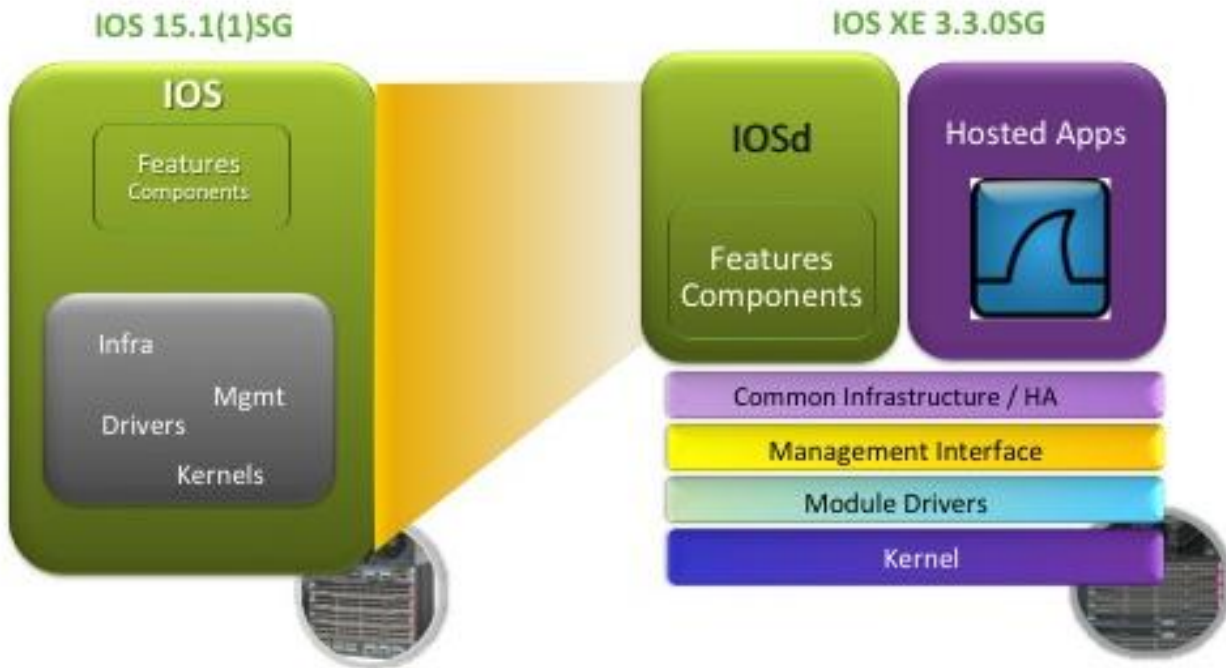
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# IOS XE Architecture

## Enabling Integrated Open Service Platform

### IOS-XE

- Modern IOS to enable multi-core CPU
- Same IOS functionality, look and feel
- Support for hosted applications like Wireshark



A nighttime photograph of a city street with light trails from cars and buildings in the background. The scene is illuminated by city lights, and the foreground shows blurred streaks of light from moving vehicles.

# Catalyst 4500-X Fixed 10GE Aggregation Switch



# Catalyst 4500-X Aggregation Portfolio

## Catalyst 4500-X PORTFOLIO



WS-C4500X-40X-ES



WS-C4500X-32SFP+



WS-C4500X-24X-ES



WS-C4500X-F-16SFP+

Software Release: IOS-XE 3.3.0 SG

### Front to Back Airflow

Burgandy color fan and P/S handle



### Back to Front Airflow

Blue color fan and P/S handle



8-port 10GE Modular Uplink Module C4KX-NM-8SFP+



Removable Fan Module

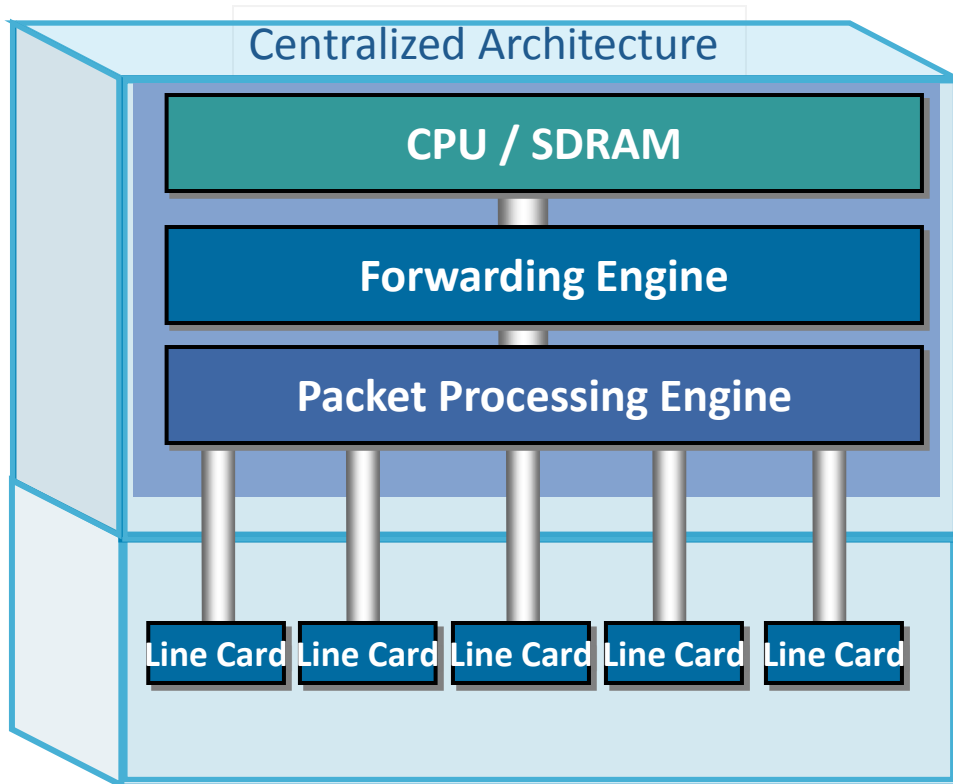


750WAC Modular P/S

A long-exposure photograph of a city street at night. The foreground is dominated by vibrant, multi-colored light trails from moving vehicles, creating a sense of motion and energy. In the background, a modern pedestrian bridge with a glass railing spans across the street. The surrounding buildings are illuminated with various lights, and a traffic light is visible in the distance. The overall scene is a dynamic urban environment.

# Catalyst 4500E Architecture

# Catalyst 4500E Architecture

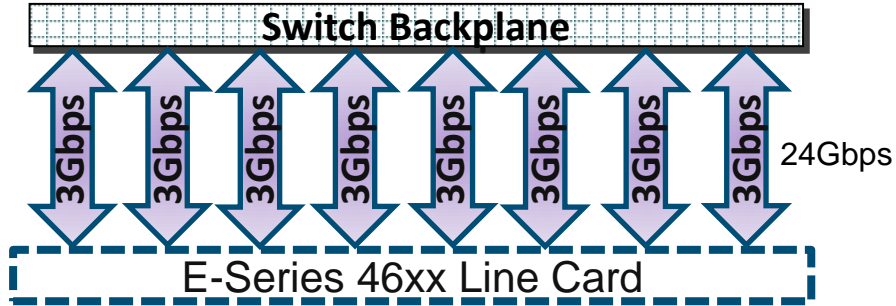


- Shared memory switch  
**Passive Backplane**
- All forwarding, queuing, security is implemented on the Supervisor
- The individual **line cards** are considered to be '**transparent**' and contain "stub" ASICs and the PHYs
- Each **47XX-Series line card** has **48 Gbps** full- duplex connections to the central forwarding engine
- IOS XE that can leverage multi-core CPU, and ability to host applications separately outside IOS context



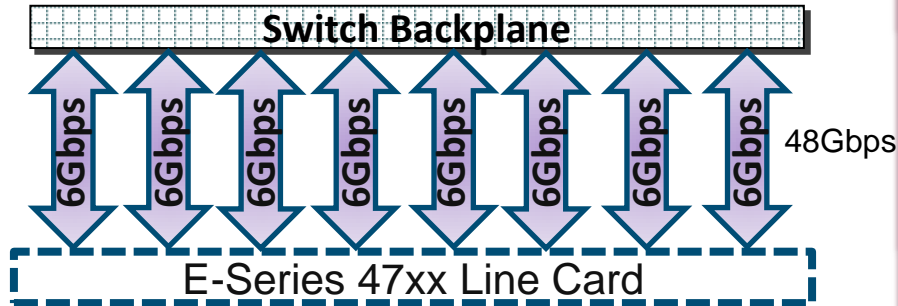
# Catalyst 4500E Line Card Architecture

# 46xx and 47xx Line Card Backplane Speeds



E-Series Chassis—Bandwidth per Slot with 46XX series line card:

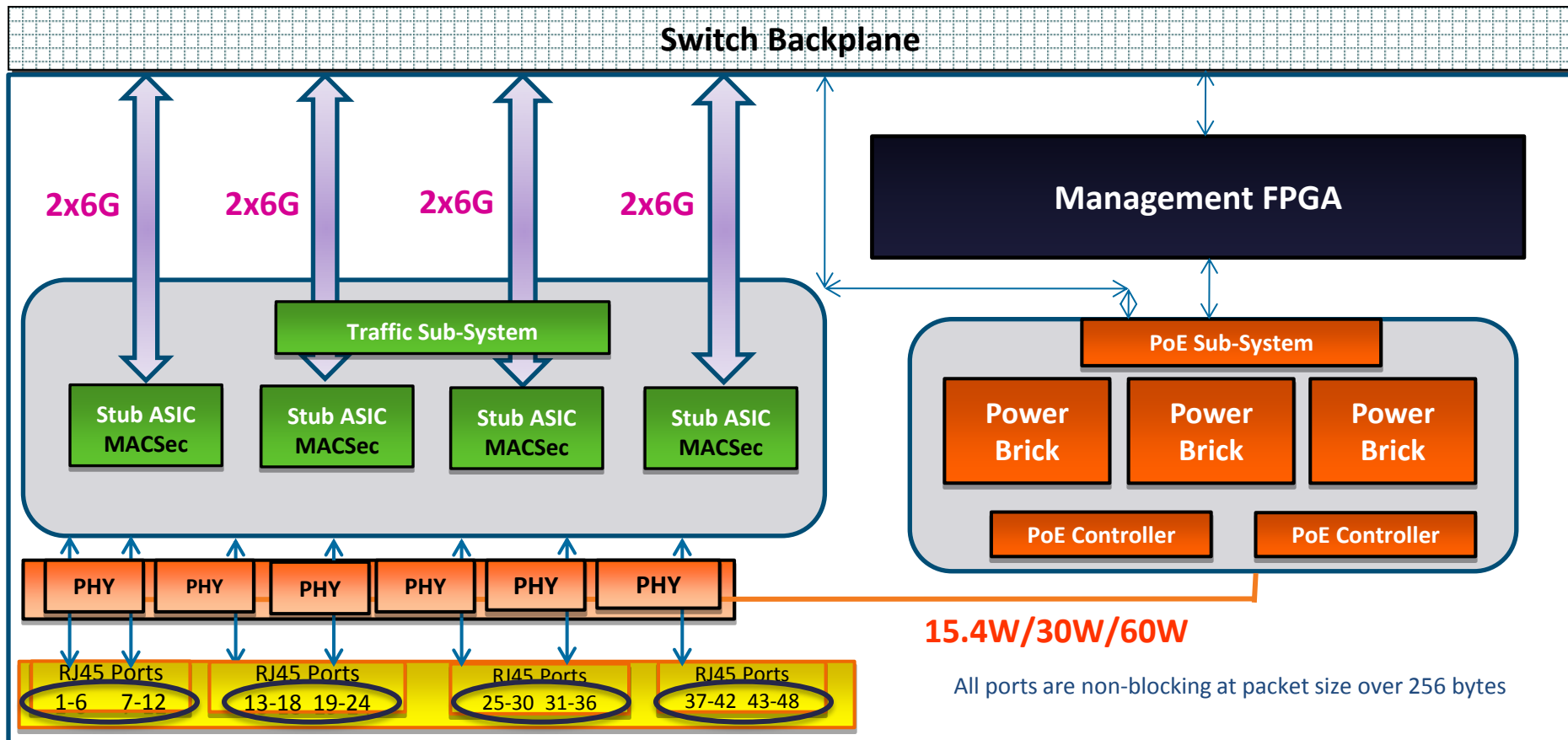
- 8 dedicated lanes to Supervisor
- Each lane operates at **3Gbps**



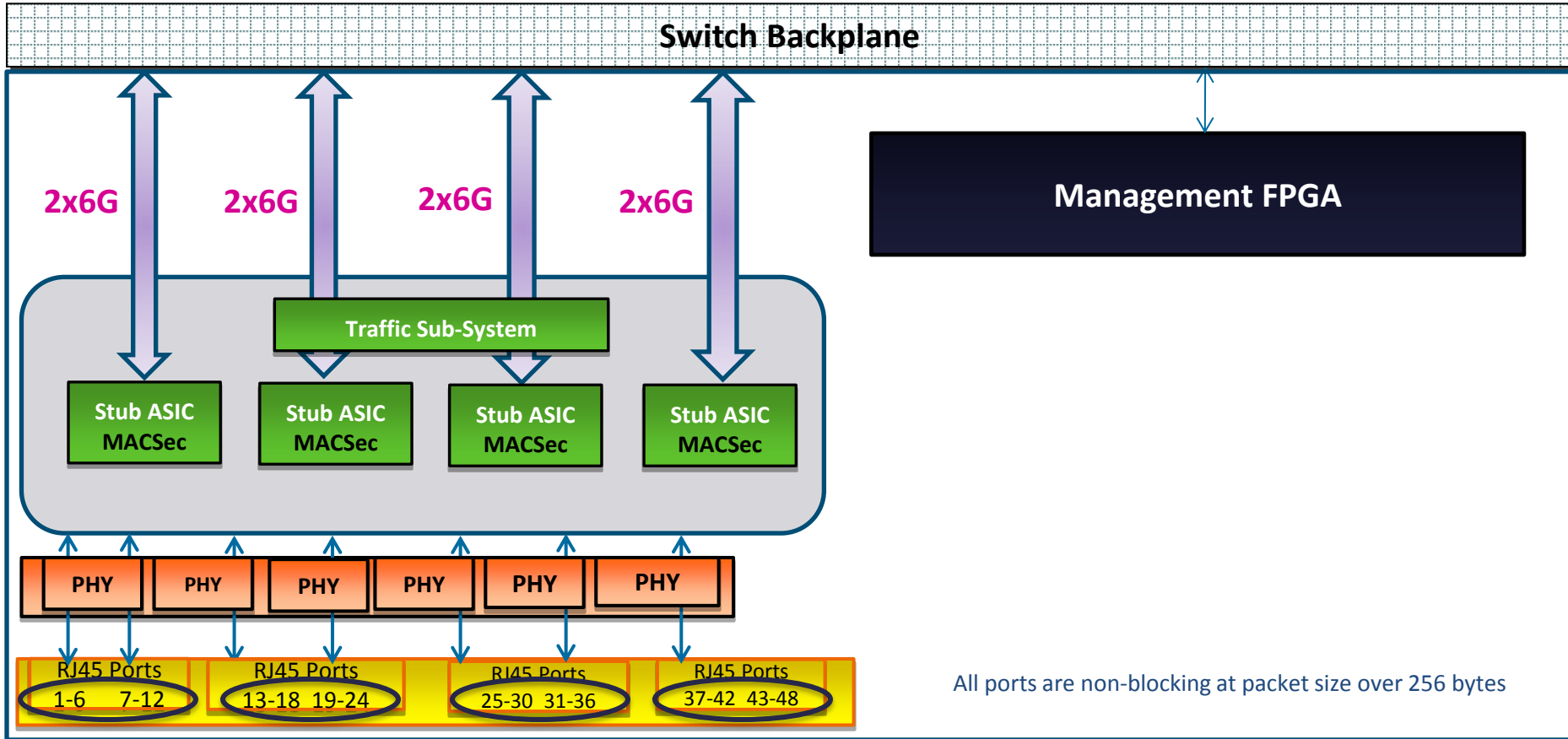
E-Series Chassis—Bandwidth per Slot with 47xx series line cards

- 8 dedicated lanes to Supervisor
- Each lane runs at **6Gbps**

# WS-X4748-UPOE+E Block Diagram

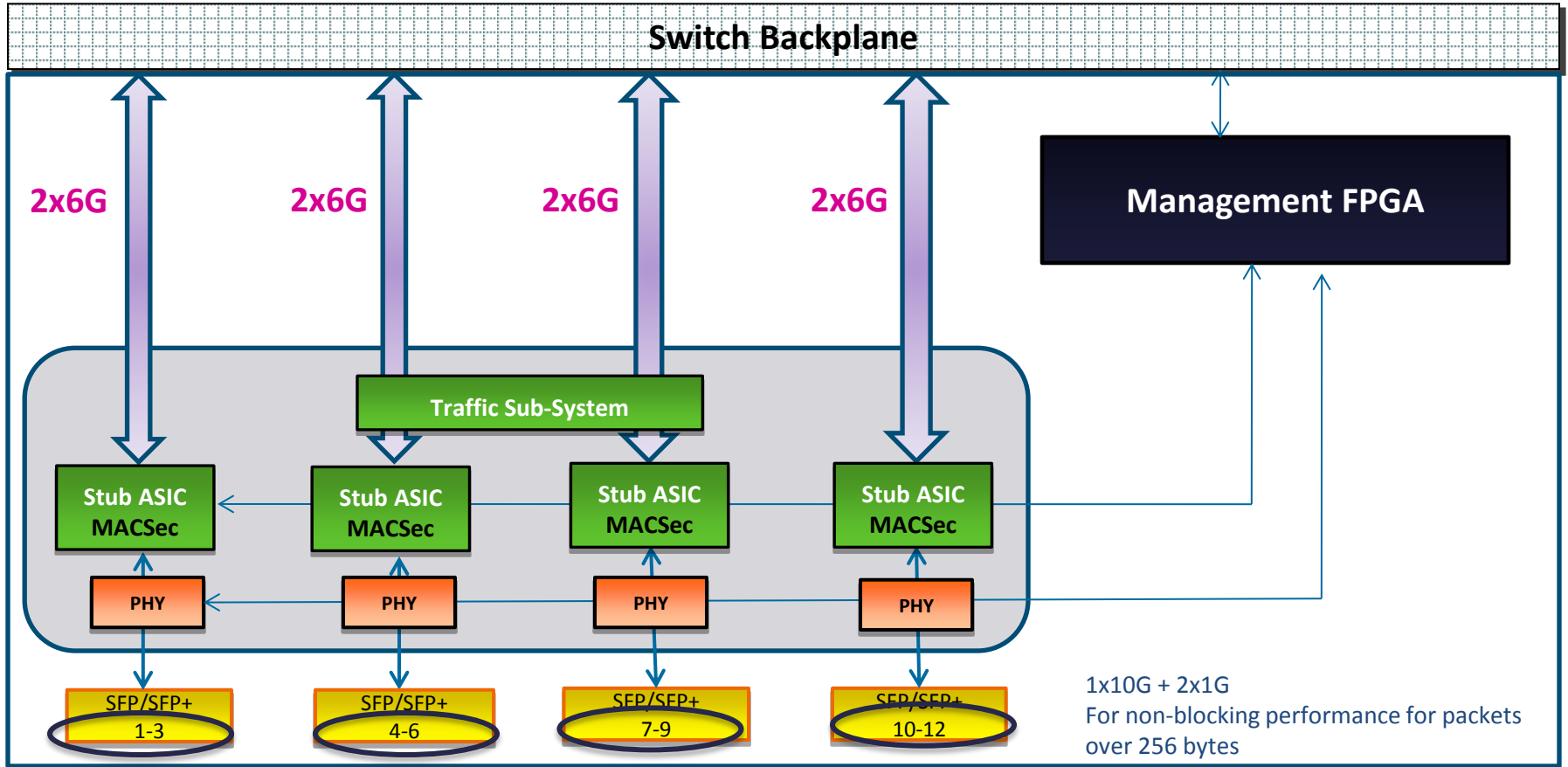


# WS-X4748-SFP-E Block Diagram



All ports are non-blocking at packet size over 256 bytes

# WS-X4712-SFP+E Block Diagram

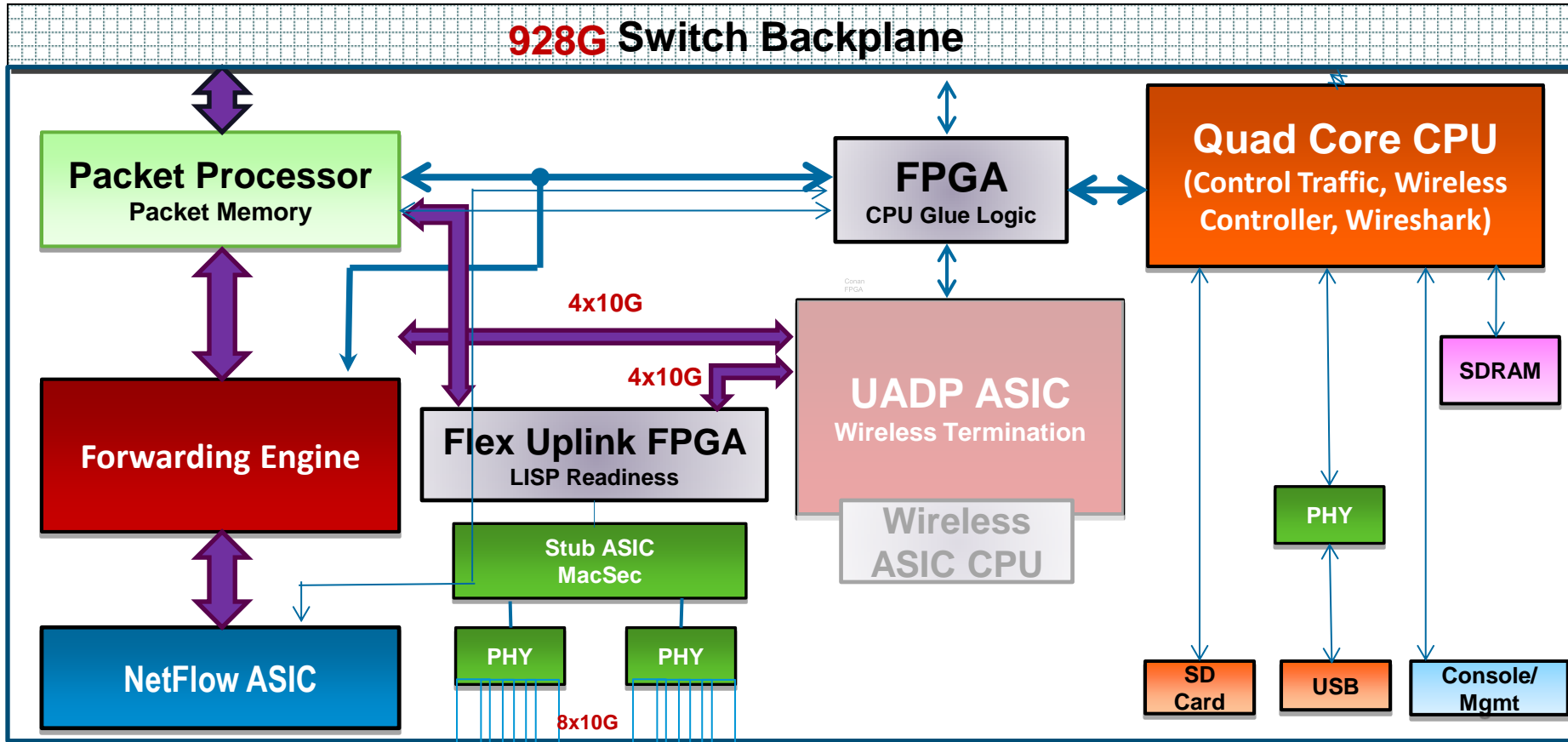




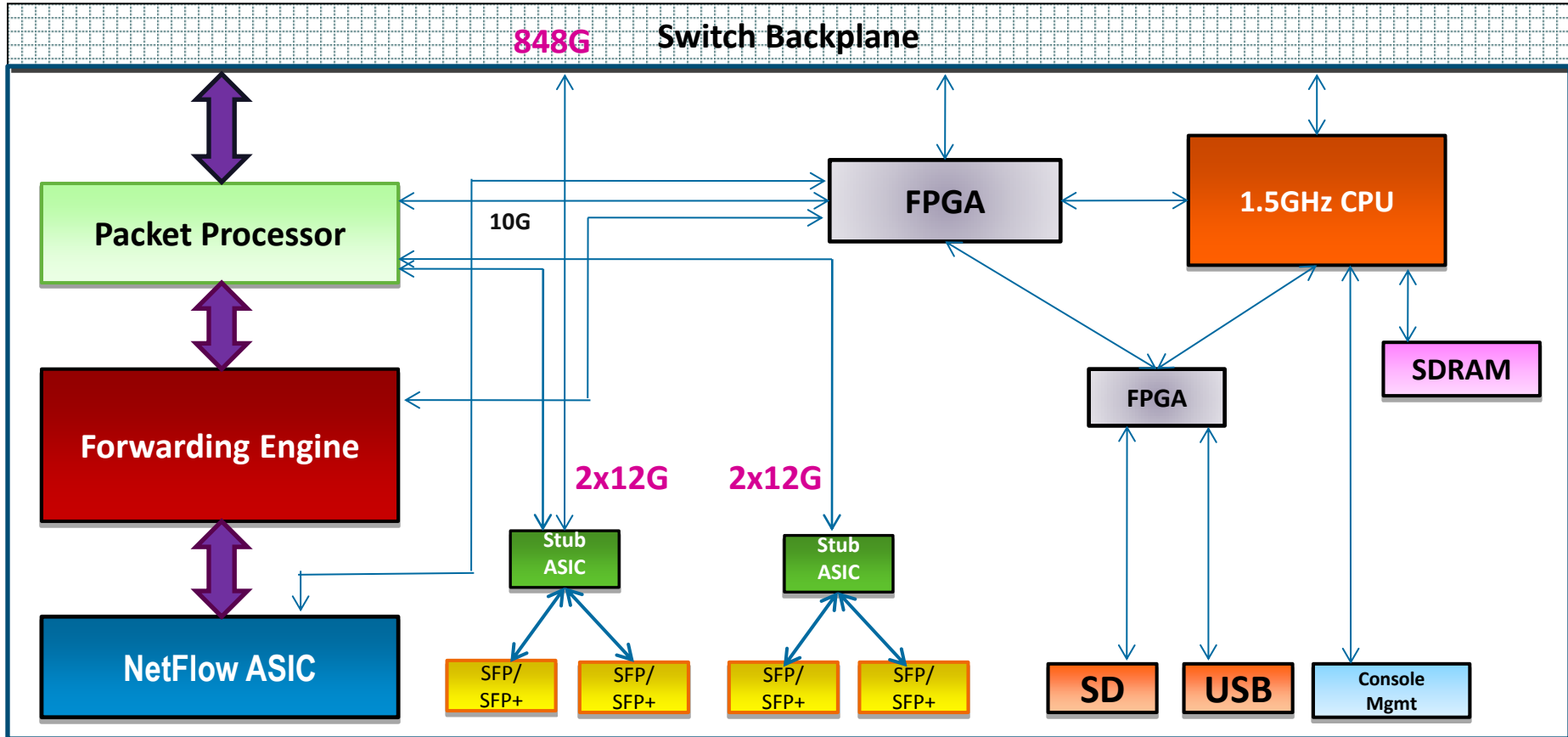
A nighttime photograph of a city street. In the foreground, there are long, curved light trails from cars, primarily in shades of yellow and orange. In the middle ground, a pedestrian bridge with a glass railing spans across the street. The background features several modern buildings with lit windows and some flags on poles. The overall scene is illuminated by city lights, creating a vibrant and dynamic atmosphere.

# Catalyst 4500E Supervisor Architecture

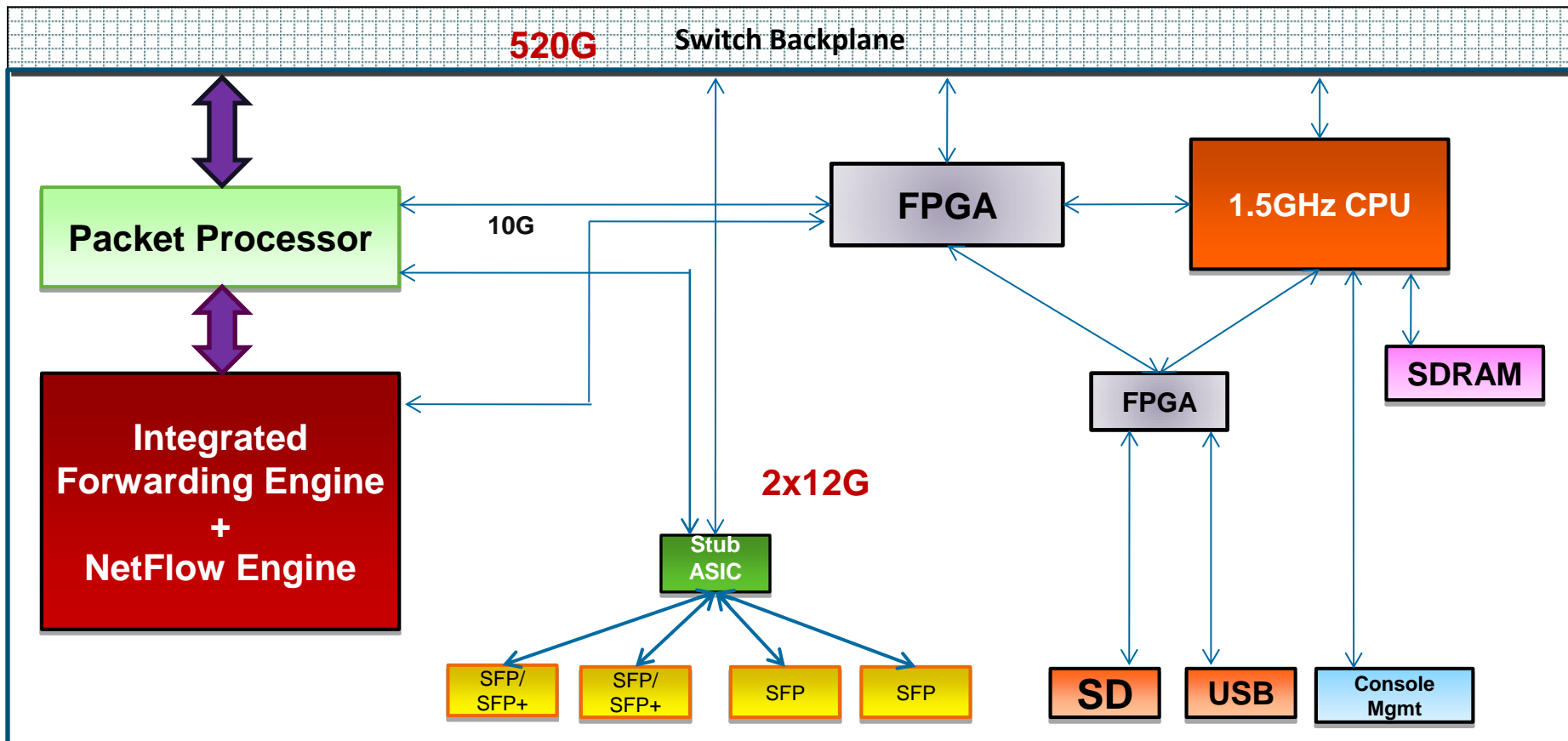
# Catalyst 4500E Supervisor 8-E Block Diagram



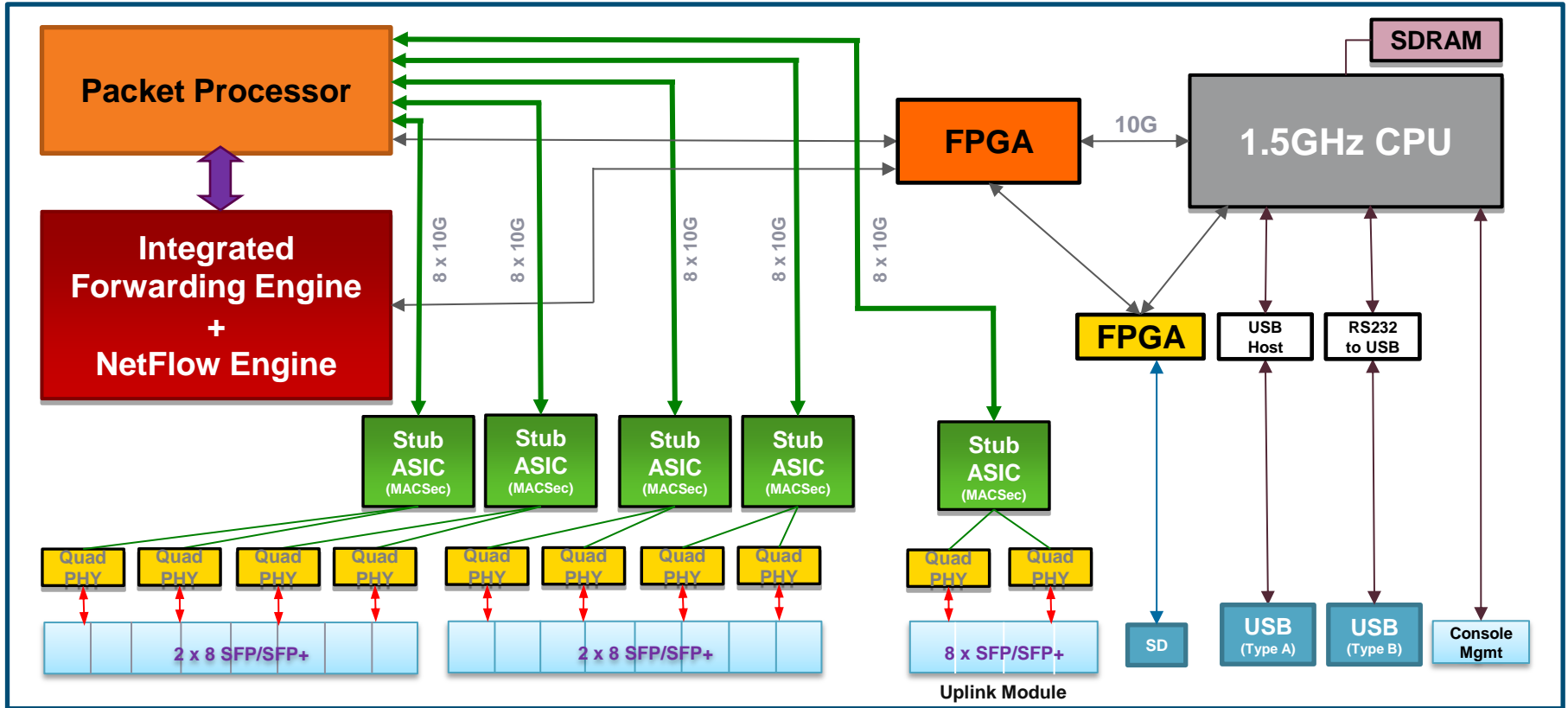
# Catalyst 4500E Supervisor 7-E Block Diagram



# Catalyst 4500E Supervisor 7L-E Block Diagram



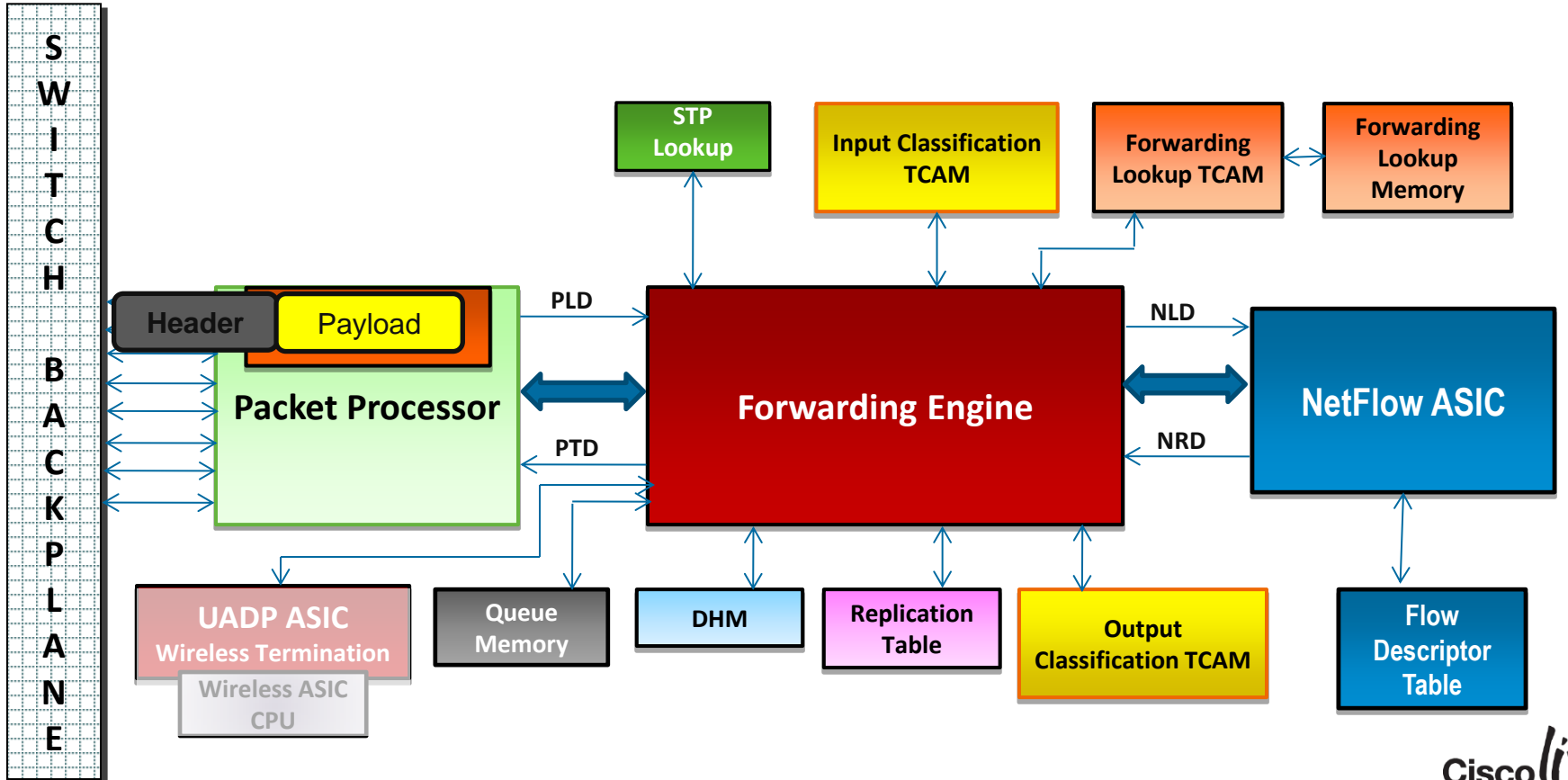
# Catalyst 4500-X Block Diagram





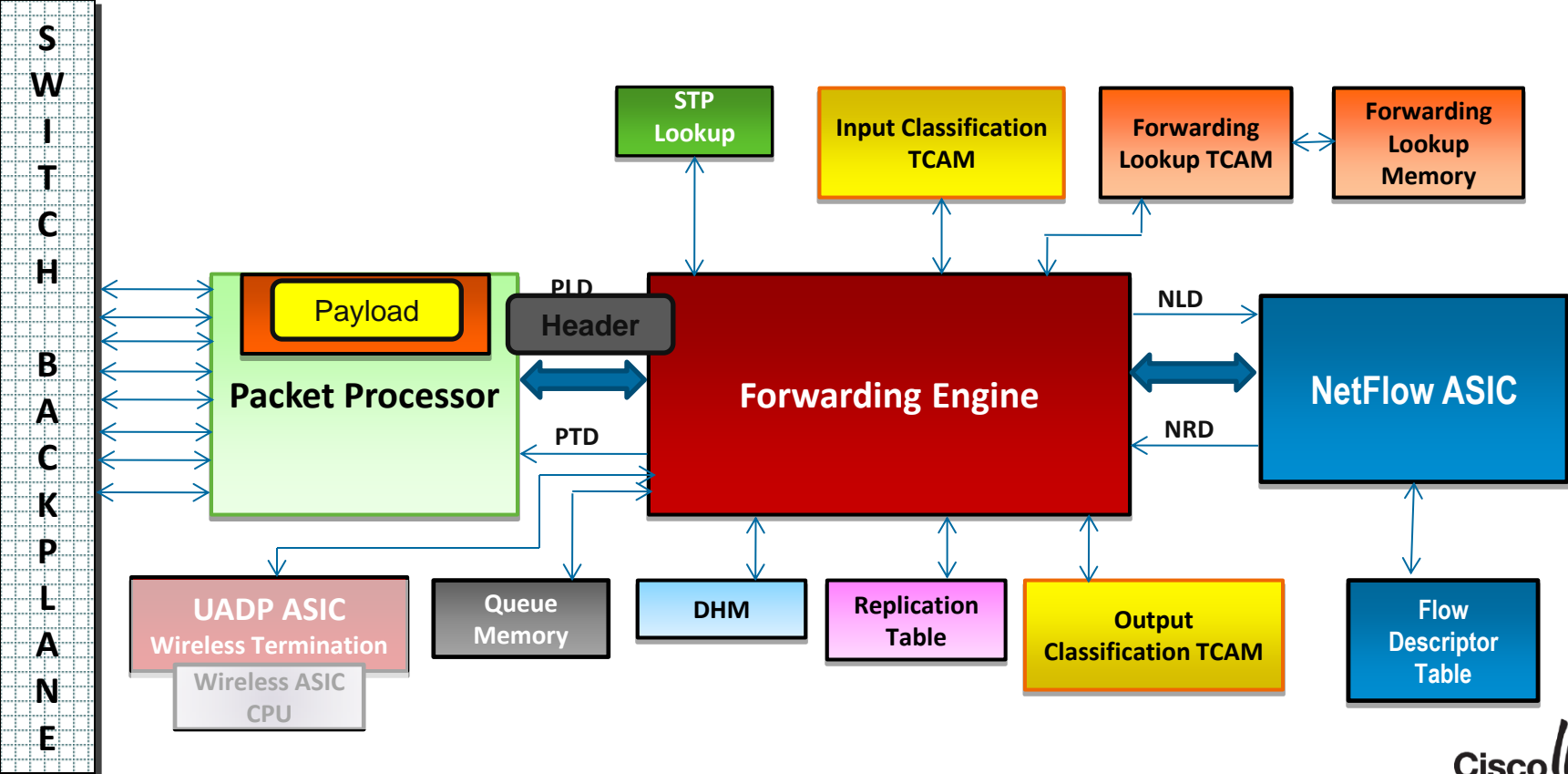
Catalyst 4500E – Unicast Packet Walk

# Supervisor Packet Walk – Packet Reception



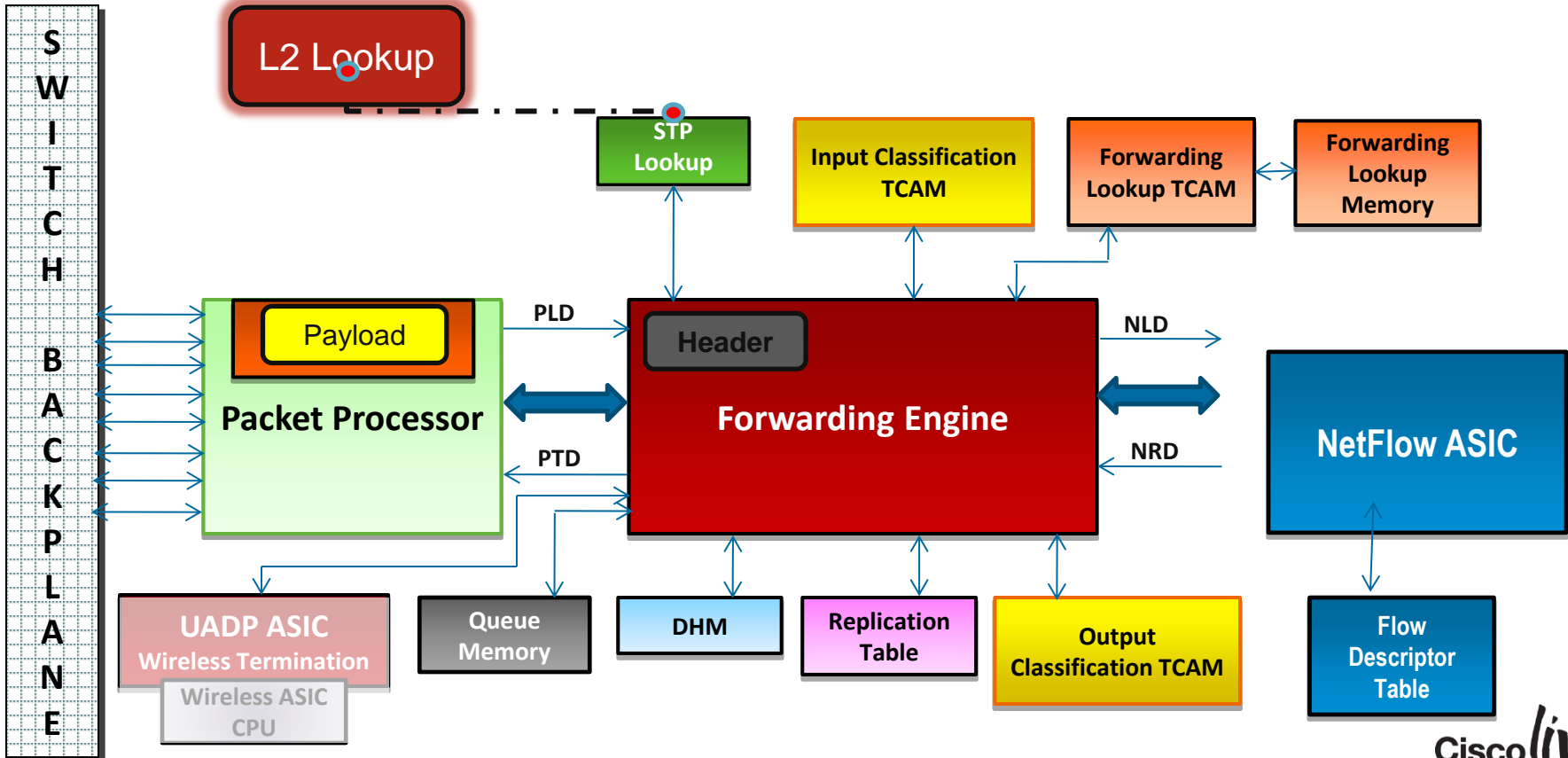
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# Supervisor Packet Walk – Pass PLD to FE

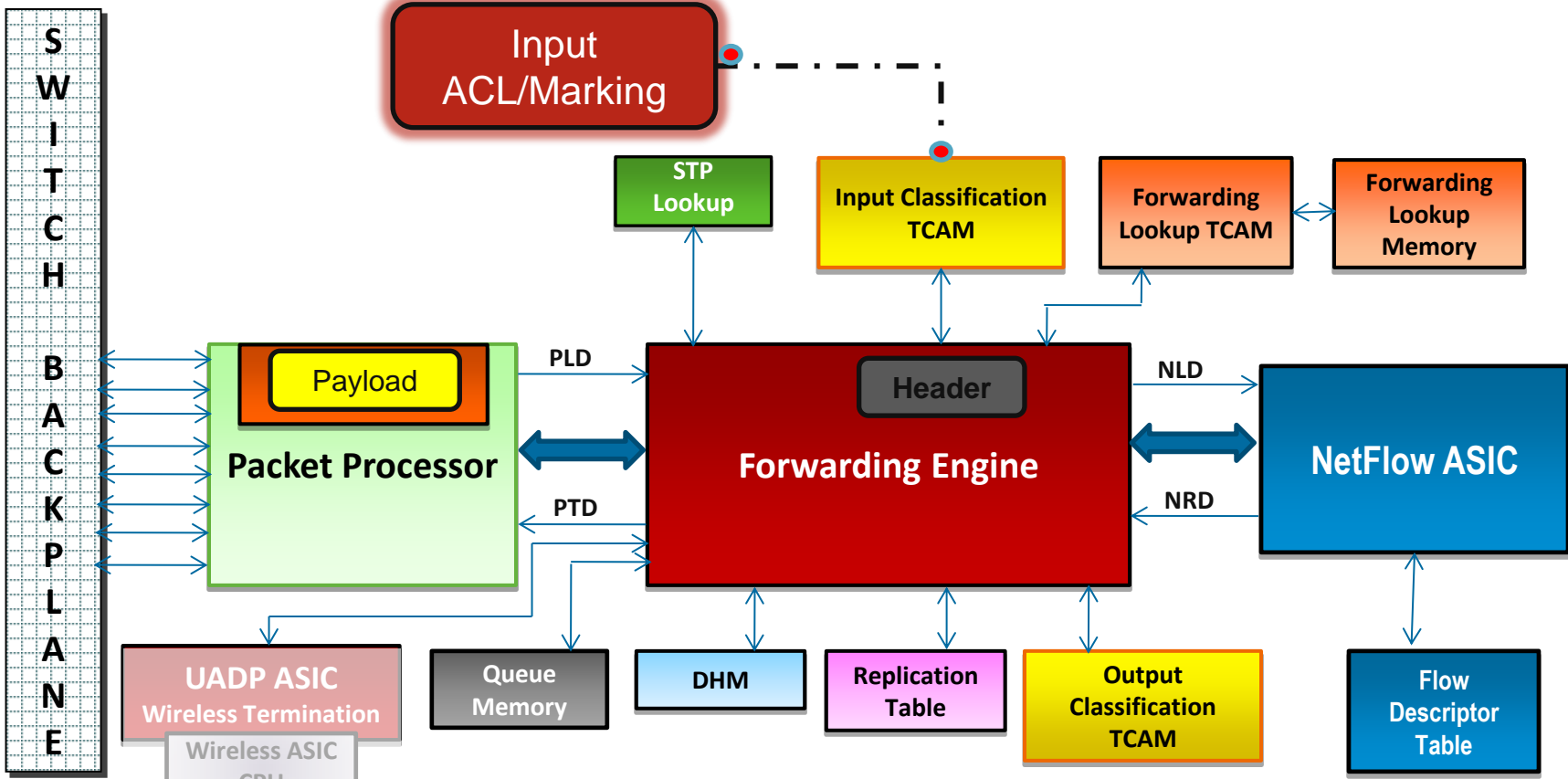




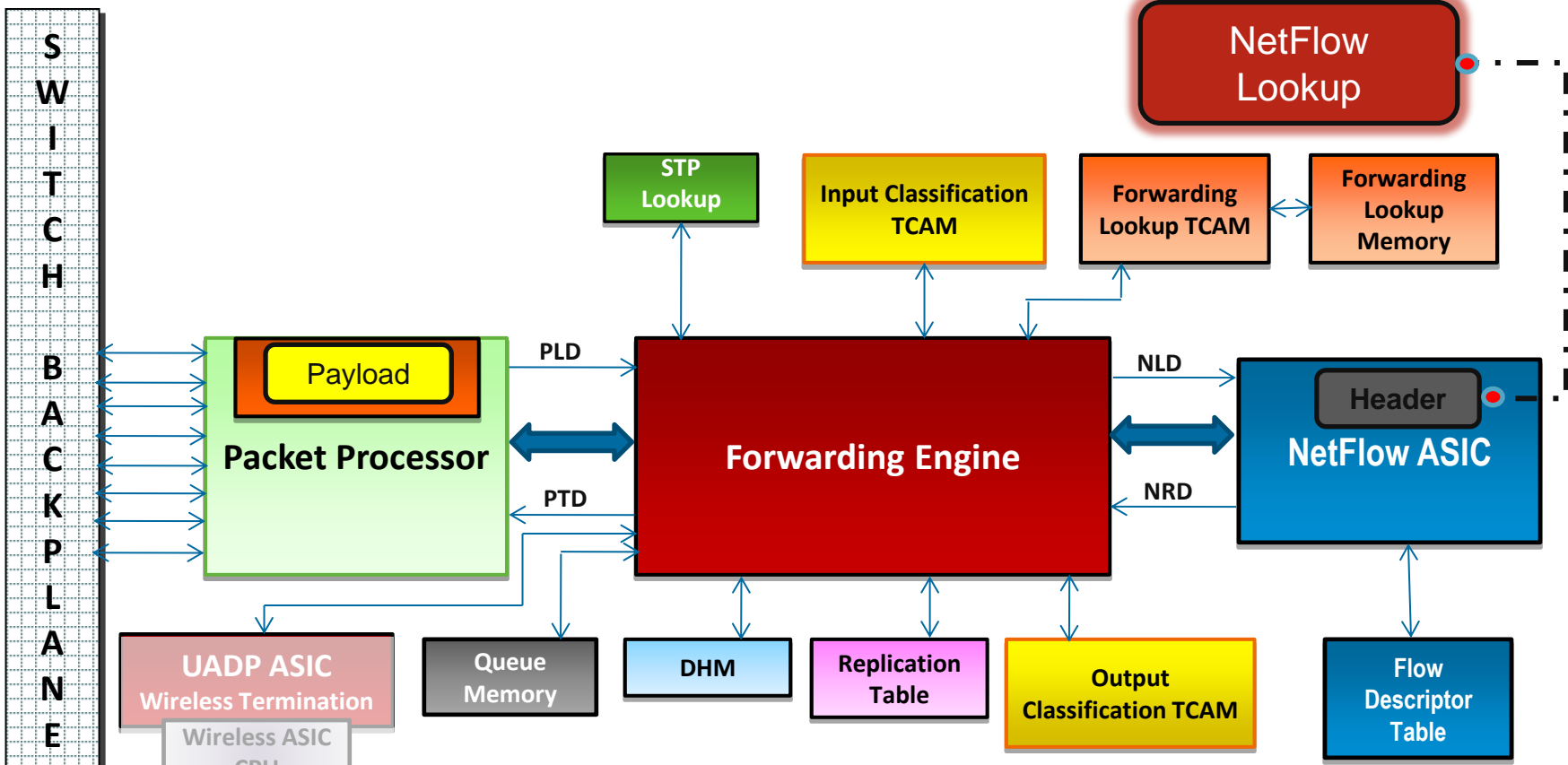
# Supervisor Packet Walk – L2 Lookup



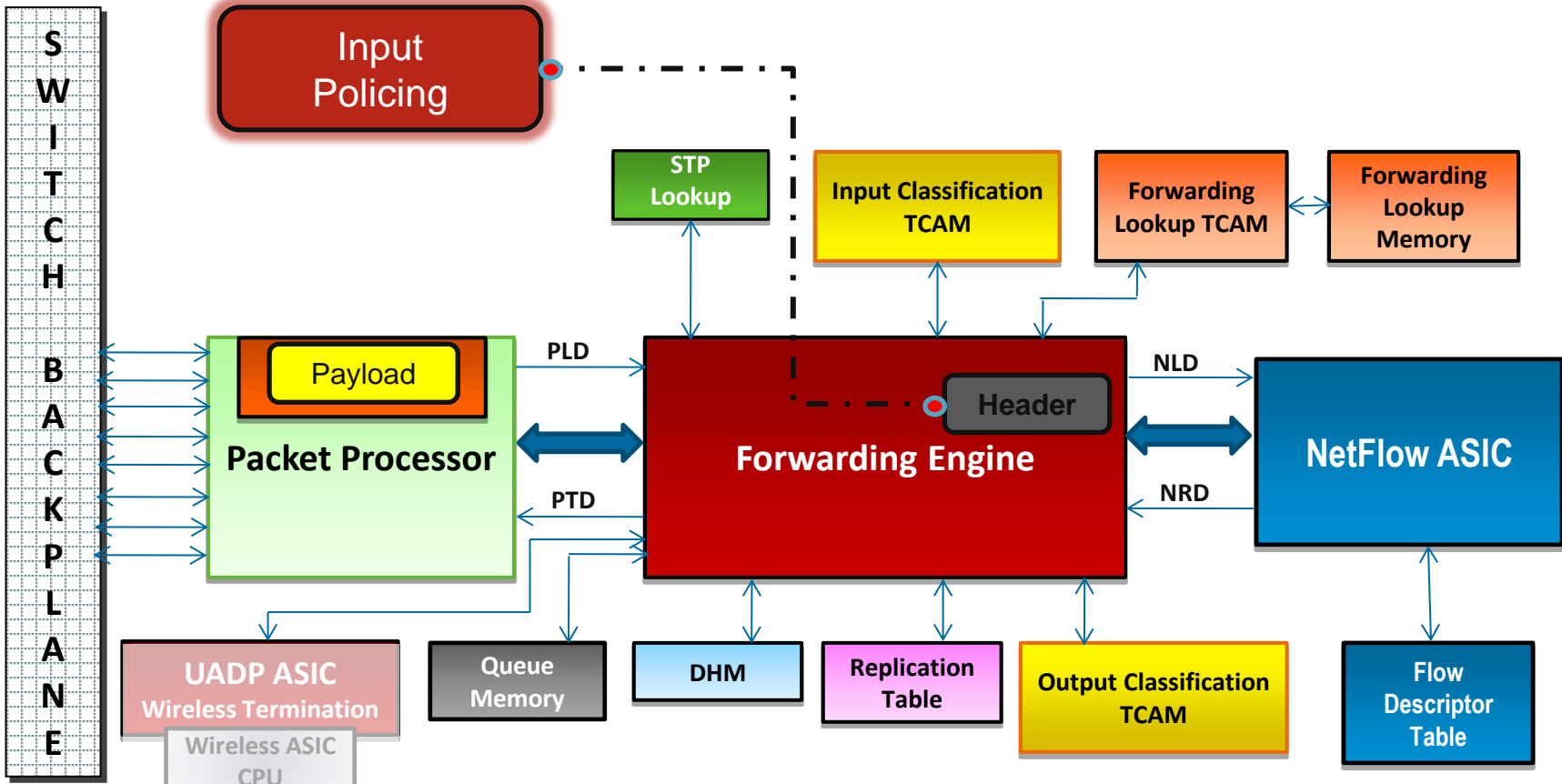
# Supervisor Packet Walk – Input ACL/QoS



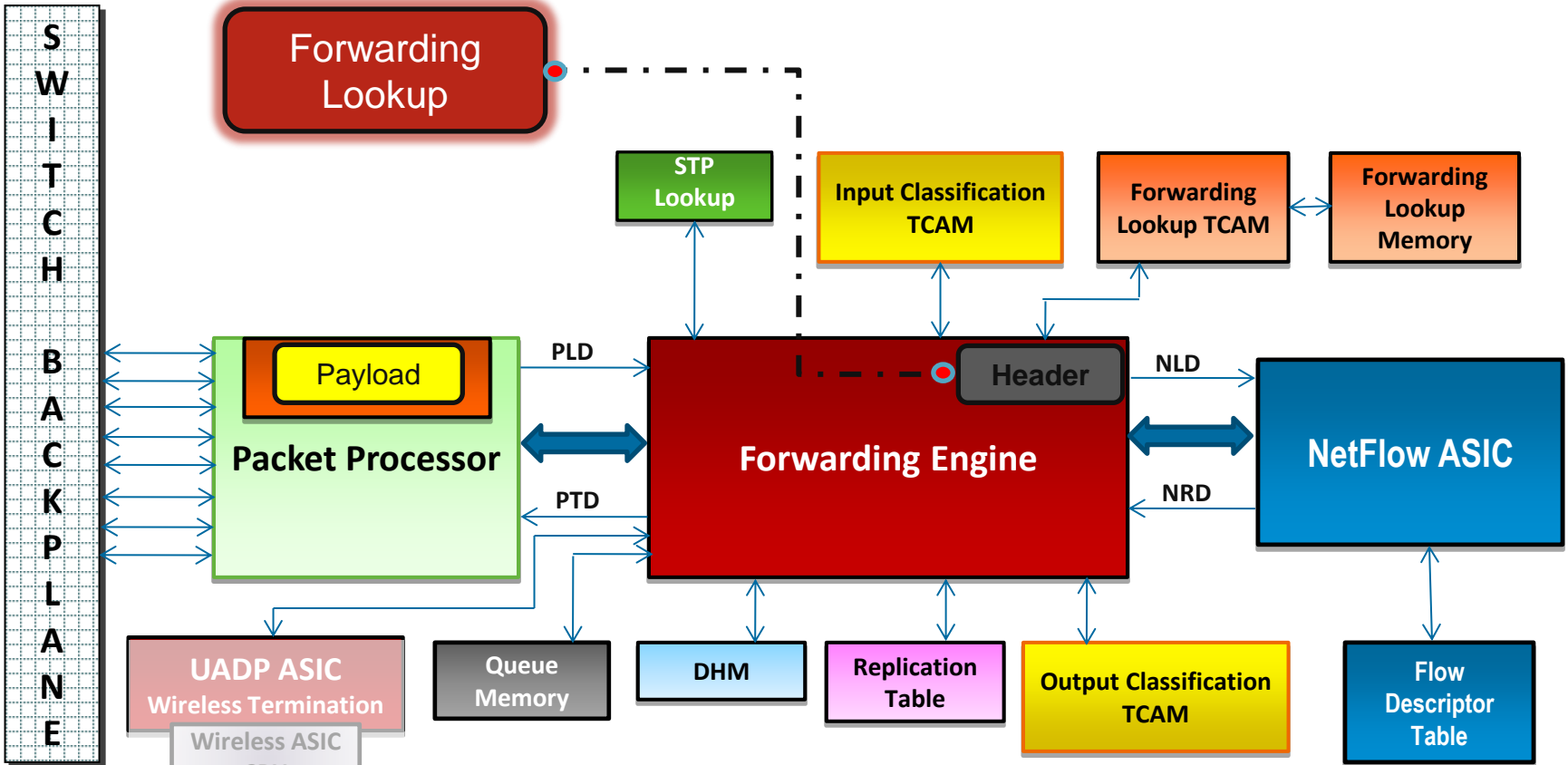
# Supervisor Packet Walk – NetFlow Lookup



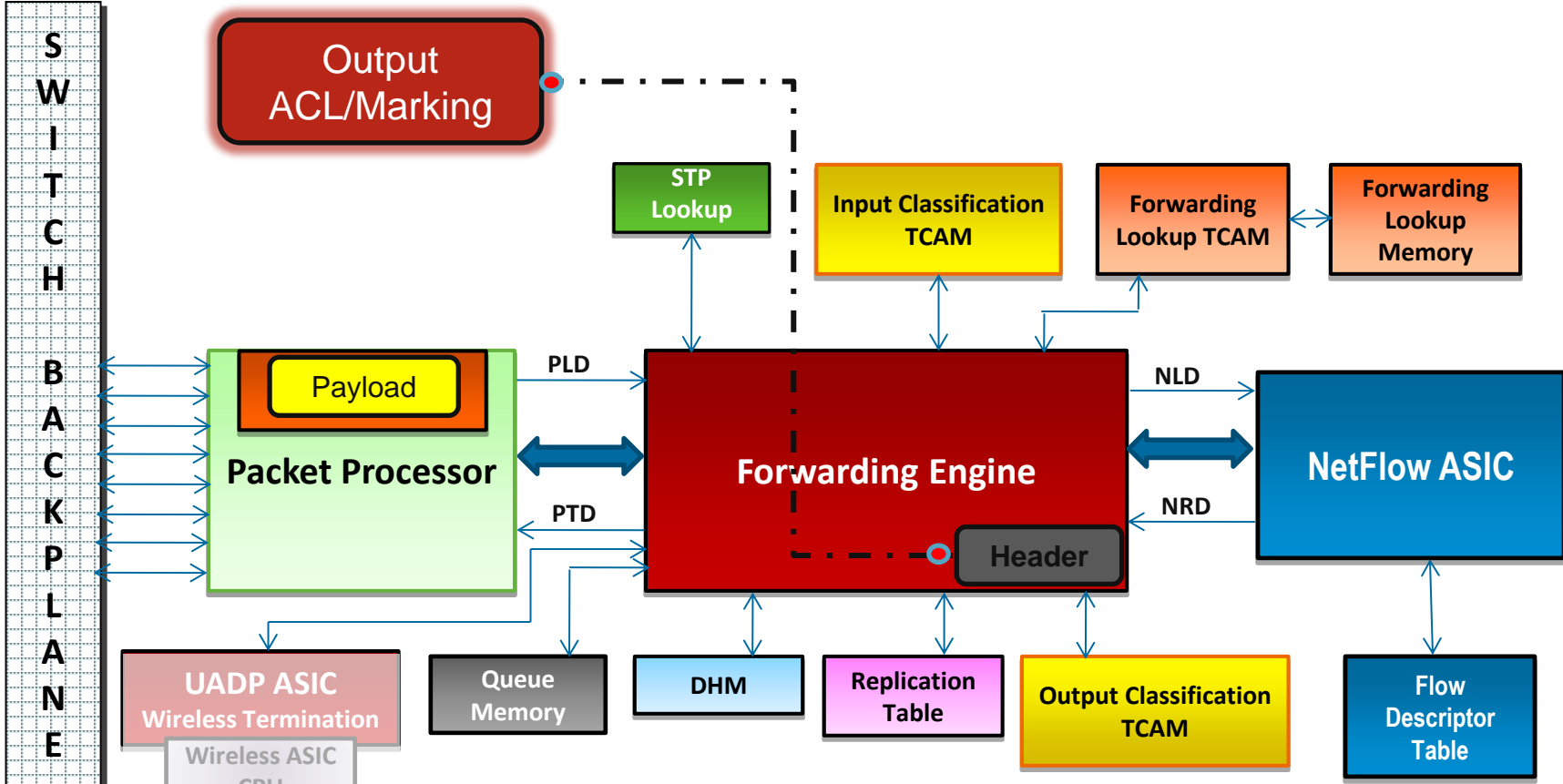
# Supervisor Packet Walk – Input Policing



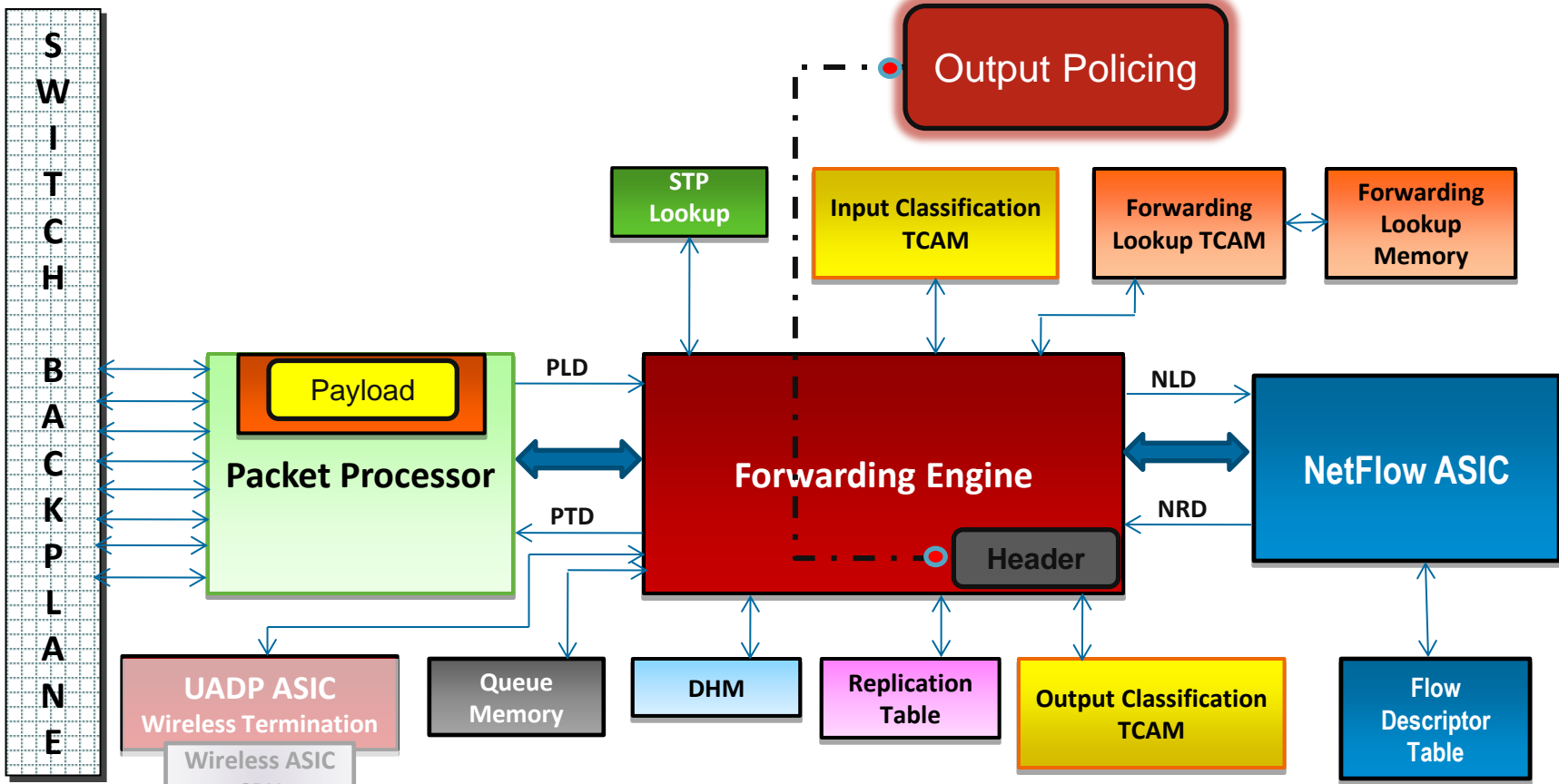
# Supervisor Packet Walk – Layer 3 Lookup



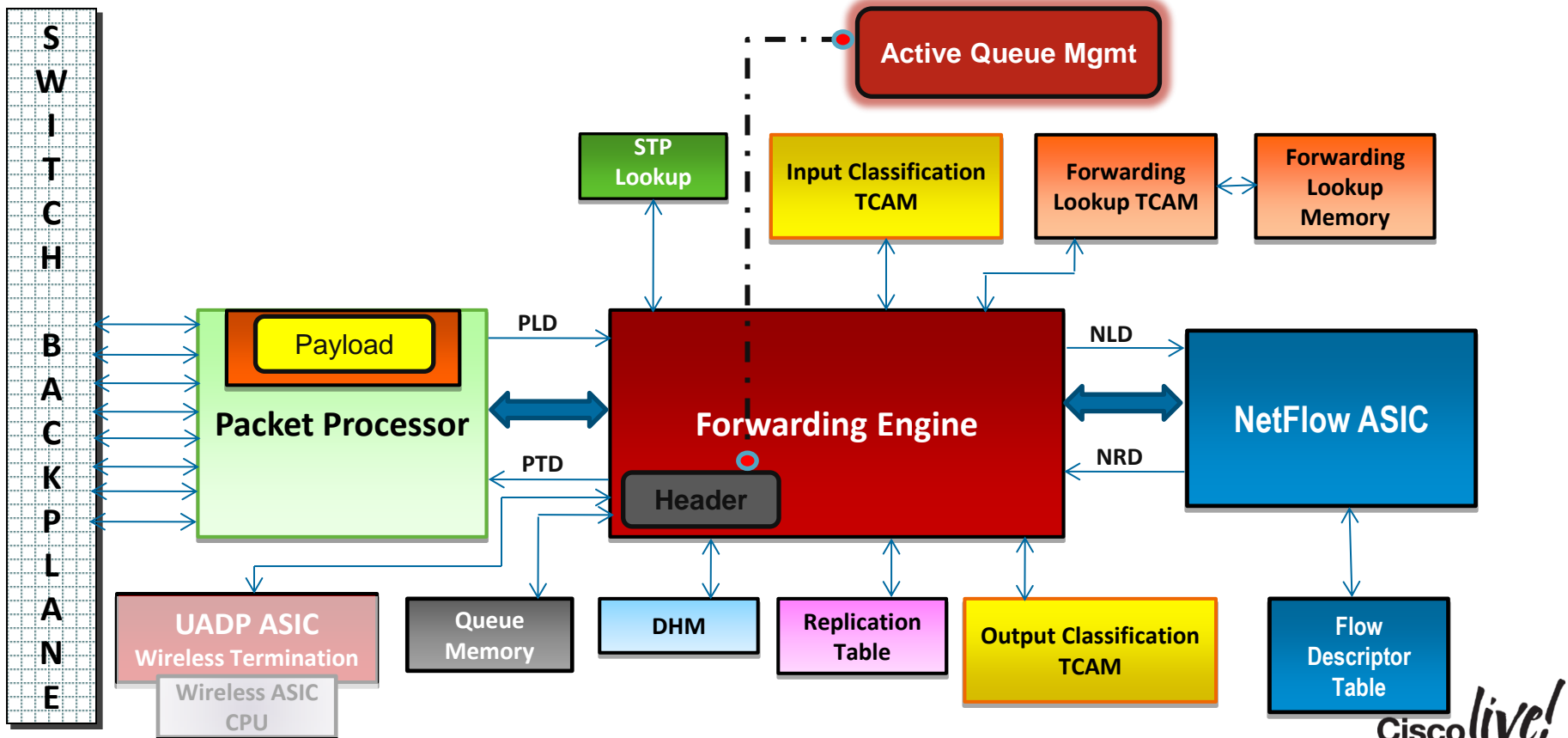
# Supervisor Packet Walk – Output ACL/QoS



# Supervisor Packet Walk – Output Policing

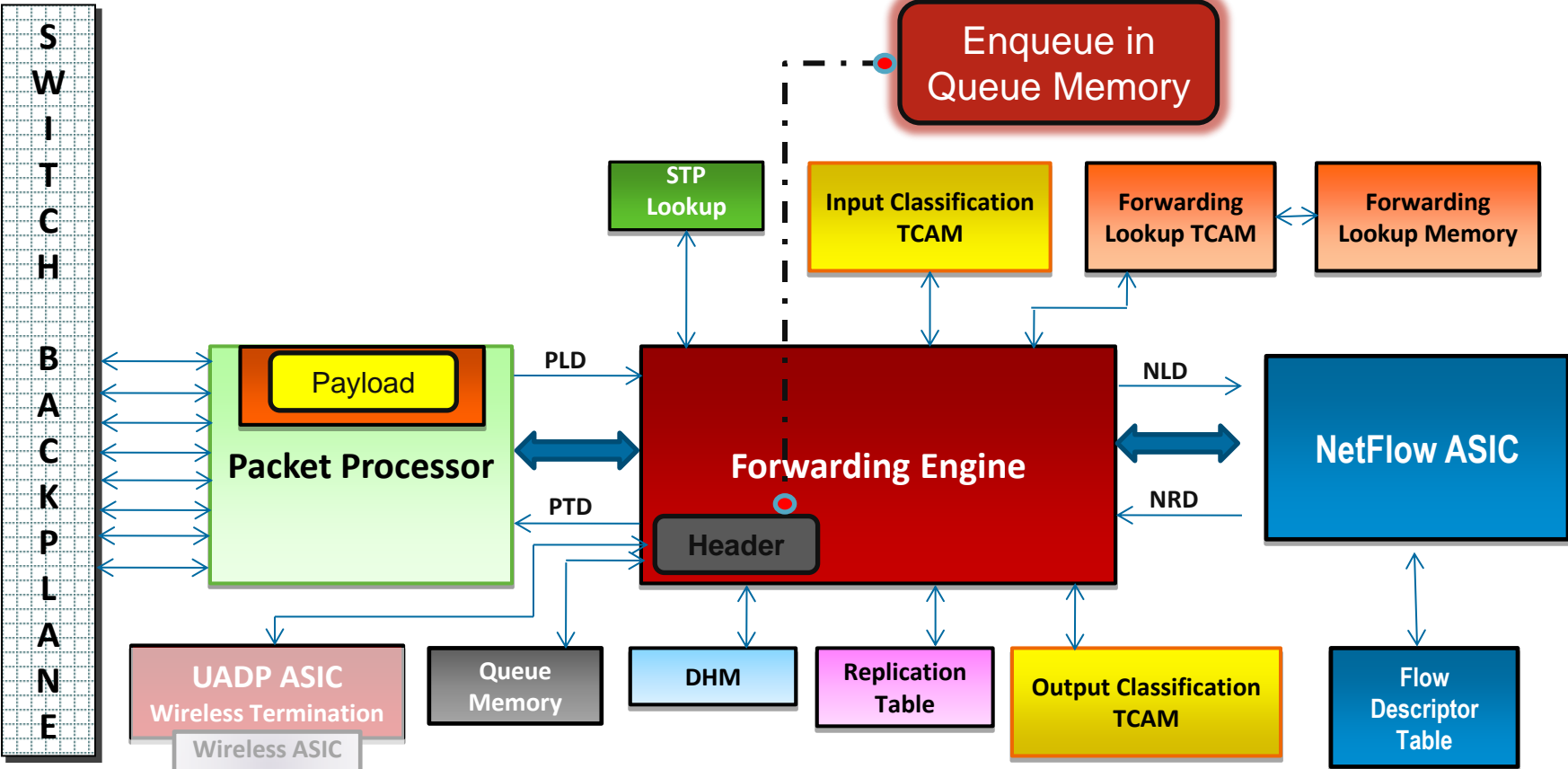


# Supervisor Packet Walk – DBL Processing

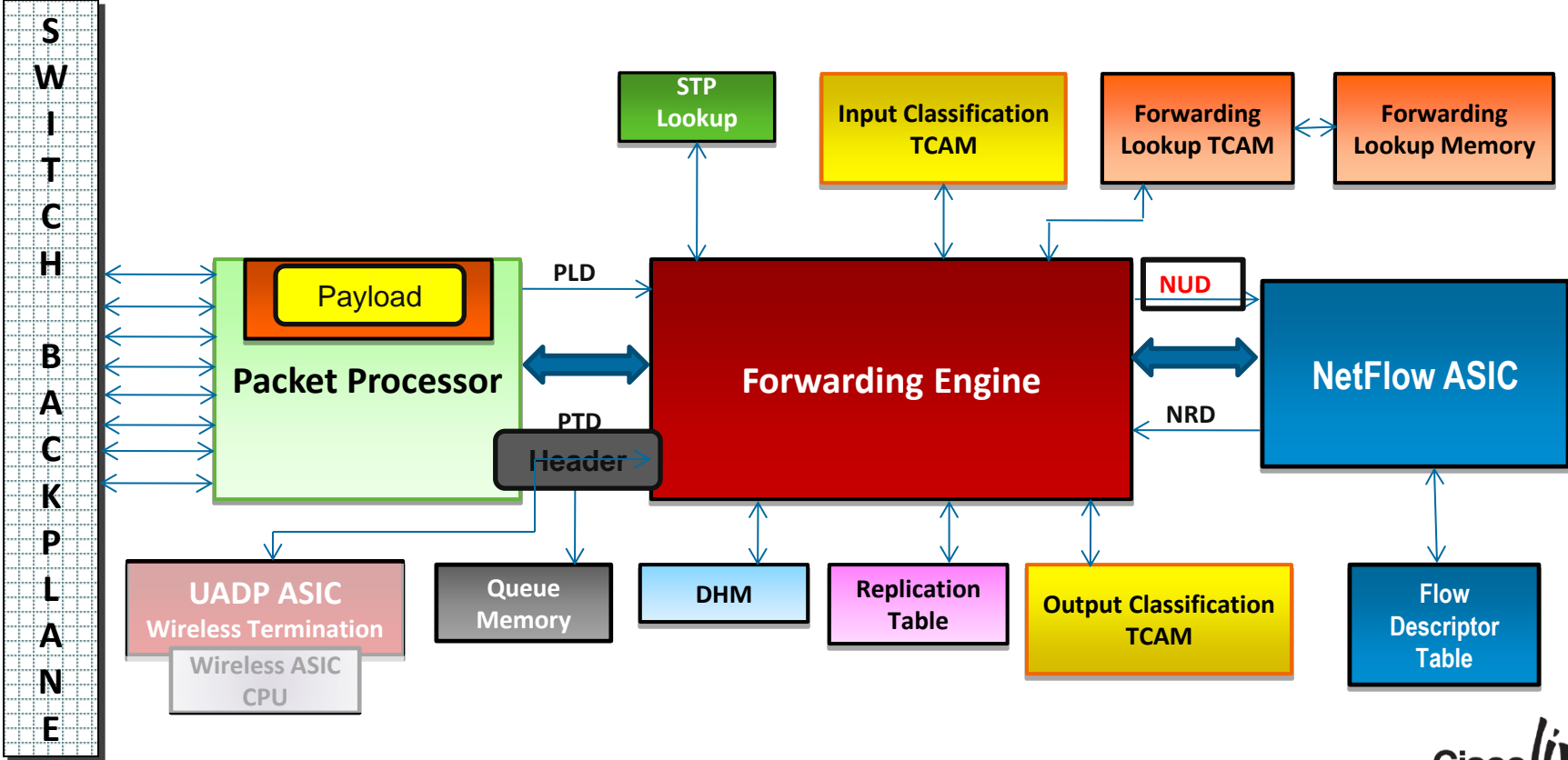




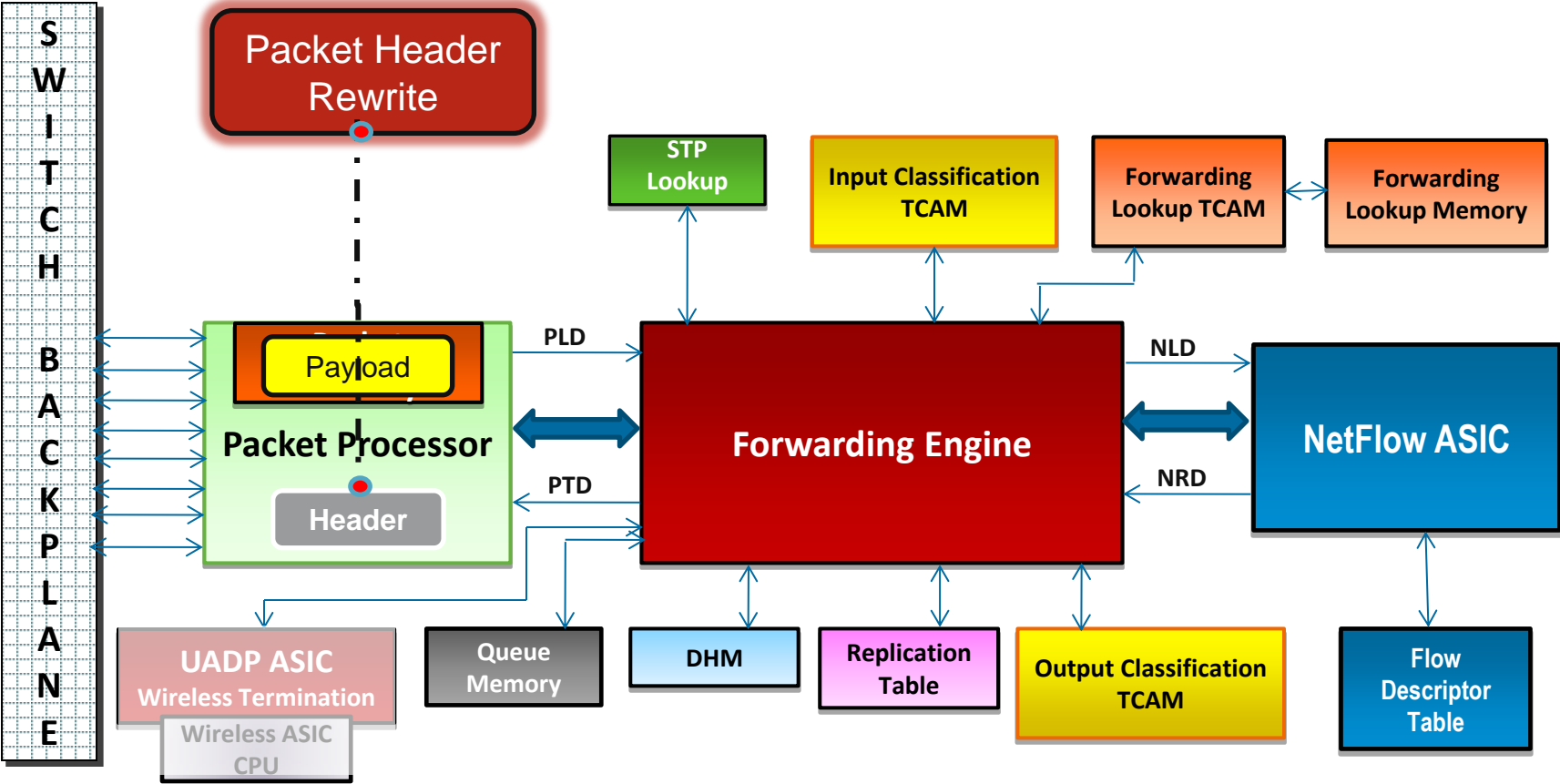
# Supervisor Packet Walk – Enqueue



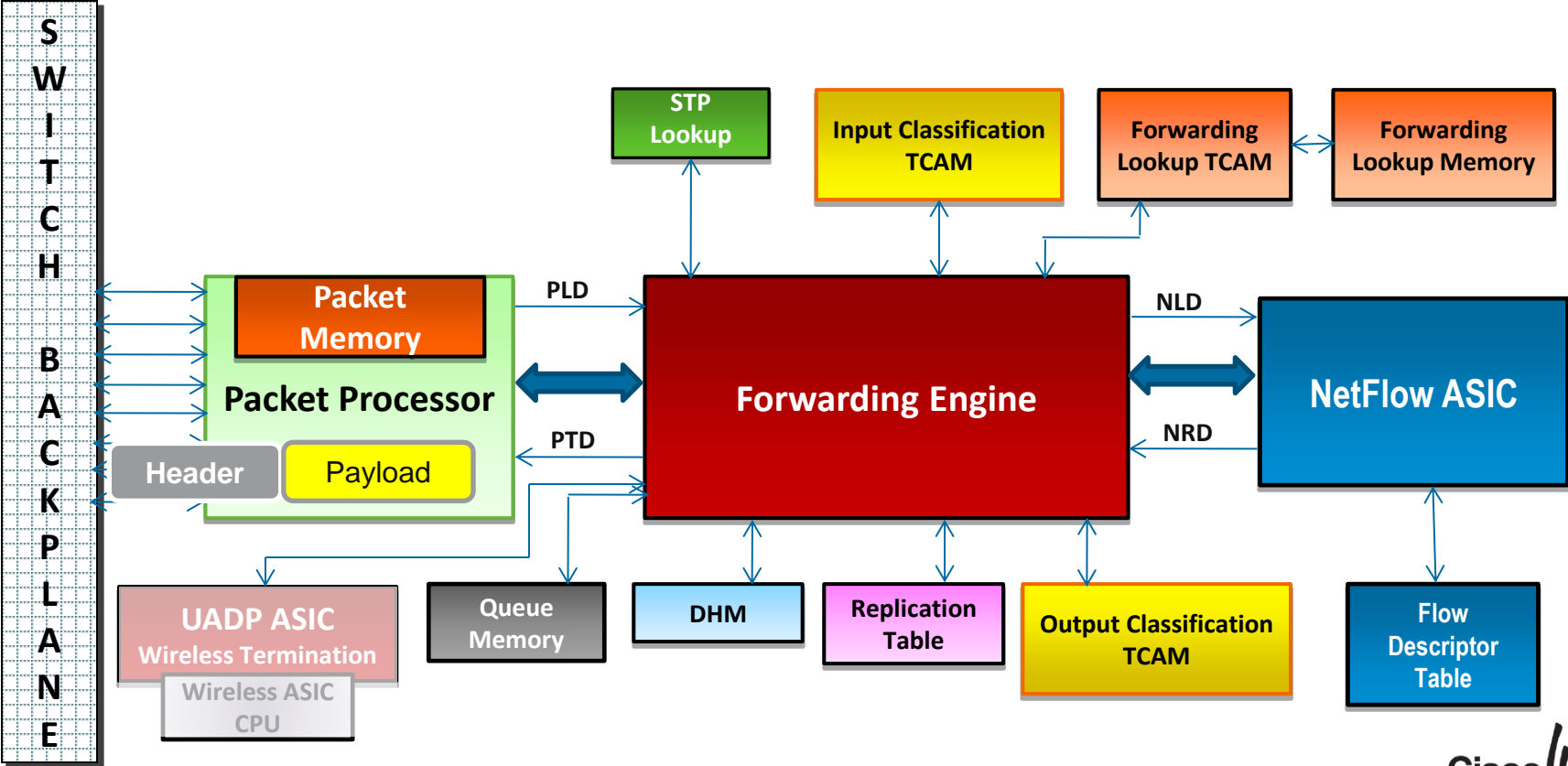
# Supervisor Packet Walk – Header to PP



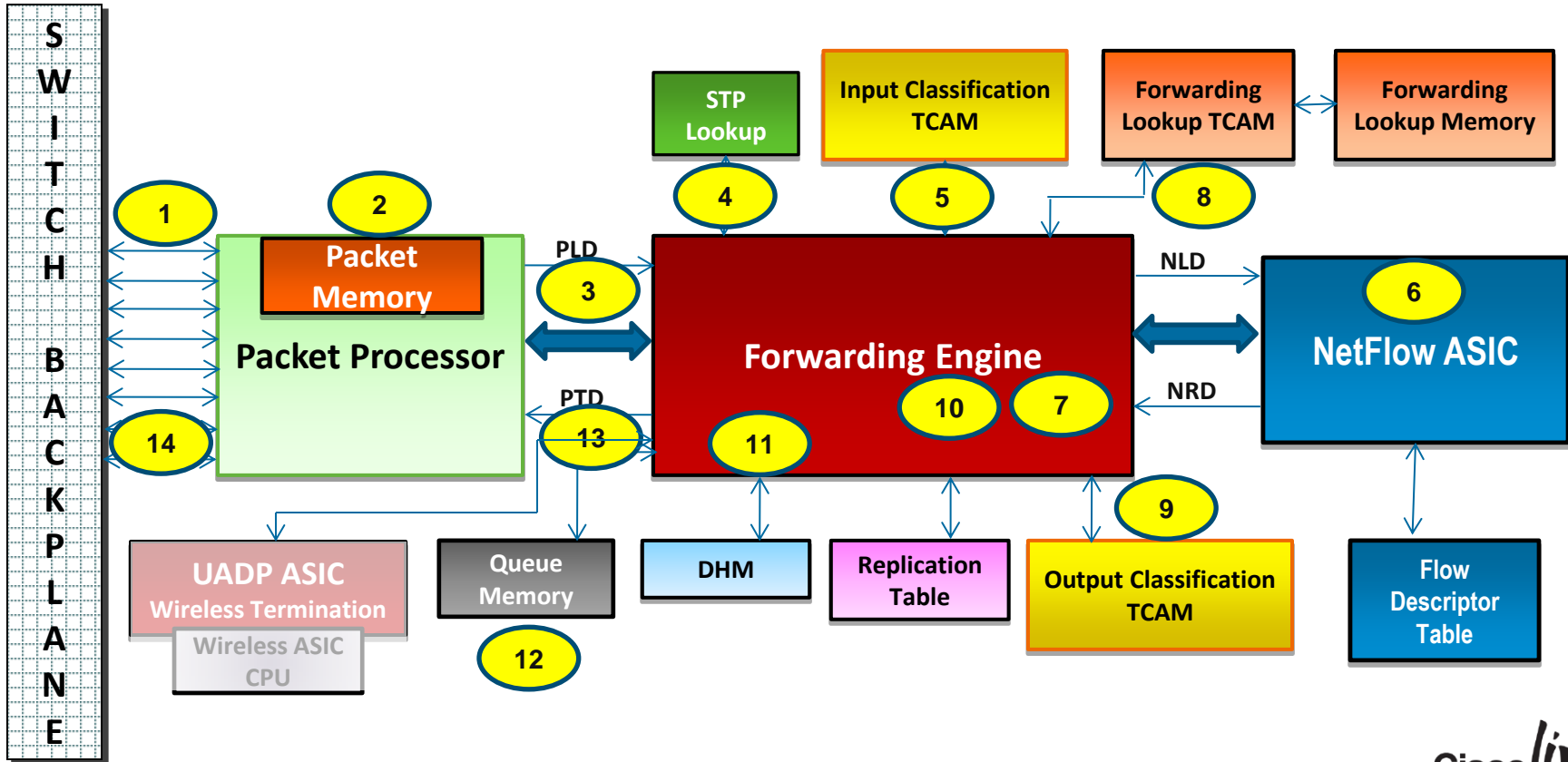
# Supervisor Packet Walk – Packet Rewrite



# Supervisor Packet Walk – Attach Payload



# Supervisor Forwarding Engine Blocks



# Supervisor – Unicast Packet Walk



For Your  
Reference

1. A packet enters the PHY in the line module and travels across the backplane before reaching the supervisor
2. The packet enters the Supervisor and the Packet Processor performs parsing of VLAN tag and header and stores the packet into Packet Memory
3. The stripped header is used to construct a Packet Lookup Descriptor (PLD) and forwarded to the Forwarding Engine ASIC
4. The packet goes through L2 lookup. Spanning tree state is checked. Packet MAC source and MAC destination together with receive vlan ID are looked up in the L2 Hash Table. L2 lookup also determines whether the packet is destined for router functionality.
5. Input Classification is used to classify the packet via rules loaded into the Input Classification TCAM. ICC stores input ACL and QoS rules in TCAM4
6. A NLD (Netflow Lookup Descriptor) is created by the Forwarding Engine and fed into the NetFlow ASIC. Here new flow is created or updated; also microflow policing is done here.
7. NRD (Netflow Result Descriptor) is created by NetFlow ASIC and passed to the Forwarding Engine ASIC. Input Aggregate policing result from VFE and Ingress Microflow policing result from NetFlow ASIC are merged, and packet policed accordingly.
8. Header is looked up in the FLC for L3 Lookup. FLC stores L3 (or L2 lookup) forwarding and unicast RPF check rules. Contains mainly IPv4 and IPv6 FIB entries.

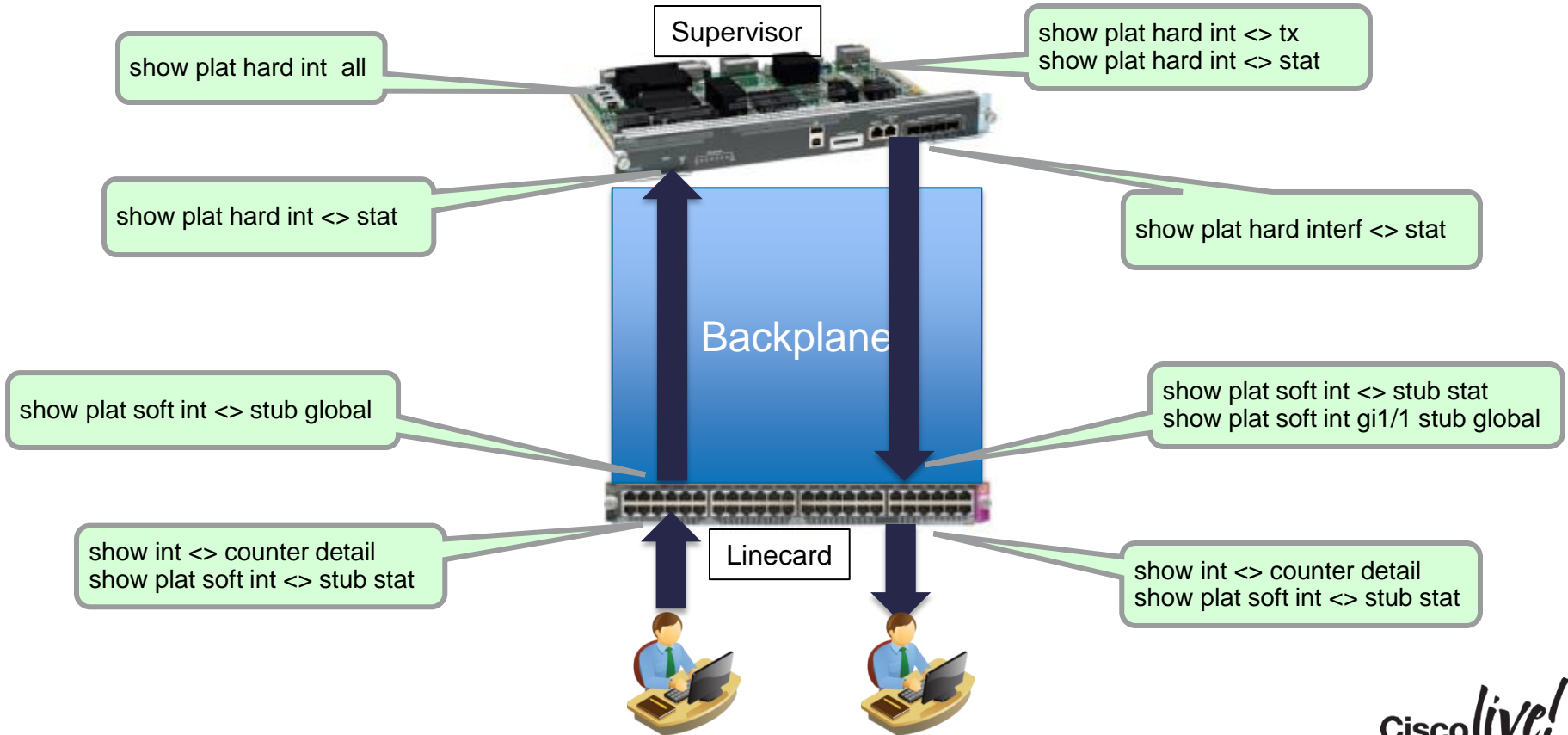
# Supervisor – Unicast Packet Walk



For Your  
Reference

9. OCC stores output ACL and QoS rules in TCAM4
10. Output policing is done at this stage.
11. DBL Hashing Memory is algorithm for avoiding congestion in the ASIC.
12. The transmit descriptor is enqueued in the queue memory
13. Packet Transmit Descriptor (PTD) is sent to the Packet Processor. A NetFlow Update Descriptor (NUD) is sent by the Forwarding Engine to the NetFlow ASIC to update Transmit Statistics for that flow.
14. Packet Processor transmits the packet across the backplane to the correct egress line card.

# Troubleshooting / Packet Flow







High Availability

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# Cisco Catalyst 4500E

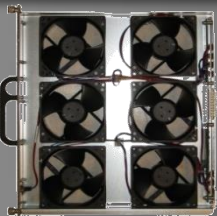
## Designed from the ground up for High Availability

**Redundant Power Supplies**



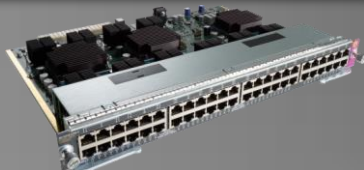
Active Standby Design

**Redundant Fans**



No disruption with single fan failure

**“Transparent” Linecards**



Reduces Line Card failures

**Power Circuit Redundancy**

Pwr Rail 1

Pwr Rail 2



**Unique Redundant Uplinks**

All uplinks (active & standby Sup.) active, even when a Sup. fails

**Dual Supervisors**



Stateful Switchover



High Availability for Dual Homing

**Virtual Switching System**

**Cisco UPOE**

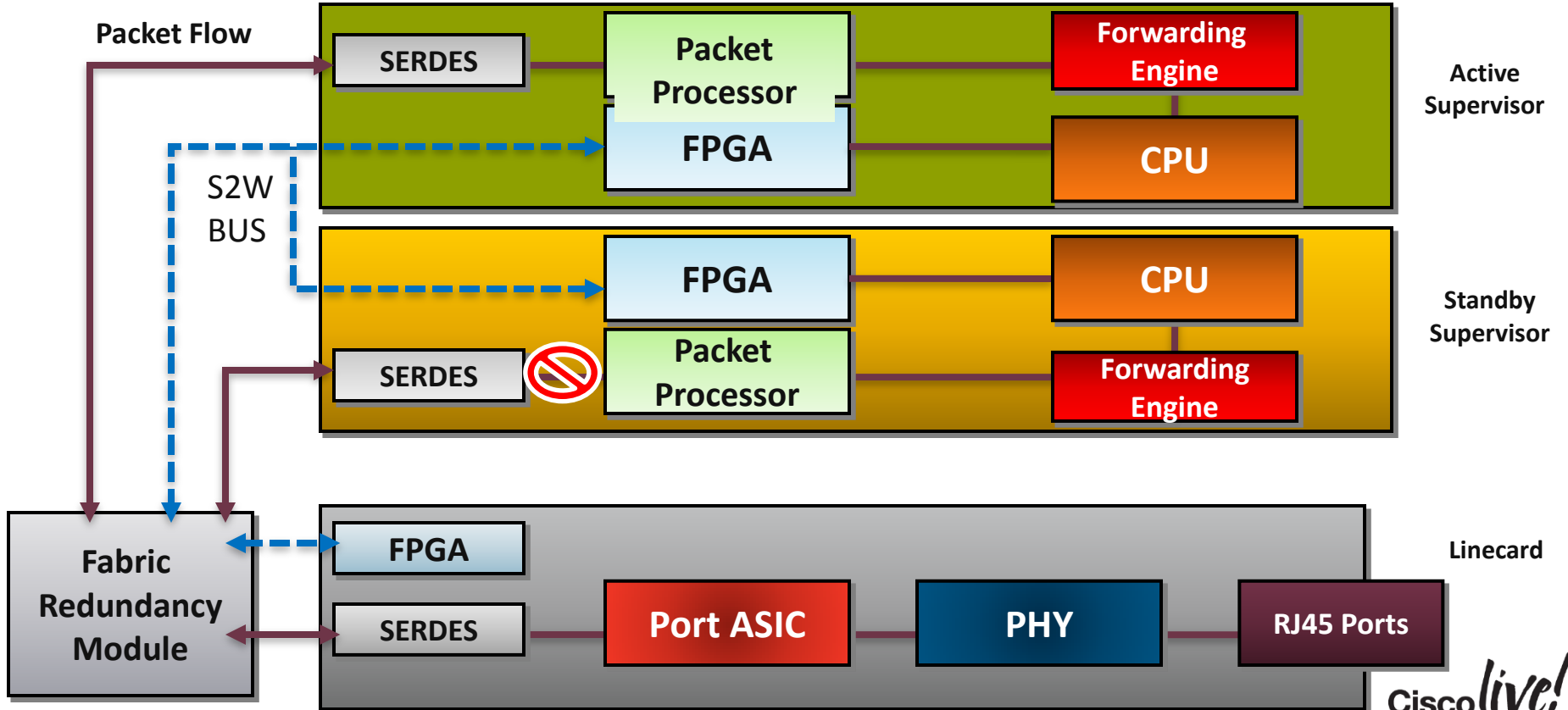


Endpoint data and power convergence

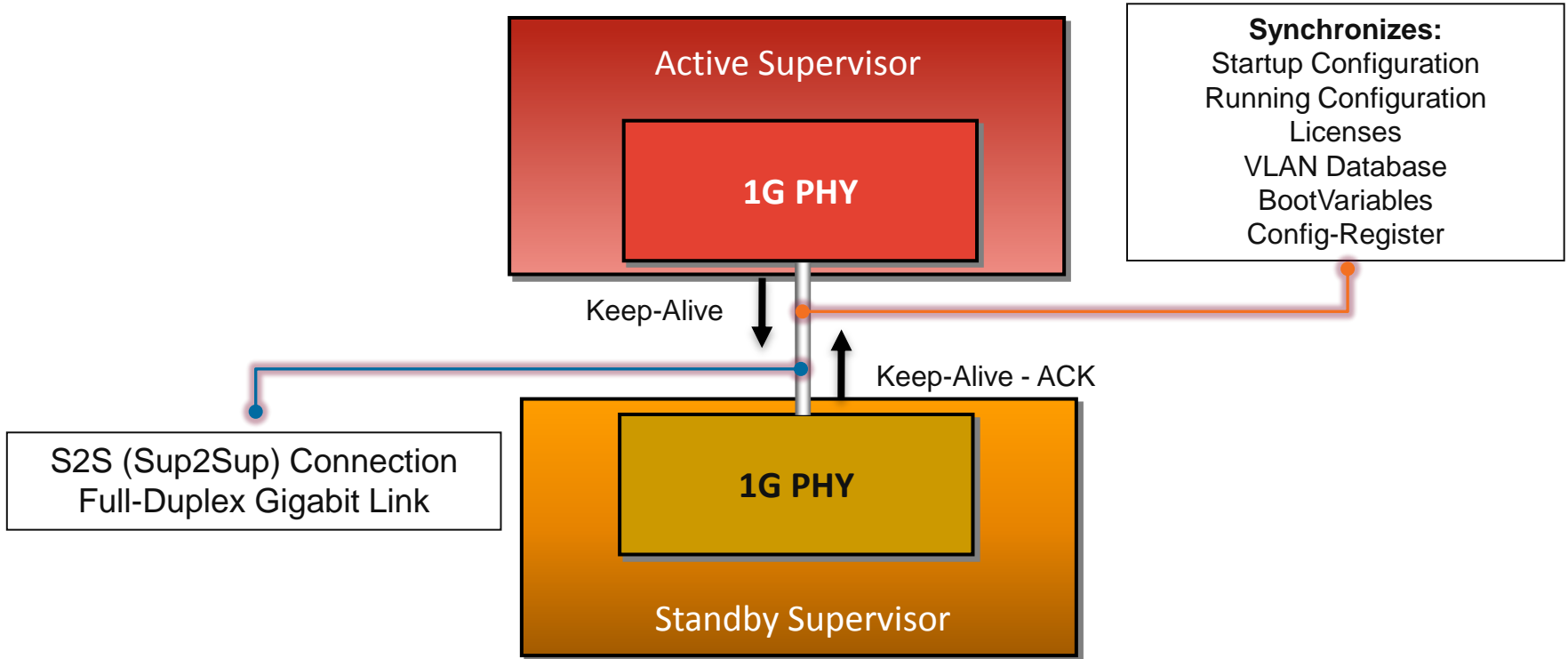


# Stateful Switchover (SSO)

# Chassis + Sup-Packet Flow



# Redundant Supervisor Communication



# Redundant Supervisor Uplinks



Active Ports

Inactive Ports



# SSO–Stateful SwitchOver

SSO allows Redundant Supervisors to run a **stateful IOS** and **stateful applications** to exchange state in order to minimize outage at the time of switchover from Active to Standby Supervisor.



**SSO** – supported in Cisco IOS Release 12.2(46)SG with Sup6-E, and now with Sup7-E

Default Redundancy Mode –  
Redundant Supervisor fully initialized

Upon Switchover **Physical Links stay up** - Protocols do not reset

Traffic Interruption: **Sub-Second (<200ms)**

IOS Images need to be identical

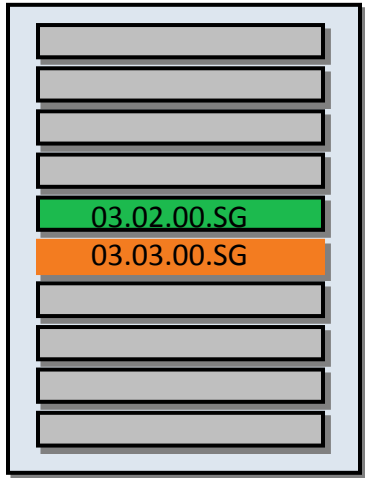
Cisco *live!*



In Service Software Upgrade (ISSU)



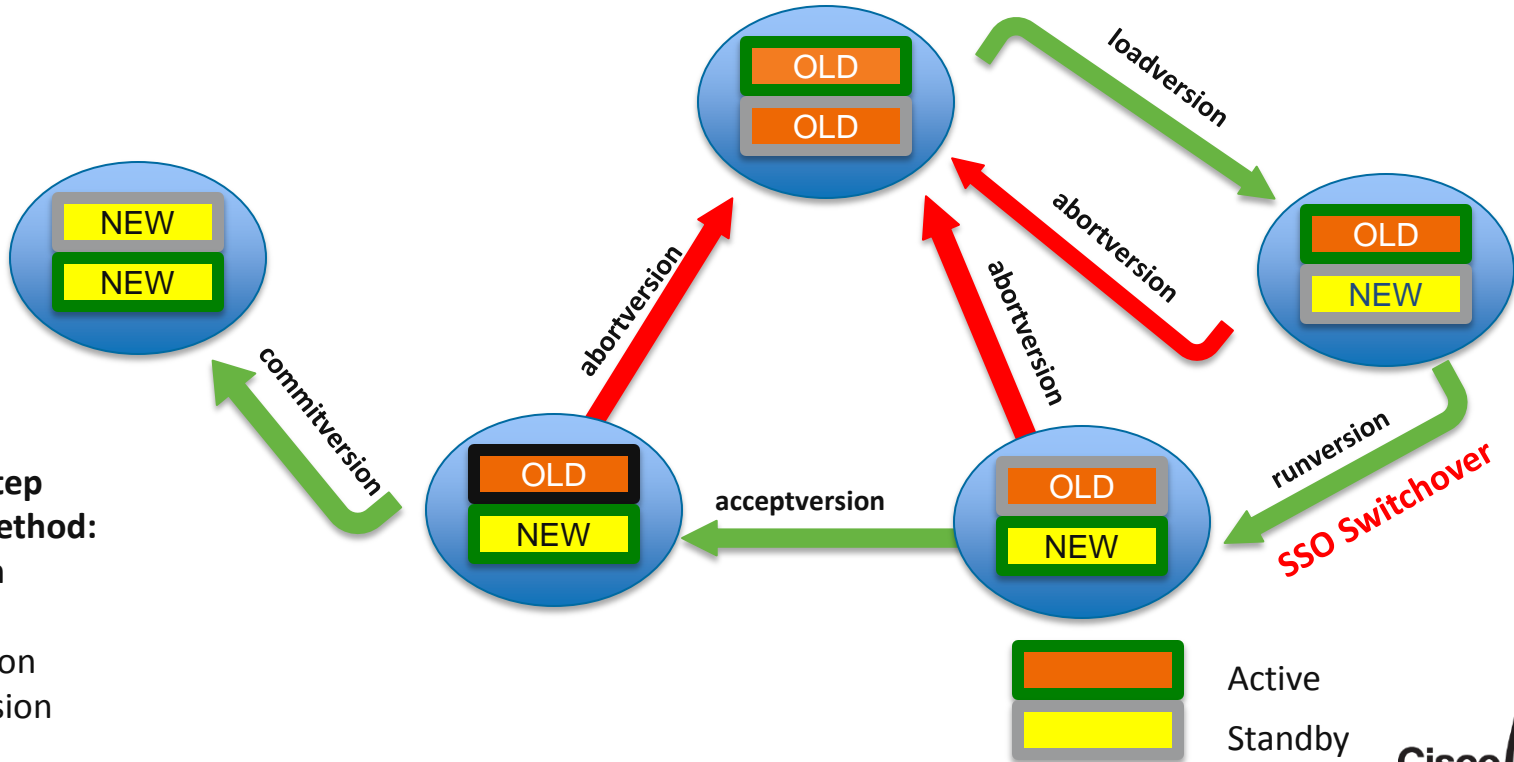
# Catalyst 4500–In Service Software Upgrade



Targets Planned Downtime  
Due to Software Upgrades

- Software Maintenance Windows are significant case of downtime
- On redundant systems, the ISSU process allows the running IOS software to be upgraded while packet forwarding continues
- ISSU mechanism leverages architecture for High Availability - NSF / SSO
- Catalyst 4500 utilizes full image upgrades for the addition of new features, defects, and PSIRTs
- Increases network availability and reduces downtime caused by planned upgrades

# In Service Software Upgrade Process

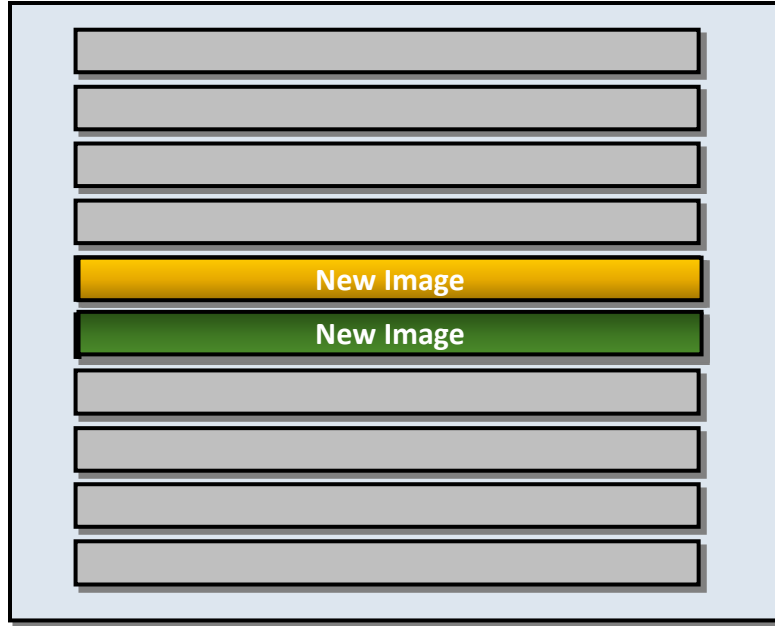


There is a 4-Step Traditional Method:

- Load Version
- Run Version
- Accept Version
- Commit Version

# Supervisor 7-E – Single Line ISSU

```
issu changeversion bootflash:New_Image quick
```



Slot-5

Slot-6

 Active Supervisor

 Standby Supervisor

Standby Supervisor in Slot-6 is Reset and.....

Boots with New Image

Initiate SSO Switchover between Active Supervisor in Slot-5 and Standby Supervisor in Slot-6

Active Supervisor in Slot-5 resets

Standby Supervisor in Slot-6 takes over as Active Supervisor

Supervisor in Slot-5 boots up as a Standby Supervisor with the New\_Image.....

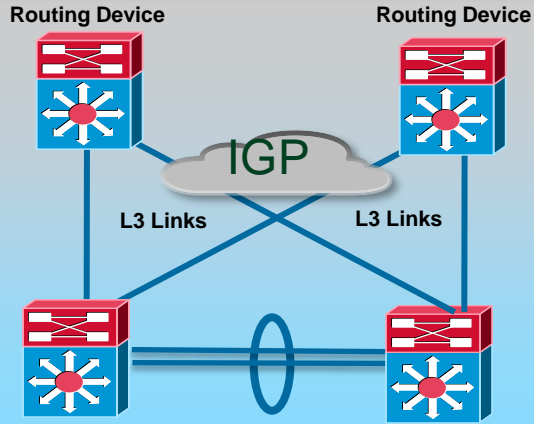
Completing the ISSU Process



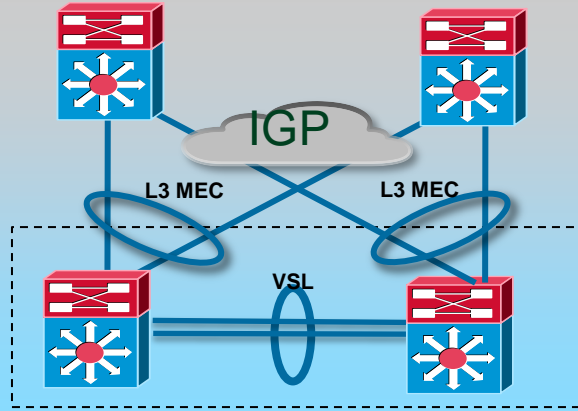
# Virtual Switch System (VSS)

# Catalyst 4500E/X Virtual Switching System – Phase II

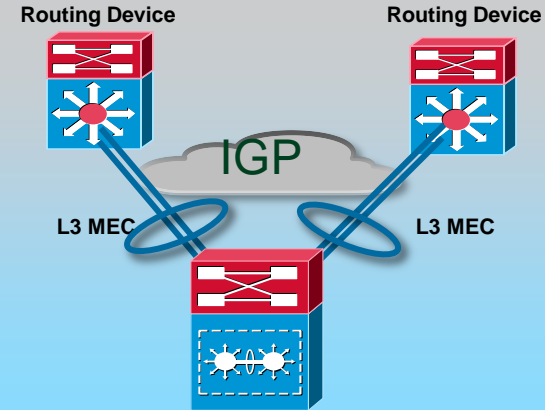
## Standalone



## VSS (Physical view)



## VSS (logical view)



Support for L3-MEC reducing needs for Routing Convergence

VSS is now supported between Asymmetric Chassis (chassis with Different Slots)

VSS on Catalyst 4500E now provides support for VSLP Fast Hello providing sub-second convergence

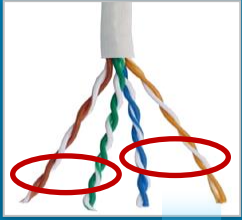


Key Features & New Introductions...

# Cisco Universal PoE (UPOE)

## IEEE 802.3at (PoE+)

Cat5e

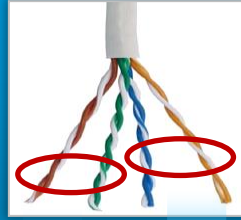


30W

- Maximum power sourced = 30W

## UPOE

Cat5e



30W

30W

60W

- Maximum power sourced = 60W
- Supported by all cabling standards
- Compatible with PoE and PoE+

## Universal Nature

- Standard RJ45 Connector
- No Cabling Change from PoE+

## High Availability

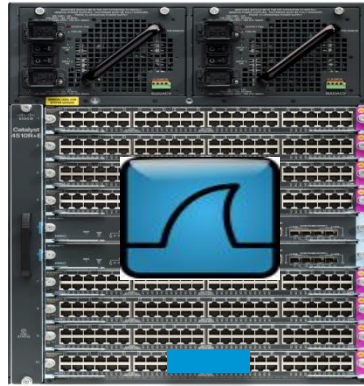
- Uptime for critical apps (e911)
- Low TCO with UPS consolidation

## Green

- 10% more efficient than bricks
- Management with EnergyWise

# Wireshark Operation – How is it done?

Local Display



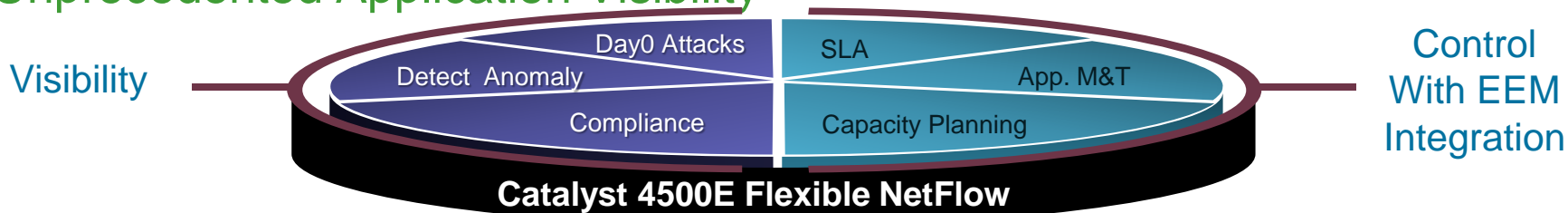
Cisco *live!*

- Original packets are hardware-switched to destination
- Copies of the interesting traffic are generated in hardware
- Processed by software at a rate-limited Packet per second, to protect CPU utilization
- The software interacts with the Wireshark module and writes the PCAP Files



# Catalyst 4500E Flexible NetFlow

## Unprecedented Application Visibility



### Benefits

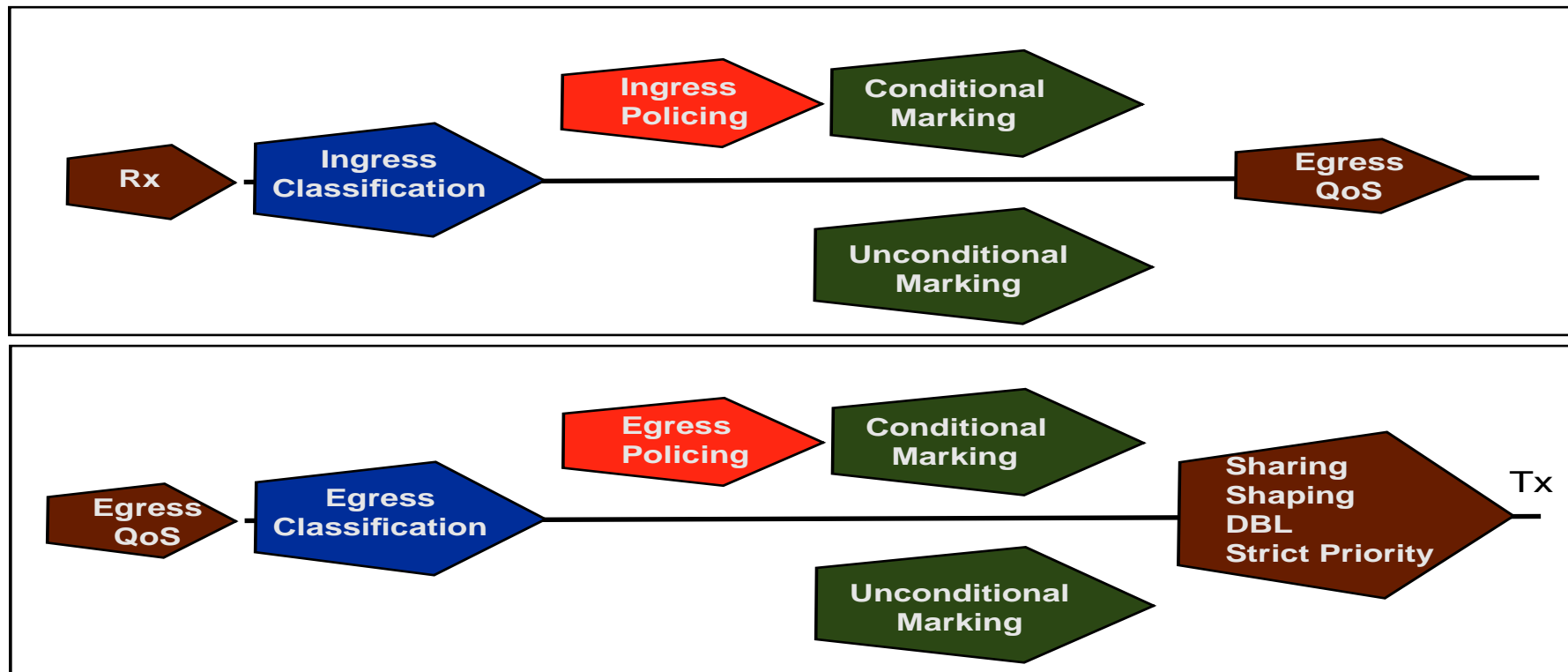
- Lower CAPEX
  - Better insight for capacity planning, network upgrade
- Lower OPEX
  - Better service and user experience
  - Increased IT staff productivity

### Catalyst 4500E Capabilities

- Unprecedented visibility w/ new L2~7 fields
- Scalable, flexible flow monitors
- On-box Customizable policy action w/ EEM
- Broad collector partner ecosystem

# Catalyst 4500E QoS Overview

## QoS Architecture



# Coming up... IOS-XE 3.6.0E/15.2(2)E

**IOS-XE**  
**3.6.0E/15.2(2)E**



# Bonjour Service Discovery Gateway Ph 2 – Starting 3.6.0



## Static Service Definition

- Service visibility w/o announcements
- Independent Service Availability



## Redundancy & HA Awareness

- Multiple SDGs per segment
- Designated Gateway
- VSS Support
- HSRP/VRRP Support



## Location Awareness

- Wireless proximity
- Civic Location per static interface definition



## Ease of Use

- Service Enumeration
- Additional Statistics
- Rate Limiting

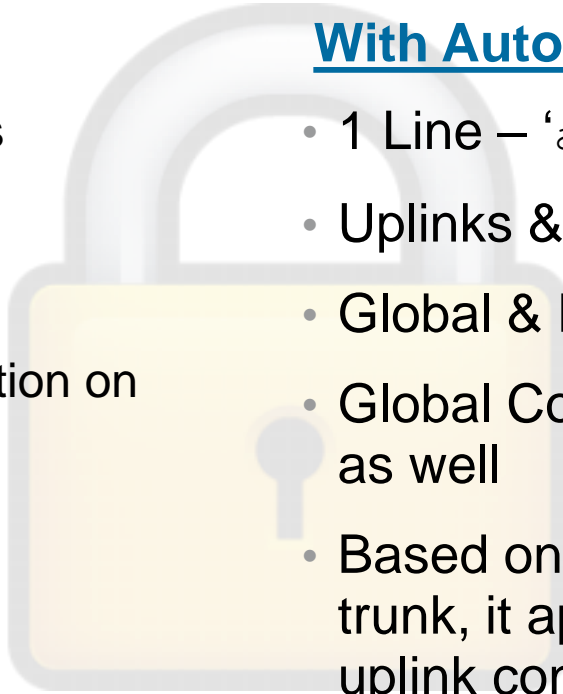
# AutoSecure – Starting 3.6.0

## Without AutoSecure

- 3 Simple Security Features
  - DHCP Snooping
  - Dynamic ARP Inspection
  - Port Security
- Several Lines of Configuration on each port
- Difficult to Validate

## With AutoSecure

- 1 Line – ‘auto security’
- Uplinks & Downlinks
- Global & Per Port Option
- Global Config enables on all ports as well
- Based on port mode – access OR trunk, it applies host config or uplink config



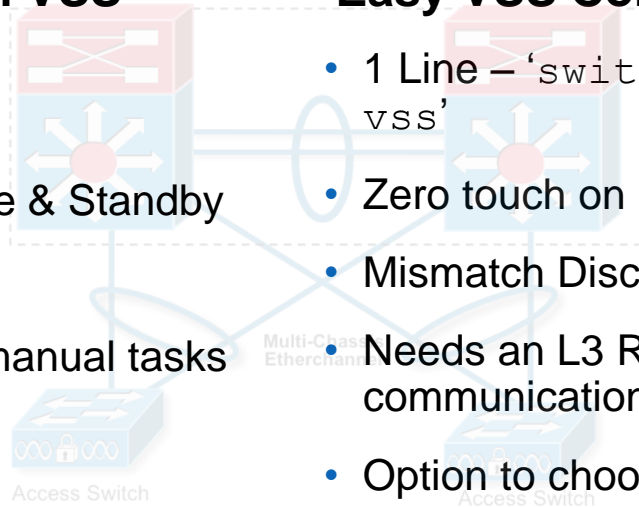
# Easy VSS – Starting 3.6.0

## Problem with Traditional VSS Configuration

- Up to 30 Lines
- Configuration on both Active & Standby
- Error prone
- Version Mismatch – More manual tasks

## Easy VSS Configuration

- 1 Line – 'switch convert mode easy-vss'
- Zero touch on Standby (No Config Needed)
- Mismatch Discovery & Fix
- Needs an L3 Reachability to the pair for communication
- Option to choose VSL Link



# Participate in the “My Favorite Speaker” Contest

Promote Your Favorite Speaker and You Could be a Winner

- Promote your favorite speaker through Twitter and you could win \$200 of Cisco Press products (@CiscoPress)
- Send a tweet and include
  - Your favorite speaker’s Twitter handle Muhammad Imam – @m\_a\_imam
  - Two hashtags: #CLUS #MyFavoriteSpeaker
- You can submit an entry for more than one of your “favorite” speakers
- Don’t forget to follow @CiscoLive and @CiscoPress
- View the official rules at <http://bit.ly/CLUSwin>

# Complete Your Online Session Evaluation

- Give us your feedback and you could win fabulous prizes. Winners announced daily.
- Complete your session evaluation through the Cisco Live mobile app or visit one of the interactive kiosks located throughout the convention center.



Don't forget: Cisco Live sessions will be available for viewing on-demand after the event at [CiscoLive.com/Online](https://www.cisco.com/live/online)



# Continue Your Education

- Demos in the Cisco Campus
- Walk-in Self-Paced Labs
- Table Topics
- Meet the Engineer 1:1 meetings



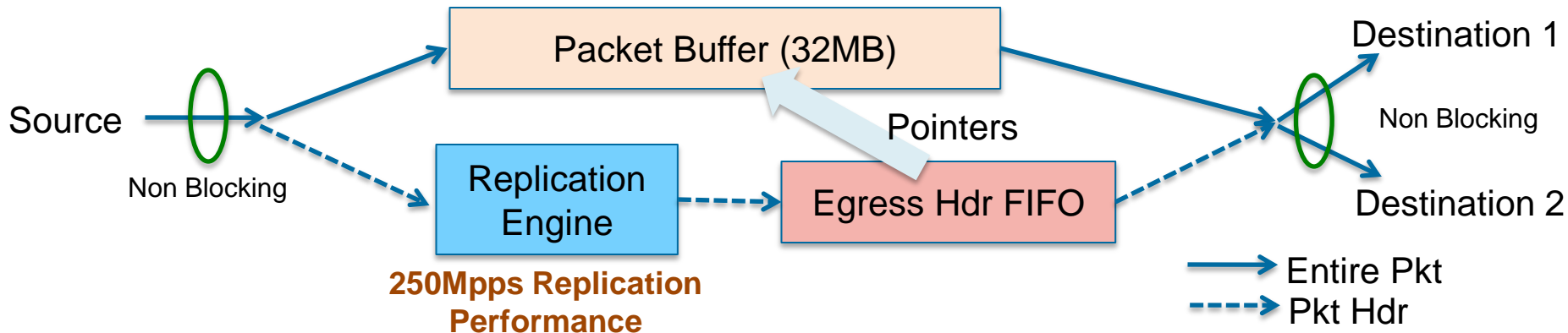
Thank you.

Cisco *live!*



**CISCO**

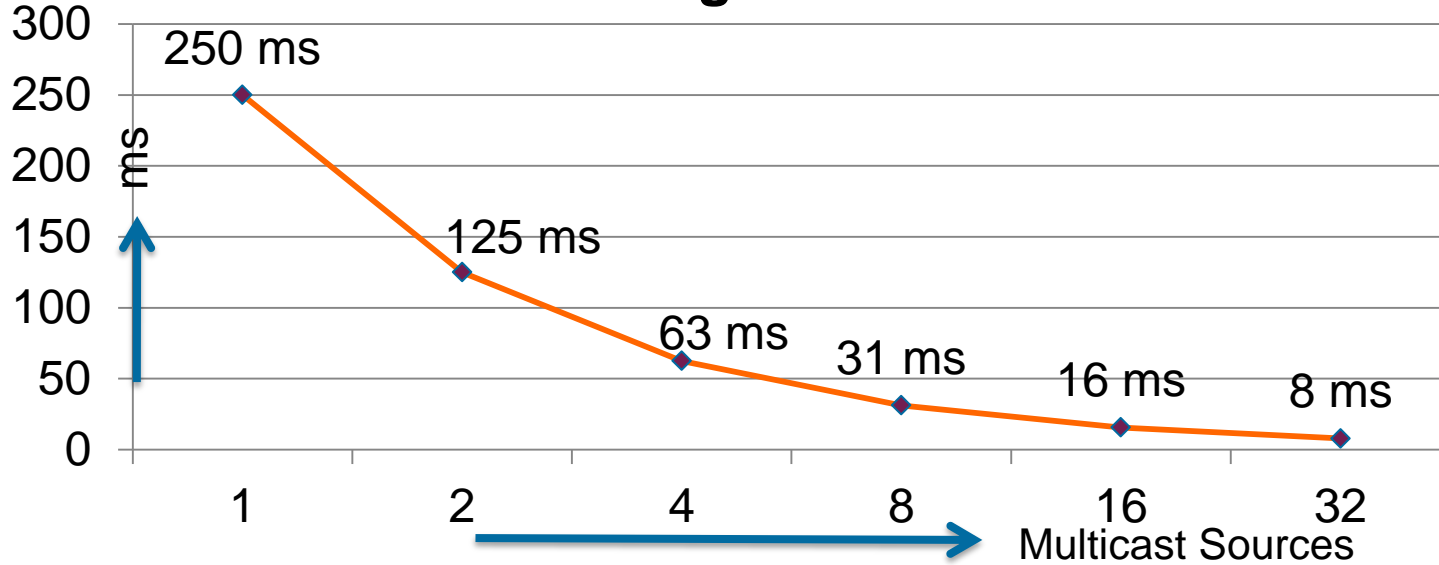
# Catalyst 4500E Multicast Replication & Buffering



- Only 1 copy of packet is stored in the packet buffer
- Packet header is replicated with pointer referenced into packet buffer
- 32MB of packet buffer => ~ 250ms of **shared** egress buffering
- **250Mpps** multicast packet replication performance
- **Non blocking bandwidth** to 10G uplinks and 1G access ports

# Egress Buffering vs. Multicast Sources

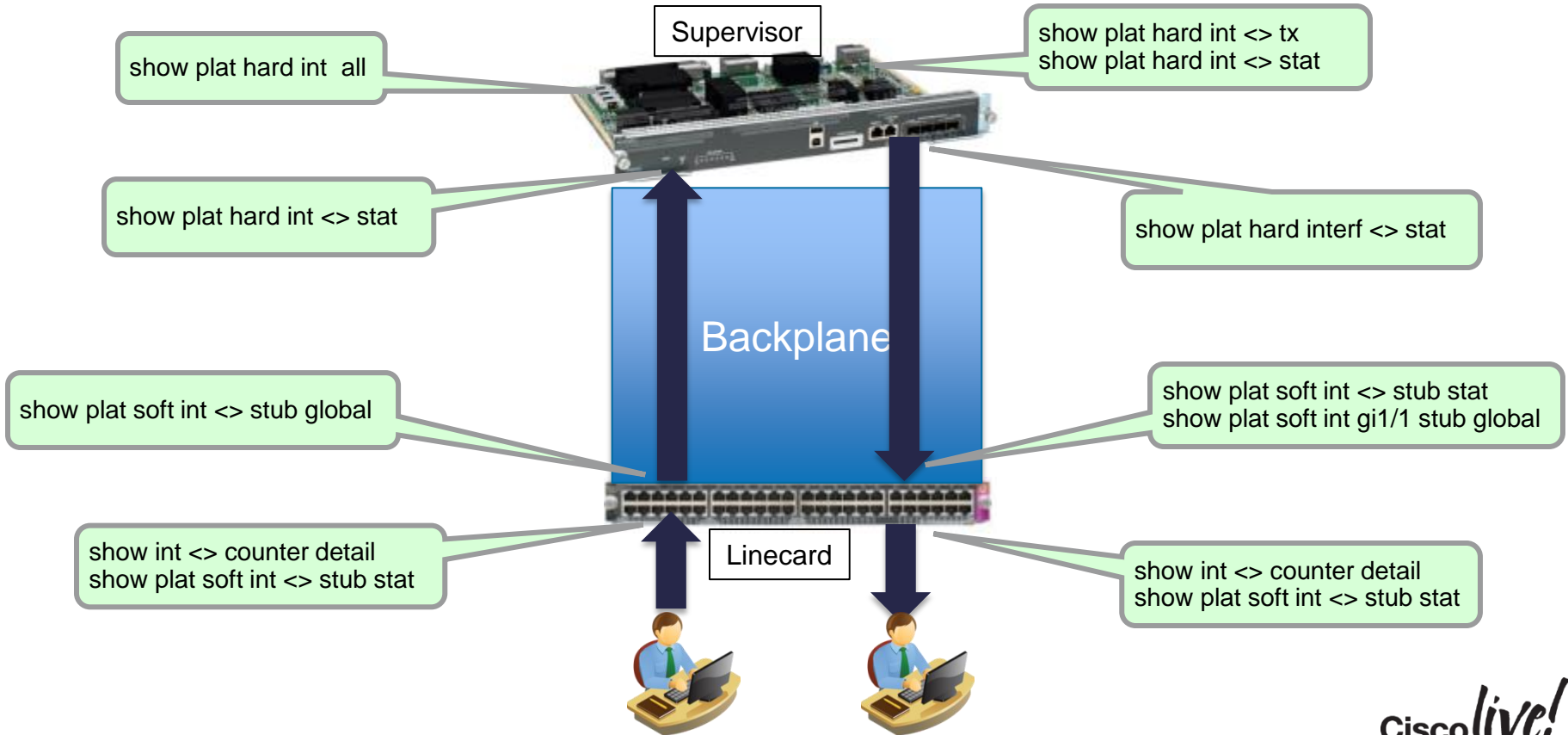
## \*Worst Case Buffering vs Multicast Source



\* Worst case assumes all multicast sources burst simultaneously





















- **250ms** of egress buffering when multiple sources do not burst simultaneously
- When all sources burst simultaneously, Catalyst 4500 provides better buffering when number of multicast **sources is less than 32**

# Troubleshooting / Packet Flow



# Cat4500E/X : VSS Phase 1 and Phase 2

## Comparison

Capability	Catalyst 4500E/X Phase I (Shipping Now)	Catalyst 4500E/X Phase II (IOS-XE3.5.0E - 3QCY2013)
Single-sup cross-chassis VSS support		
Quad Sup Forwarding Uplinks		
L2-based Multi-chassis EC		
L3 based Multi-chassis EC		
Split Brain Detection (Dual Active)	ePAgP	Fast-Hello, ePAgP
Cross-chassis NSF/SSO		
Cross-chassis ISSU		
PoE LC support in VSS*		
Support for Classic Line Cards		
Asymmetric chassis (VSL between different slot chassis)		 (E series)
Smart Install Director w/VSS	 (Standalone only)	

# Feature Gaps between Standalone and VSS mode

Features	Standalone	VSS
VLAN Management Policy Server (VMPS) Client		Roadmap
Unidirectional Ethernet (UDE)		Roadmap
CFM D8.1		Roadmap
REP and associated features		Roadmap
Flexlinks		Roadmap
PVL,L2PT, Fast UDLD		Roadmap
WCCP		Roadmap
Dot1q Tunnel (Dot1Q tunnel)		Roadmap
Vlan Translation (1:1, 1:2-Selective QinQ)		Roadmap
Mediatrace and Metadata		Roadmap
EnergyWise		Roadmap
Smart Install Director		Roadmap

3.5.0E

Cisco *live!*



# Generic Online Diagnostics—What is it?

**GOLD** defines a common framework for diagnostics operations across Cisco Platforms running IOS software. The goal is to check the health of hardware components and verify proper operation of the system control and data plane at run-time and boot...



## Power-On Diagnostics

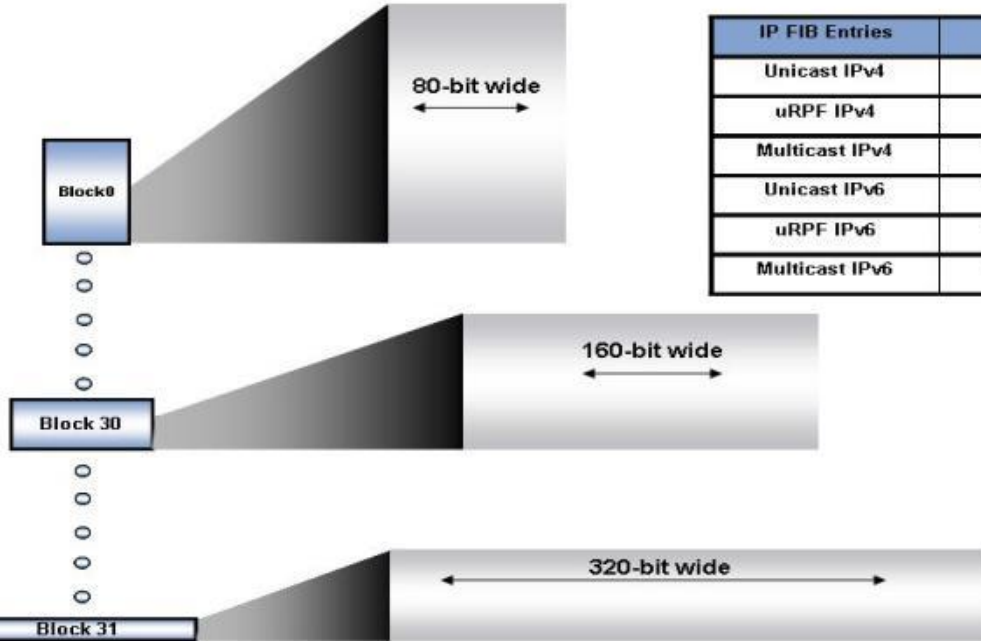
Supervisor, Backplane  
L2 ASIC, L3 ASIC  
Memory, CPU, Port

## Runtime Diagnostics

Line Card Module, Temperature,  
Power Supply, Fan Tray



# TCAM4 Forwarding Blocks



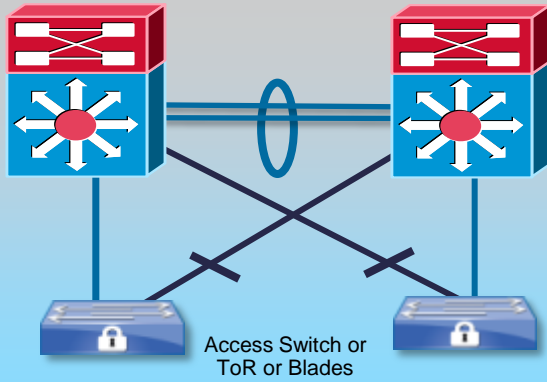
IP FIB Entries	TCAM Mode	Entries / Block
Unicast IPv4	80-bit mode	4000
uRPF IPv4	80-bit mode	4000
Multicast IPv4	160-bit mode	2000
Unicast IPv6	160-bit mode	2000
uRPF IPv6	160-bit mode	2000
Multicast IPv6	320-bit mode	1000

Dual Forwarding CAMs provide 64 blocks to store IPv4 and IPv6 Unicast Multicast Routes -  
256,000 IPv4 Routes  
128,000 IPv6 Routes

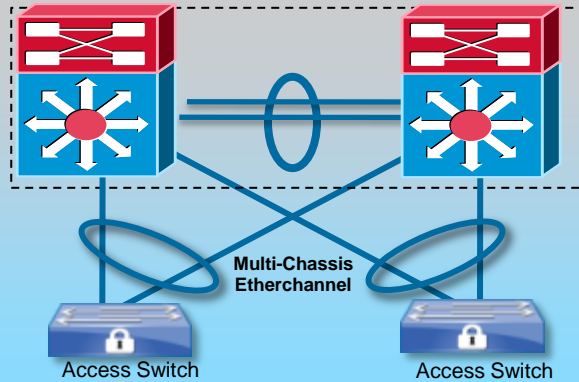
Optimized Space Allocation for IPv4 and IPv6 Configurations!  
Hardware Support for IPv6

# Virtual Switching System (VSS)

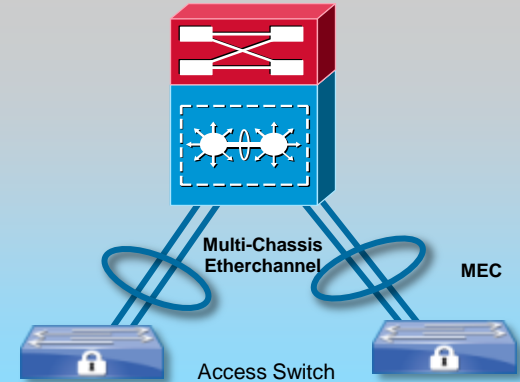
## Standalone



## VSS (Physical view)



## VSS (logical view)

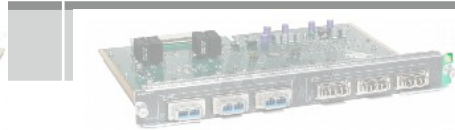
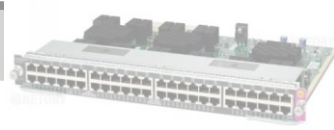
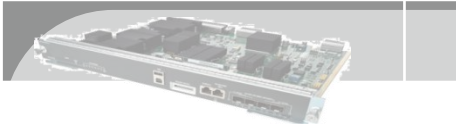


Simplifies operational Manageability via Single point of Management, FHRP

Doubles bandwidth utilization with Active-Active Multi-Chassis Etherchannel (802.3ad/PagP) Reduce Latency

Minimizes traffic disruption from switch or uplink failure with Deterministic subsecond Stateful and Graceful Recovery (SSO/NSF)

# Catalyst 4500E: VSS Support for Classic Line Cards



Supervisor 7-E*	WS-X4748-RJ45V+E	WS-X4606-X2-E*
Supervisor 7L-E*	WS-X4712-SFP+E *	WS-X4648-RJ45V-E & +E
	WS-X4748-UPOE+E	WS-X4648-RJ45-E
	WS-X4748-RJ45-E	WS-X4640-CSFP-E
		WS-X4624-SFP-E
		WS-X4612-SFP-E

WS-X4306-GB
WS-X4548-RJ45V+
WS-X4232-L3
WS-X4448-GB-SFP
WS-X4248-RJ45V
WS-X4248-FE-SFP
WS-X4148-FX-MT
WS-X4148-RJ

**VSS Supported since 15.1(2)SG/ XE3.4.0SG**

1GE/10GE ports can be configured as VSL

Classic Line Cards not VSL capable but supported in a VSS

# ISSU System Status

```
Switch#show issu state detail
```

```
                Slot = 5
                RP State = Standby
                ISSU State = Init
                Operating Mode = Stateful Switchover
                Current Image = bootflash:xo166
    Pre-ISSU (Original) Image = N/A
    Post-ISSU (Targeted) Image = N/A
```

```
                Slot = 6
                RP State = Active
                ISSU State = Init
                Operating Mode = Stateful Switchover
                Current Image = bootflash:xo166
    Pre-ISSU (Original) Image = N/A
    Post-ISSU (Targeted) Image = N/A
```

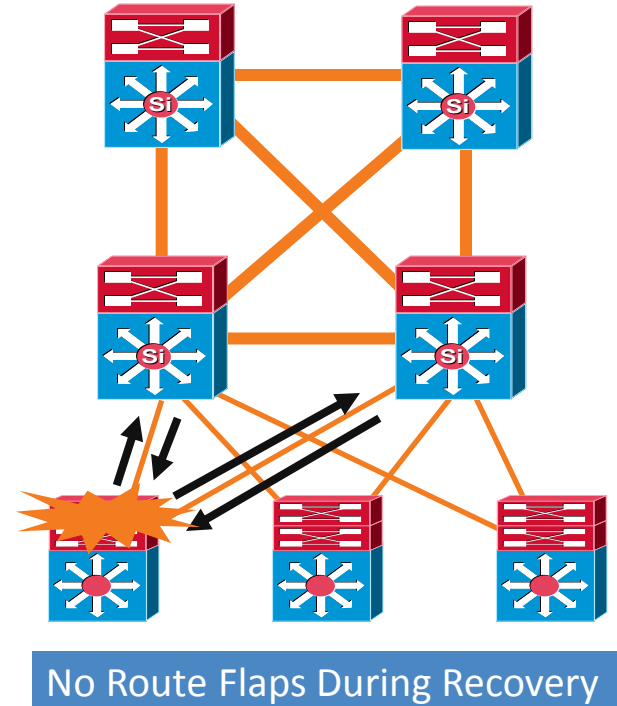


Non Stop Forwarding (NSF)

# System High Availability

## NSF Recovery (Routing Protocol Recovery)

- Non-Stop Forwarding (NSF) provides the capability for the routing protocols to gracefully restart after an SSO fail-over
- The newly active redundant supervisor continues forwarding traffic using the synchronized HW forwarding tables
- The NSF capable Routing Protocol requests a graceful neighbor start
- Routing neighbors reform with no loss of traffic



# Enabling NSF Configuration–Routing

```
Switch(config)#router eigrp 100
```

```
Switch(config-router)#nsf
```

```
Switch(config-router)#timers nsf ?
```

```
converge    EIGRP time limit for convergence after switchover
route-hold  EIGRP hold time for routes learned from nsf peer
signal      EIGRP time limit for signaling NSF restart
```

← EIGRP Example

```
Switch(config)#router ospf 100
```

```
Switch(config-router)#nsf ?
```

```
cisco      Cisco Non-stop forwarding
ietf       IETF graceful restart
```

← OSPF Example

```
Switch(config-router)#nsf cisco ?
```

```
enforce    Cancel NSF restart when non-NSF-aware neighbors detected
helper     helper support
```

```
Switch(config-router)#nsf ietf ?
```

```
helper     helper support
restart-interval Graceful restart interval
```

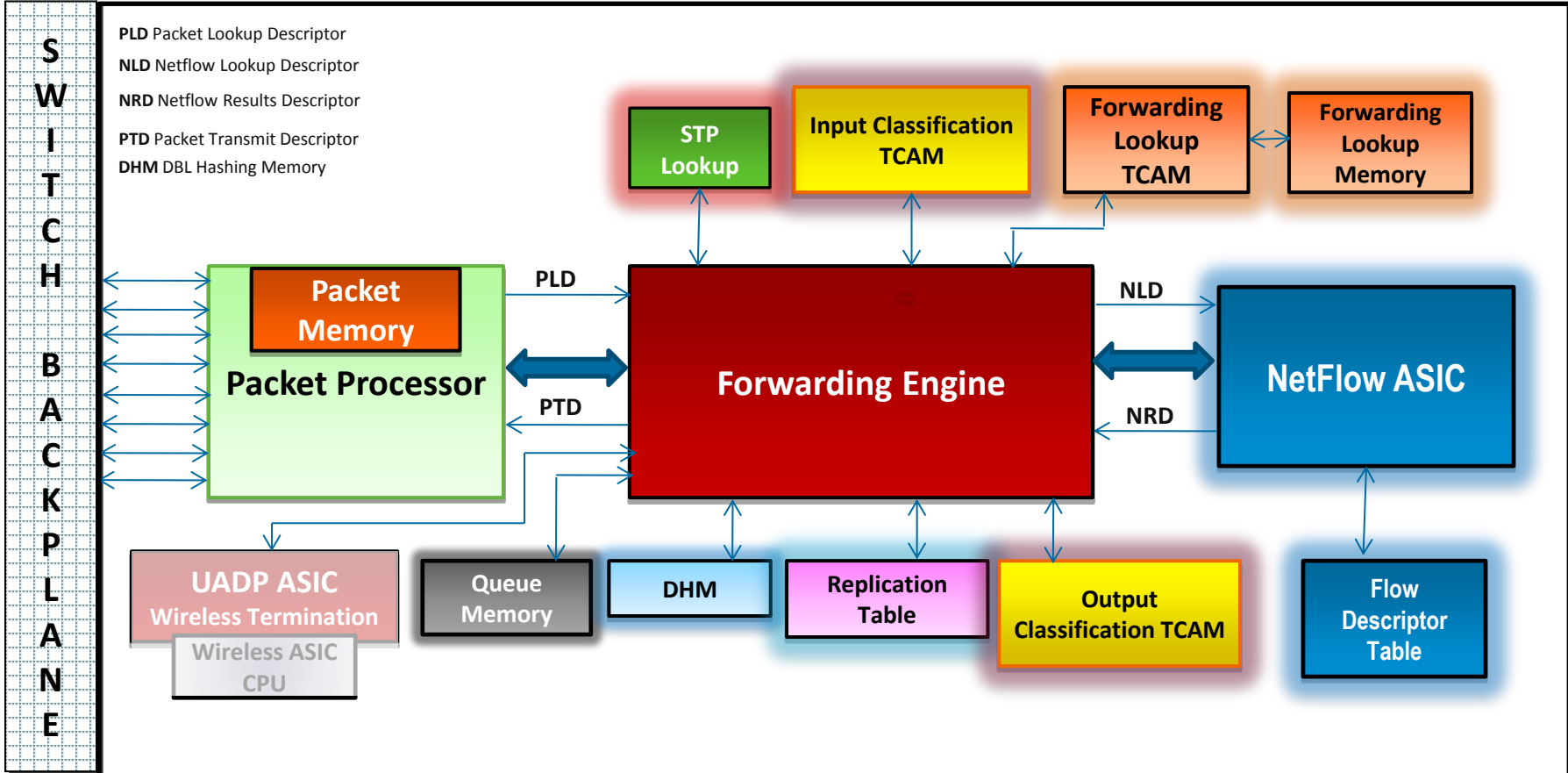
```
Switch(config-router)#bgp graceful-restart ?
```

```
restart-time Set the max time needed to restart and come back up
stalepath-time Set the max time to hold onto restarting peer's stale paths
```

← BGP Example



# Supervisor Forwarding Engine Blocks



# Catalyst 4500-X Physical Characteristics



Dual redundant AC/DC P/S and 5 Fans



Burgundy color fan and P/S handles for front to back airflow



Airflow vent above the ports for optimal cooling

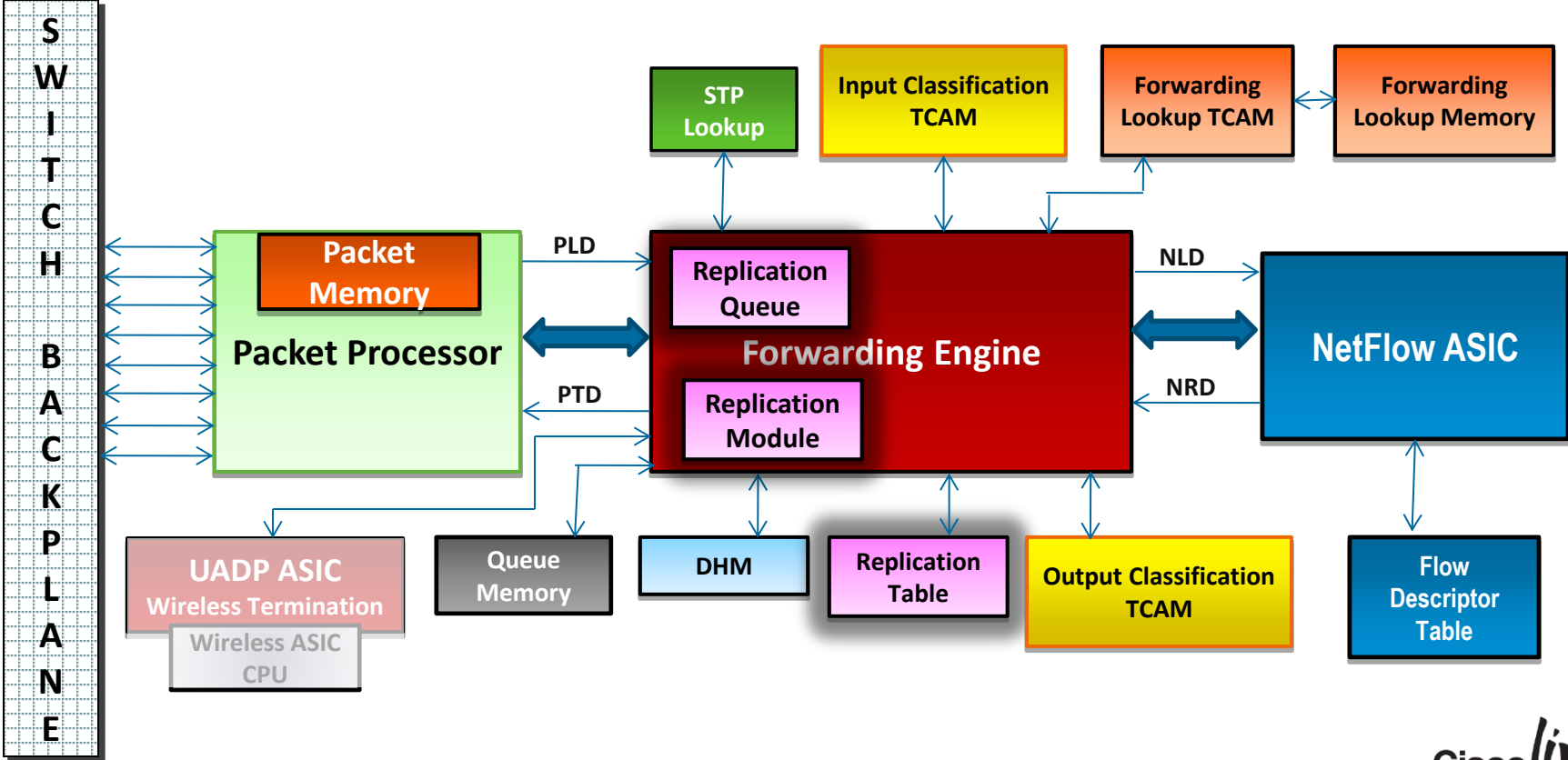


Blue color fan and P/S handles for back to front airflow

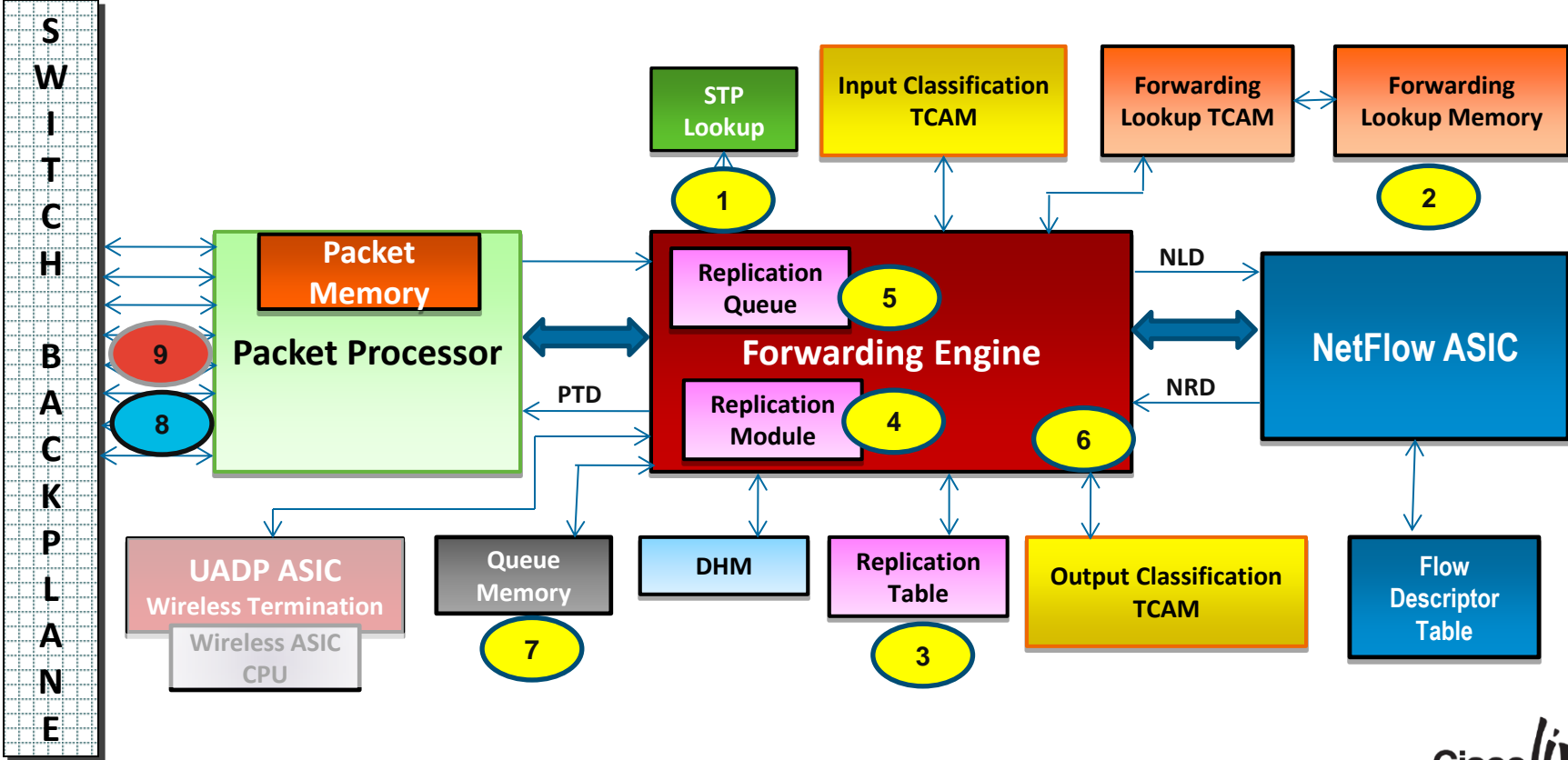


Catalyst 4500E – Multicast Packet Walk

# Supervisor Multicast Architecture



# Supervisor Multicast Forwarding



# Supervisor – Multicast Packet Walk



For Your  
Reference

1. Packet comes in as a Source packet. The payload is copied to packet memory, and the small header or Descriptor is stripped off. The L2 table will indicate that the DMAC is a multicast MAC.
2. The packet will be processed pretty much like a unicast packet would.
3. At some point, during the Forwarding Lookup, the destination Multicast Group address will be looked up. This will point to an Adjacency Entry in the FLC, which points to a RET Entry, in the Replication Table.
4. The REM consults the RET Table, it stores the information as to how many copies of this Descriptor need to be created and what are the forwarding interfaces for each copy of the Descriptor.
5. The REM creates the Header Copies and enqueues them in the Replication Request Queue.
6. This Descriptor traverses through the Forwarding Engine like before, but none of the Ingress Processing including Forwarding Lookups are done. It proceeds straight to OCC for applying egress features on each of those OIFs.
7. Once the features are applied and the packets are permitted out the OIF – they are enqueued into the Queue Memory.
8. The copies are then forwarded to their respective OIFs.

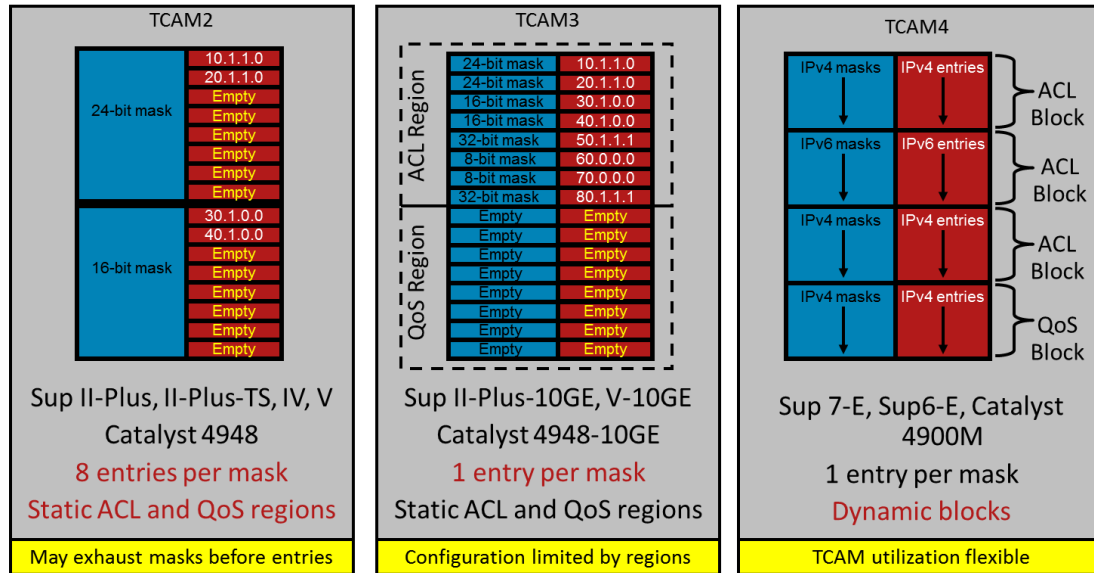


TCAM Resources

# TCAM Overview

## Ternary Content Addressable Memory

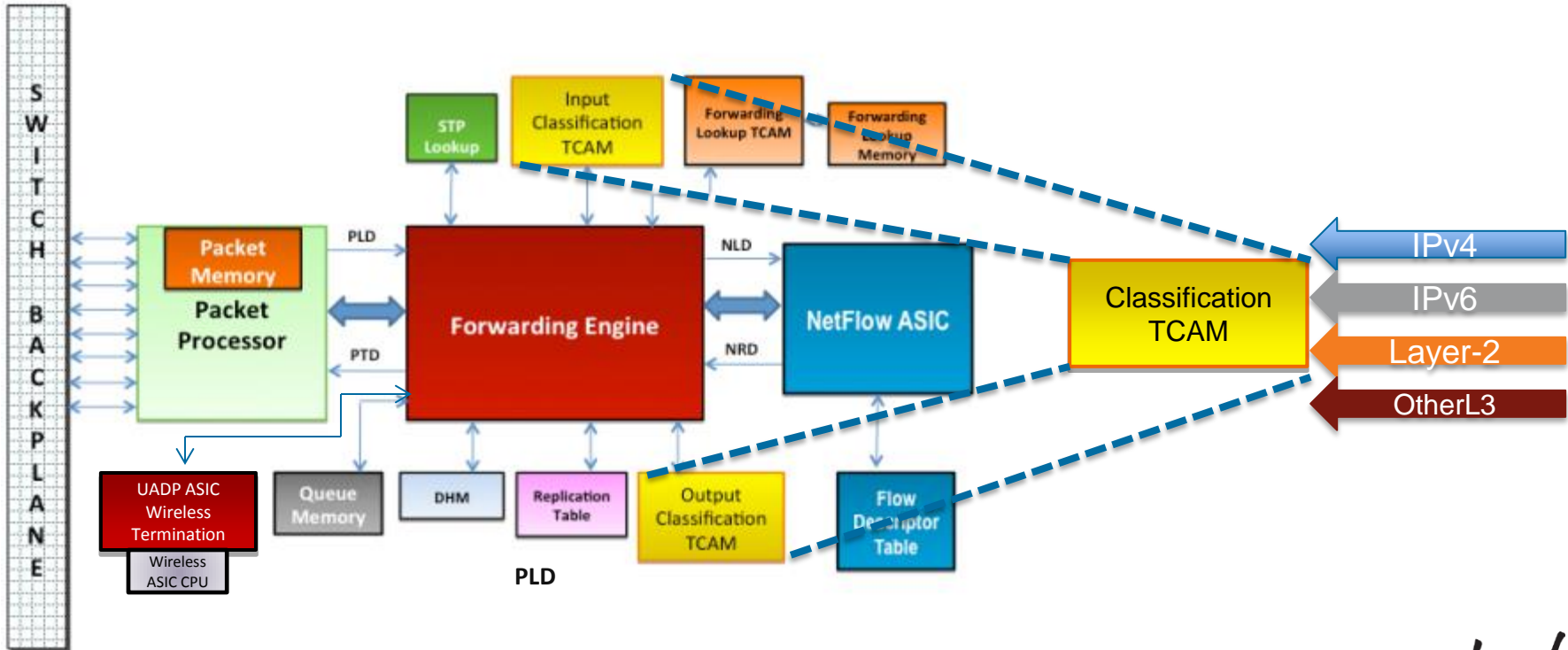
Stores ACLs, QoS policies, and L3 forwarding information\*



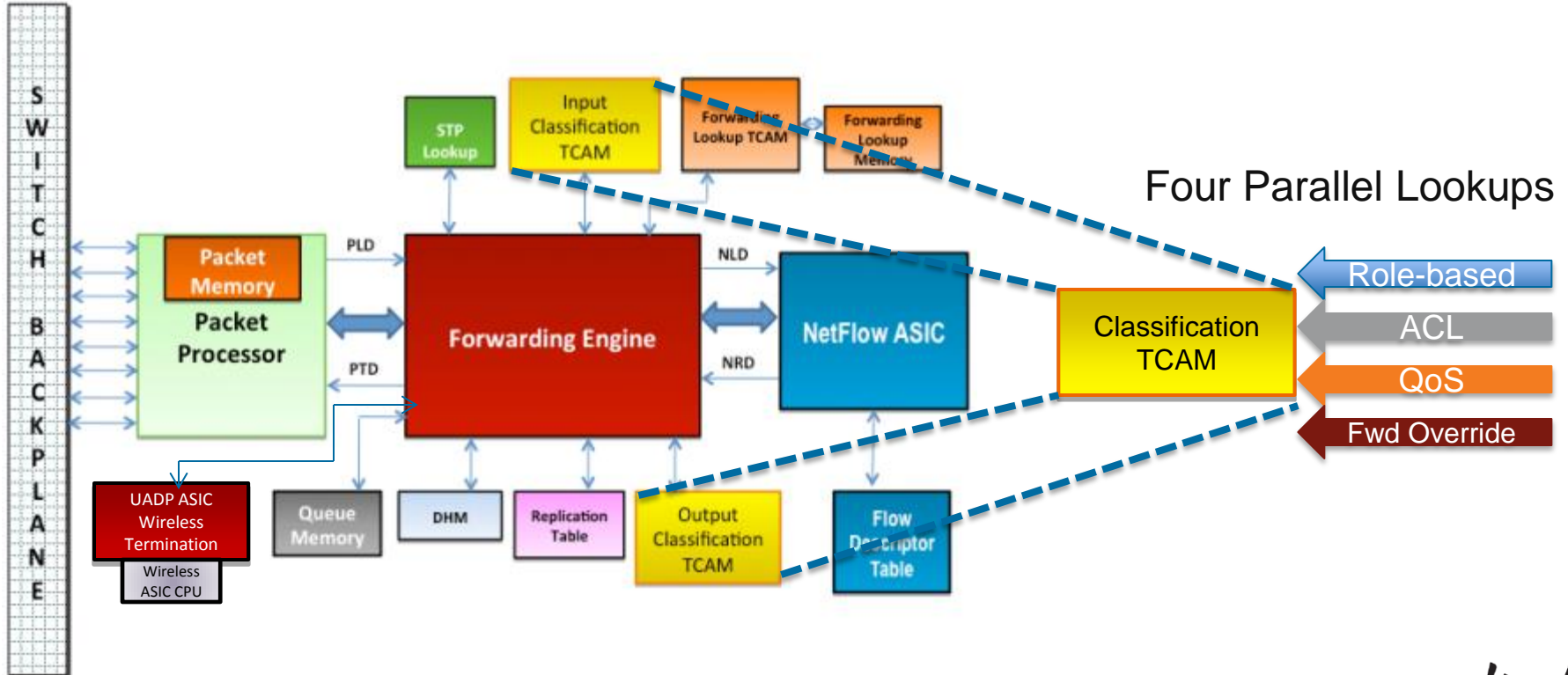
\* Not shown



# TCAM Lookup - Packet Types

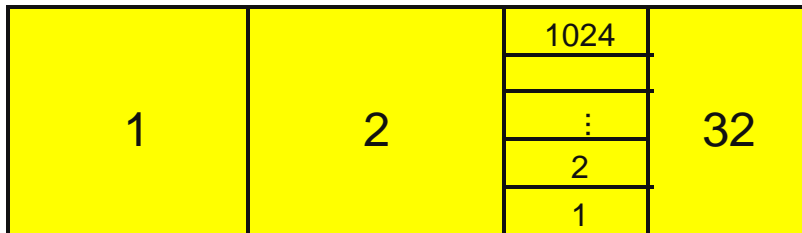
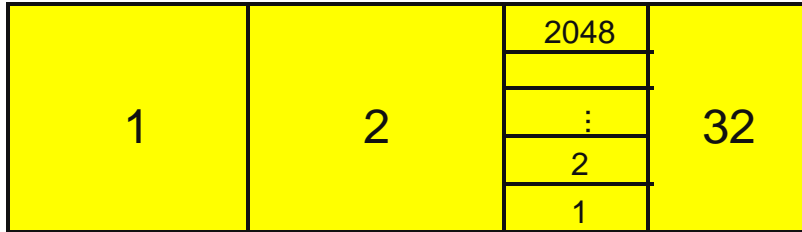
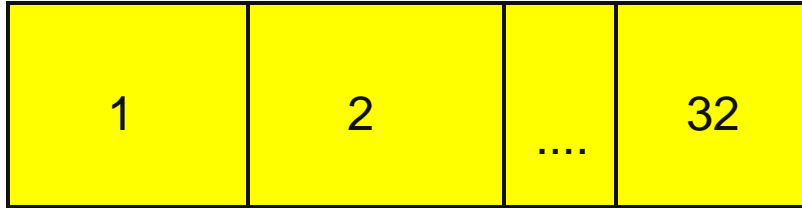


# TCAM Lookup – Feature types



# TCAM Blocks

Each Classification TCAM4 has 32 Blocks

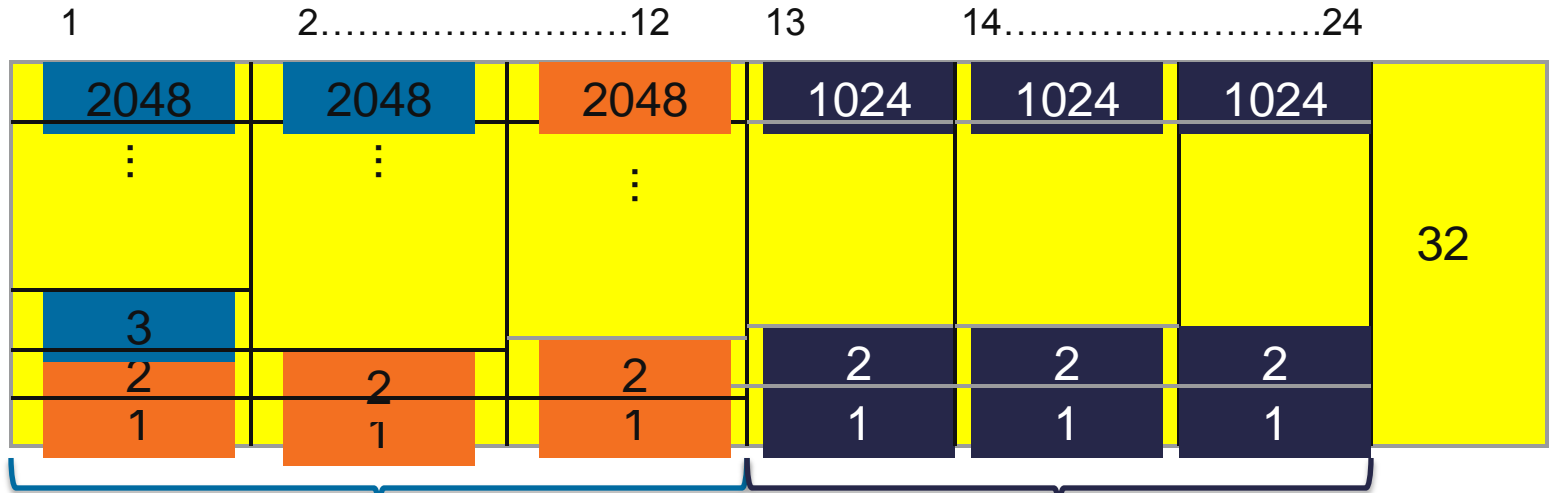


160-bit wide for IPv4  
Max is 64K entries

320-bit wide for IPv6  
Max is 32K entries

Shared across all  
packet types

# Restricted Block Usage



Maximum is 12 blocks

- Maximum number of Access Control Entries (ACE) in all policies combined on a single ACL path cannot exceed 24K ACEs
- IPv6 ACEs are double the width of IPv4; you cannot have an IPv6 ACL with more than 12K ACEs

IPv4  
block

IPv6  
block

# Monitoring TCAM Utilization

```
show platform hardware acl statistics utilization brief
```

```
CAM Utilization Statistics
```

Input Allocation

			Used		Free	Total	
Input Allocation	Input Security	(160)	37	(1 %)	2011	(99 %)	2048
	Input Security	(320)	30	(1 %)	2018	(99 %)	2048
	Input Qos	(160)	11	(0 %)	2037	(100%)	2048
	Input Qos	(320)	6	(0 %)	2042	(100%)	2048
	Input Forwarding	(160)	7	(0 %)	2041	(100%)	2048
	Input Forwarding	(320)	24	(1 %)	2024	(99 %)	2048
	Input Unallocated	(160)	0	(0 %)	53248	(100%)	53248

Output Allocation

Output Allocation	Output Security	(160)	6	(0 %)	2042	(100%)	2048
	Output Security	(320)	12	(0 %)	2036	(100%)	2048
	Output Qos	(160)	10	(0 %)	2038	(100%)	2048
	Output Qos	(320)	2	(0 %)	2046	(100%)	2048
	Output Unallocated	(160)	0	(0 %)	57344	(100%)	57344

```
Input Profiles (logical) : used 1 / 32
Input Profiles (physical): used 4 / 32
```

```
Output Profiles (logical) : used 1 / 32
Output Profiles (physical): used 4 / 32
```

160 bit entries for IPv4  
320 bit entries for IPv6

# Redundancy Configuration Status - SSO

```
Switch#show module
```

```
Chassis Type : WS-C4510R+E
```

```
Power consumed by backplane : 40 Watts
```

Mod	Ports	Card Type	Model	Serial No.
2	48	10/100/1000BaseT Premium POE E Series	WS-X4748-RJ45V+E	CAT1418L036
3	48	10/100/1000BaseT Premium POE E Series	WS-X4748-RJ45V+E	CAT1352L00L
4	48	10/100/1000BaseT Premium POE E Series	WS-X4748-RJ45V+E	CAT1352L00Y
5	4	Sup 7-E 10GE (SFP+), 1000BaseX (SFP)	WS-X45-SUP7-E	CAT1418L08C
6	4	Sup 7-E 10GE (SFP+), 1000BaseX (SFP)	WS-X45-SUP7-E	CAT1418L08R

```
<snip...snip>
```

Mod	Redundancy role	Operating mode	Redundancy status
5	Active Supervisor	SSO	<b>Active</b>
6	Standby Supervisor	SSO	<b>Standby hot</b>

# Redundancy Configuration Status - SSO

```
Switch#show redundancy status
  my state = 13 -ACTIVE
  peer state = 8 -STANDBY HOT
  Mode = Duplex
  Unit = Primary
  Unit ID = 5
```

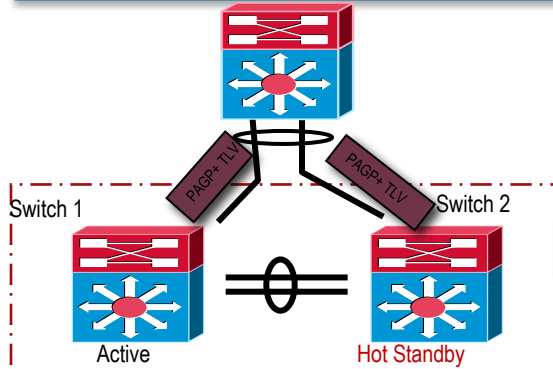
```
Redundancy Mode (Operational) = Stateful Switchover
Redundancy Mode (Configured) = Stateful Switchover
Redundancy State = Stateful Switchover
Manual Swact = enabled
```

```
Communications = Up
```

```
  client count = 64
  client_notification_TMR = 240000 milliseconds
    keep_alive TMR = 9000 milliseconds
    keep_alive count = 0
  keep_alive threshold = 18
  RF debug mask = 0
```

# High Availability - Dual-Active Detection and Recovery

## Enhanced PAgP



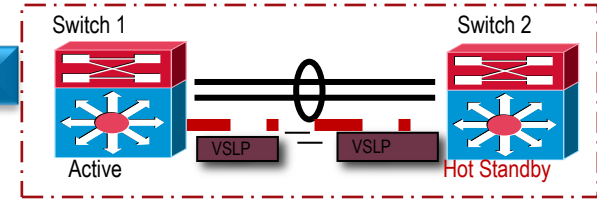
Sub-Sec Detection

- Uses PAgP messaging over the MEC links
- Neighbor switch to support PAgP enhancements

## VSLP Fast Hello



Sub-Sec Detection



- Special hello messages over backup Ethernet
- Helps integrate non-Cisco switches

Standby Switch detects complete VSL failure and assumes Active Switch role

Active Chassis continues to function leading to Dual Active situation and traffic black-hole

Dual Active Detection identifies this and prevents this from happening