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2005

CISCO CATALYST 4500 SWITCH ARCHITECTURE

SESSION RST-4500

Session Goal

To provide you with a thorough understanding of the Catalyst[®] 4500 switching architecture, packet forwarding architecture, and key features to maximize network availability, security, and performance



Agenda

- **Chassis and Supervisor Engine Architecture**
- **IPv4 and Multicast Forwarding Architecture**
- **High Availability**
- **Switching Module Architecture**
- **Power Over Ethernet**
- **Fault Handling**
- **Security and Quality of Service (QoS)**
- **Traffic Analysis using NetFlow**
- **Troubleshooting Tools**
- **Cisco IOS® Release Recommendation**

CATALYST 4500 CHASSIS ARCHITECTURE



Catalyst 4500 Unified Chassis Family

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Catalyst 4503



- Single Supervisor
- 96 linecard ports
- Seven rack units
- 64 Gbps Backplane

Catalyst 4506



- Single Supervisor
- 240 linecard ports
- 10 rack units
- 64 Gbps backplane

Catalyst 4507R



- Redundant Supervisors
- 240 linecard ports
- 11 Rack units
- 64 Gbps backplane

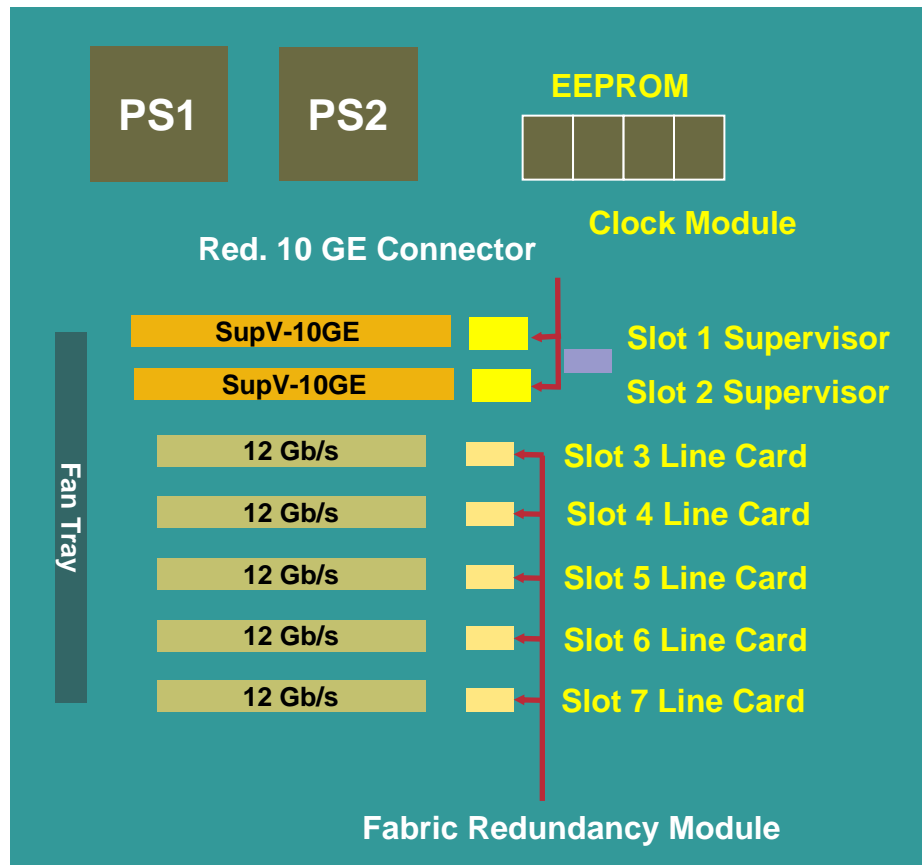
Catalyst 4510R



- Redundant Supervisors
- 384 linecard ports
- 14 Rack Units
- Up to 136 Gbps backplane

Catalyst 4500 Chassis Architecture

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- Modular chassis and fixed configuration
- Redundant power supply
- Power over Ethernet (PoE) capable
- Supports redundant Supervisors
- Fan tray for system cooling
- Redundant clock
- Chassis EEPROM
 - Stores system MAC addresses

CATALYST 4500 SUPERVISOR ARCHITECTURE



Catalyst 4500 Supervisor Architecture

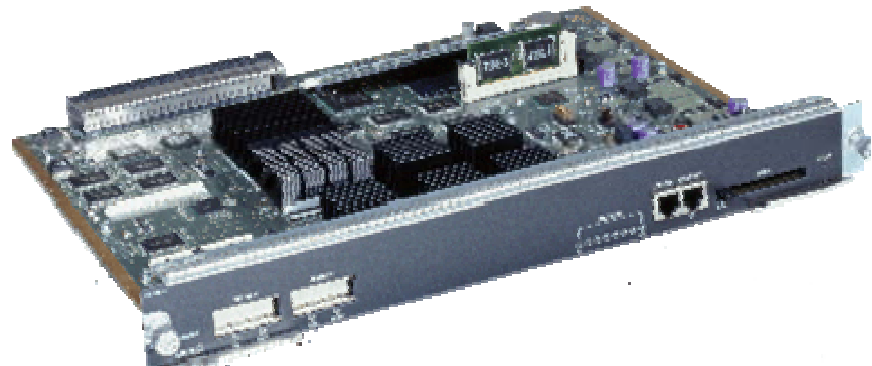
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- **Runs Cisco IOS only**
- **Compact Flash support**
- **On-board Bootflash (32 MB or 64 MB)—Allows multiple images to be stored**
- **Disaster recovery port (10/100T or 10/100/1000T) allows TFTP of Cisco IOS image from ROMMON mode**
- **NVRAM—512 Kbyte; Configuration always compressed**
- **Various types of front panel ports/uplink
GE (GBIC/SFP/RJ45), Ten GE (X2)**

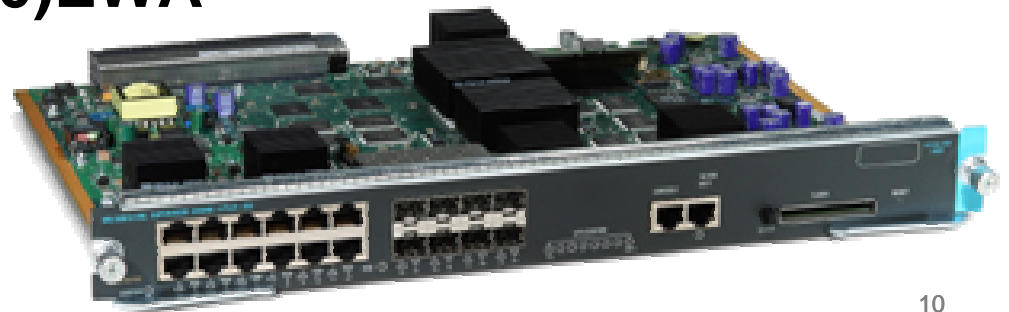
Supervisor II+ (WS-X4013+)

- 64 Gbps capacity and 48 Mpps throughput
- Supported on 4006, 4503, 4506, and 4507R
- Full Layer 2 with security, QoS and basic Layer 3
- **Redundant** Supervisor configuration support in 4507R
- Supported since 12.1(19)EW



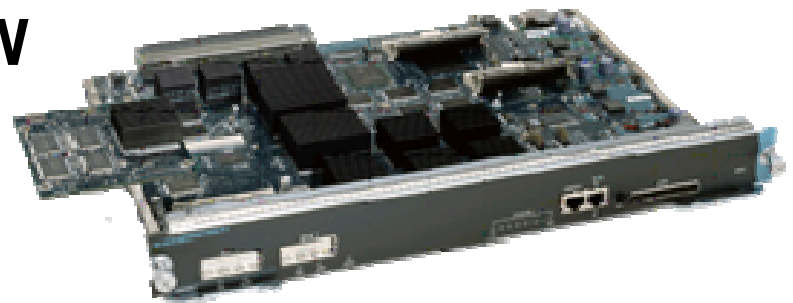
Supervisor II+TS (WS-X4013+TS)

- 64 Gbps capacity and 48 Mpps throughput
- Works **only** in 4503 chassis
- Has 20 GE front panel ports (12 10/100/1000T and 8 SFP GE ports)
- Full L2 with security, QoS and basic L3
- 12 10/100/1000T ports support inline power with/without inline power capable power-supply
- Supported since 12.2(20)EWA



Supervisor IV (WS-X4515)

- 64 Gbps capacity and 48 Mpps throughput
- Supported on 4006, 4503, 4506 and 4507R chassis
- Full L3 (EIGRP, OSPF, BGP, ISIS) with security/QoS features
- **Redundant** configuration support in 4507R chassis
- NetFlow (NFL) feature daughter card support (optional)
- Supported since 12.1(12c)EW



Supervisor V (WS-X4516)

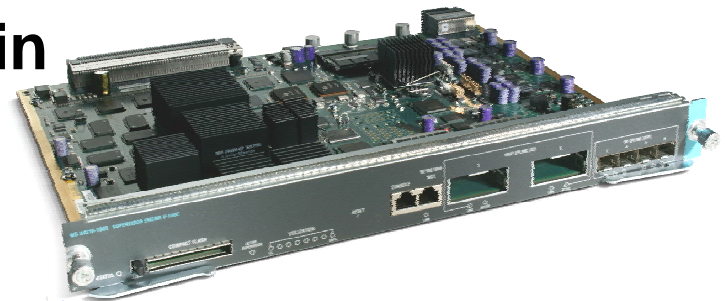
- 96 Gbps capacity with 72 Mpps throughput
- Supported on 4006, 4503, 4506, 4507R, and 4510R chassis
- In 4510R, Supervisor V slot 10 acts in Flex Slot Mode (supports either WS-X4604-GWY(**EOS**) or WS-X4302-GB only)
- Full L3 with security/QoS features
- **Redundant** configuration support in 4507R and 4510R chassis
- NFL daughter card (optional)
- Supported since 12.2(18)EW



Supervisor V-10GE (WS-X4516-10GE)

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- 136 Gbps capacity and 102 Mpps throughput
- Supported on 4503, 4506, 4507R, 4510R
- Any module allowed on slot 10 on 4510R with Sup V-GE (up to 384 ports in Catalyst 4510R)
- Full L3 with security/QoS features
- **Redundant** configuration support in 4507R/4510R
- Two wire-rate 10 GE (X2) and 4 SFP GE uplinks ports (more details later)
- Enhanced NetFlow (NFL2) built-in
- Supported since 12.2(25)EW



10 GE X2 Optical Portfolio for MMF and SMF

X2 Module Type	Maximum Distance over Specified Medium
X2-10GB-LR	10 km on SMF (G.652)
X2-10GB-CX4	Up to 15 m on IBX4 cable
X2-10GB-LX4*	300 m on MMF
X2-10GB-SR	26 m on MMF or 300 m with 2000 Mhz/km MMF
X2-10GB-ER*	40 km on SMF



XenPAK

X2

**Optical
Compatibility
Between
10 GE X2 and
XenPak**

* Available Q3CY'05

Catalyst 4500 Cisco IOS Supervisor Comparison

Supervisor	II+	II+TS	IV	V	V-10GE
Switching Capacity	64 Gbps	64 Gbps	64 Gbps	96 Gbps	136 Gbps
Throughput	48 Mpps	48 Mpps	48 Mpps	72 Mpps	102 Mpps
Multi-Layer Switching	Basic L2/3/4 Services	Basic L2/3/4 Services	Full L2/3/4 Services and Routing	Full L2/3/4 Services and Routing	Full L2/3/4 Services and Routing
(E)IGRP, OSPF, BGP, ISIS	No	No	Yes	Yes	Yes
RIP, Static Routes	Yes	Yes	Yes	Yes	Yes
Chassis Support	C4006, C4503, C4506, C4507	C4503	C4006, C4503, C4506, C4507R	C4006, C4503, C4506, C4507R, C4510R	C4503, C4506, C4507R, C4510R
CPU	266 MHz	266 MHz	333 MHz	400 MHz	833 MHz
IP CEF Entries	32K	32K	128K	128K	128k
SDRAM	256	256	512	512	512
Active VLANs	2K	2K	4K	4K	4k
Multicast Entries	12K(L3) 8K (L2)	12K(L3) 8K (L2)	28K(L3) 16K (L2)	28K(L3) 16K (L2)	28K(L3) 16K (L2)

Base Image Supports EIGRP Stub on Supervisor IV and above

Catalyst 4500 Cisco IOS Supervisor Comparison

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Supervisor	II+	II+TS	IV	V	V-10GE
STP Instance	1.5K	1.5K	3K	3K	3k
SVI	1K	1K	4K	4K	4k
NVRAM	512KB	512KB	512KB	512KB	512KB
NetFlow Support	No	No	Yes (NFL)	Yes (NFL)	Yes (NFL2)
Broadcast Suppression	Software	Software	Software	Hardware	Hardware
Multicast Suppression	No	No	No	Yes	Yes
QoS Sharing	Non-Blocking GE Only	Non-Blocking GE Only	Non-Blocking GE Only	All Ports	All Ports
QinQ	Pass-Through	Pass-Through	Pass-Through	In Hardware	In Hardware
Sup Uplinks	2 GE	8 GE	2 GE	2 GE	2 x 10GE or 4 x GE

Catalyst 4948 (WS-C4948)

- One RU, standalone switch
- 96 Gbps capacity and 72 Mpps throughput
- 48 wire-rate 10/100/1000T GE ports (45–48 alternatively wired for SFP)
- Full L3 with security/QoS features
- **Redundant** hot-swappable power-supplies and replaceable fan tray
- Supported since 12.2(20)EWA



Catalyst 4948-10GE (WS-C4948-10GE)

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- One RU, standalone switch
- 136 Gbps capacity and 102 Mpps throughput
- 48 wire-rate 10/100/1000T GE ports and two wire-rate 10GE uplink ports
- Full L3 with security/QoS features
- **Redundant** hot-swappable power-supplies and replaceable fan tray
- Supported since 12.2(25)EWA



Catalyst 4948 Comparison

Model	WS-C4948	WS-C4948-10GE
Switching Capacity	96 Gbps	136 Gbps
Throughput	72 Mpps	102 Mpps
Multi-Layer Switching	Full L2/3/4 services and routing	Full L2/3/4 services and routing
(E)IGRP, OSPF, BGP, ISIS	Yes	Yes
CPU	266 MHz	666 MHz
IP CEF Entries	32k	32k
SDRAM	256	256
Active VLANs	2K	2k
IGMP Snooping	Yes (8K)	Yes (8k)
STP Instance	1500	1500
SVI	2k	2k
NetFlow Support	No	No
Broadcast Suppression	Hardware	Hardware
Multicast Suppression	Yes	Yes
QoS Sharing	All Ports	All Ports
QinQ	In Hardware	In Hardware
Uplinks	4 SFP	2 10GE (X2)

IPv4 AND MULTICAST PACKET FORWARDING ARCHITECTURE ON CATALYST 4500

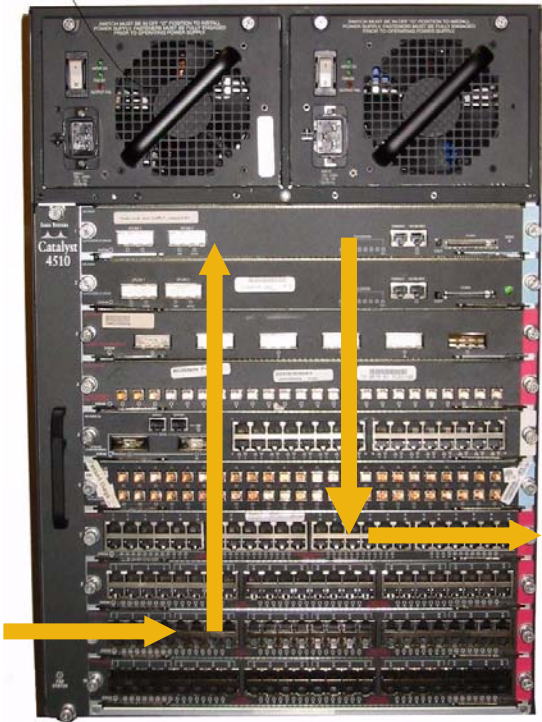


Packet Flow Overview

3—Supervisor Makes Forwarding Decision

2—All Packets Are Sent to Active Sup Over Backplane

1—Packet Received by Linecard

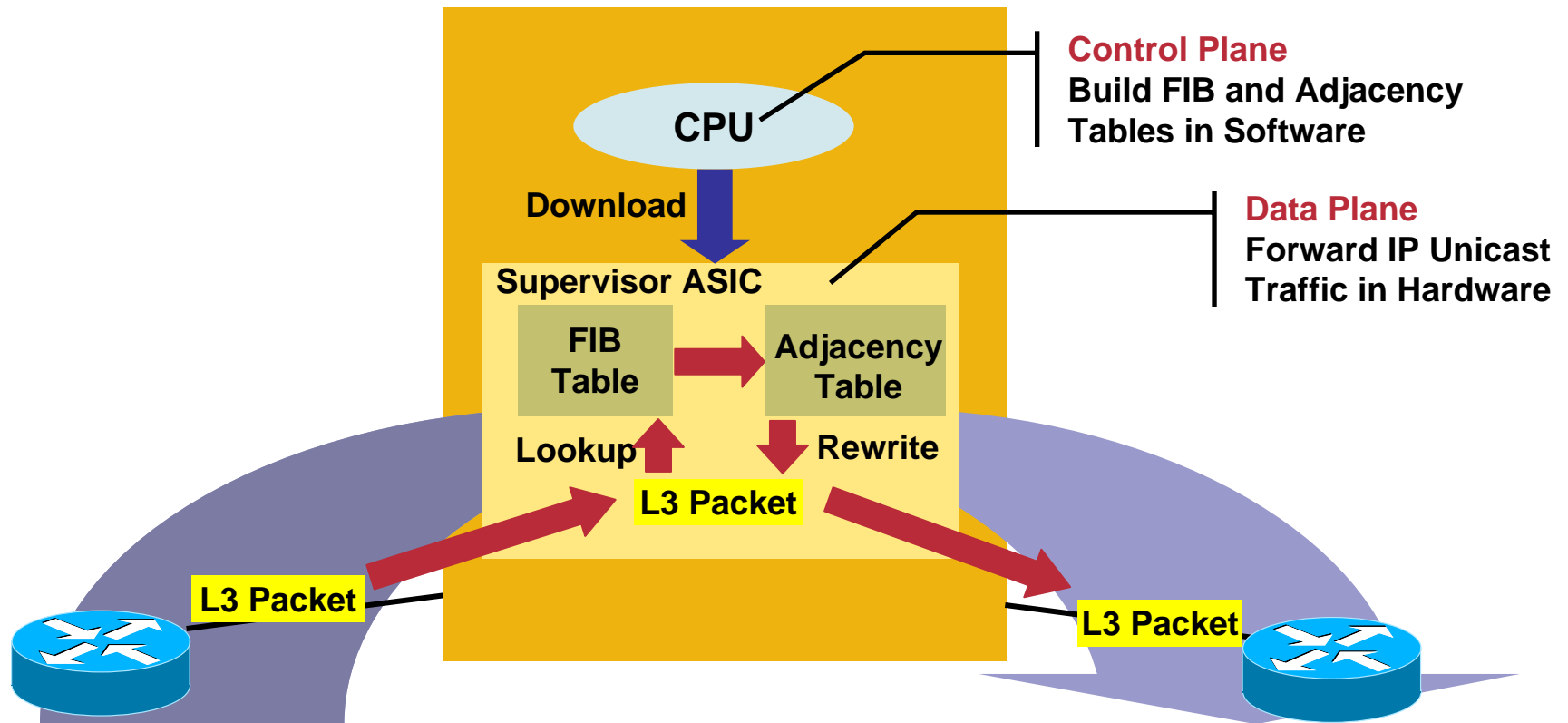


4—Supervisor Sends Packet to Correct Linecard or Uplink

5—Linecard Transmits Packet Out Port

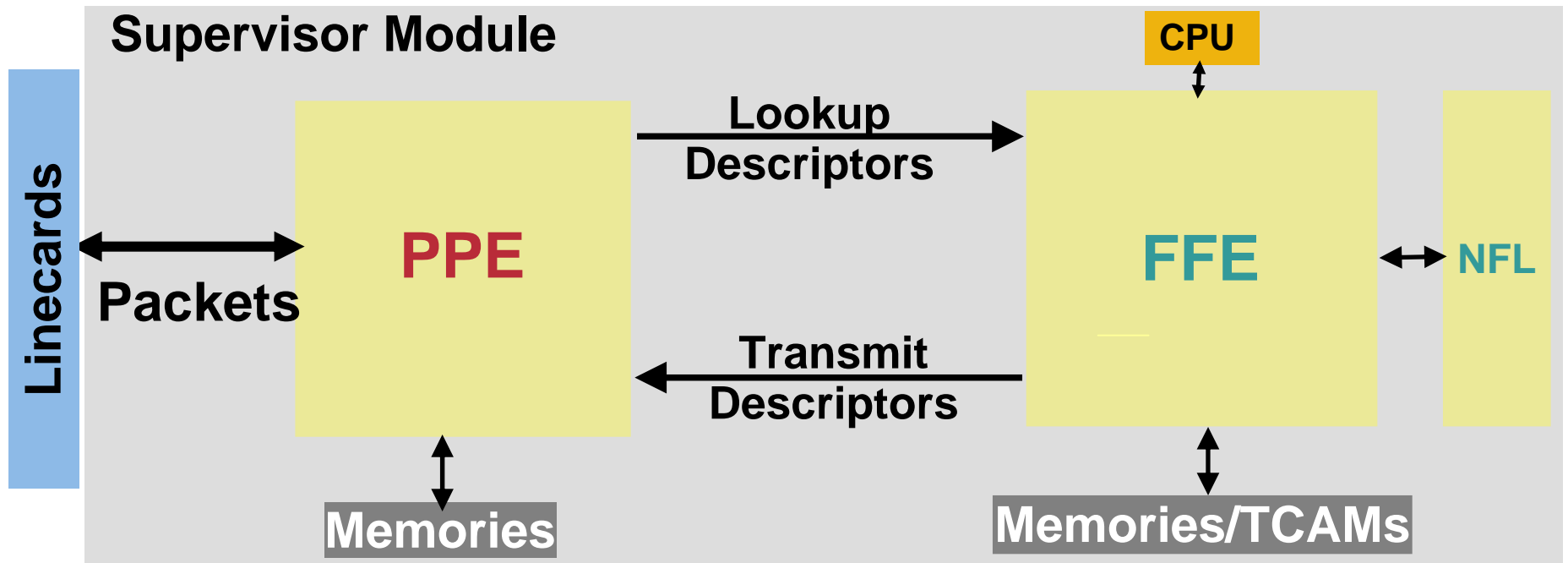
Packet Flow

CEF-Based Unicast Forwarding



Topology Based NOT Flow Based: Consistent High Performance

Catalyst 4500 Supervisor ASICs



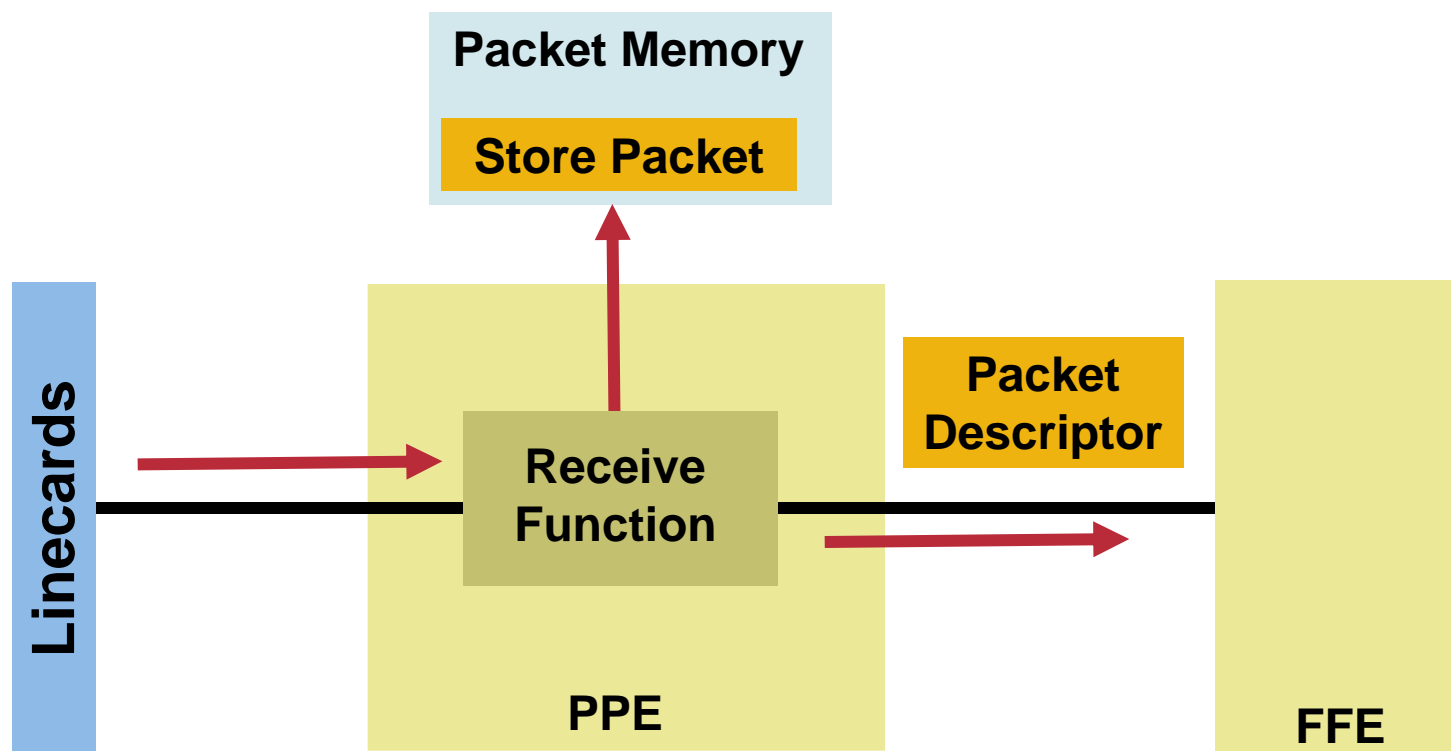
- **Packet Processing Engine (PPE)**

Packet buffering, queuing, scheduling, rewrites

- **Fast Forwarding Engine (FFE) and NFL**

Forwarding lookup, replication, QoS, NetFlow, etc.

Packet Reception at the PPE

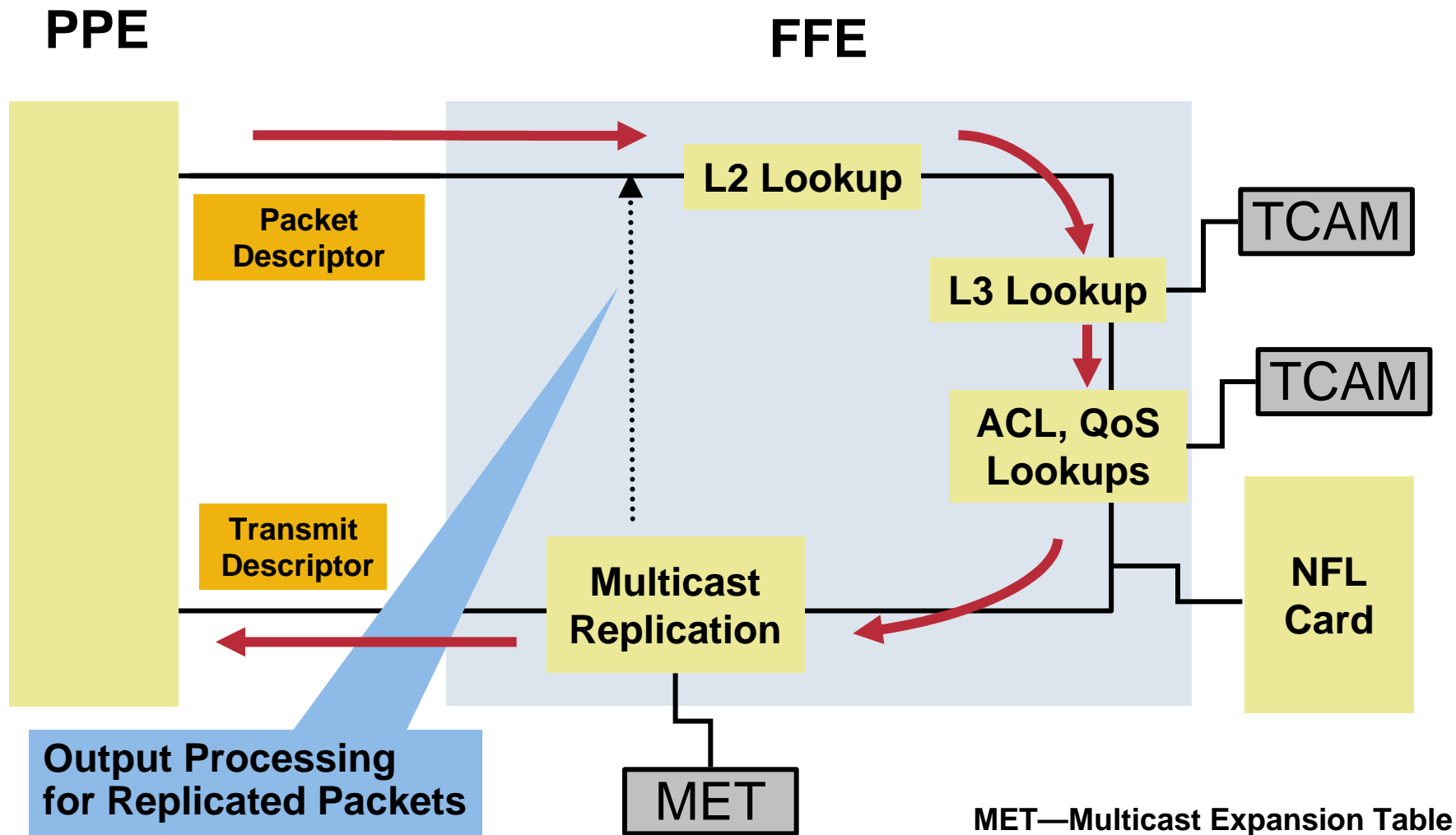


- **Packet memory: list of 256 byte chunks**

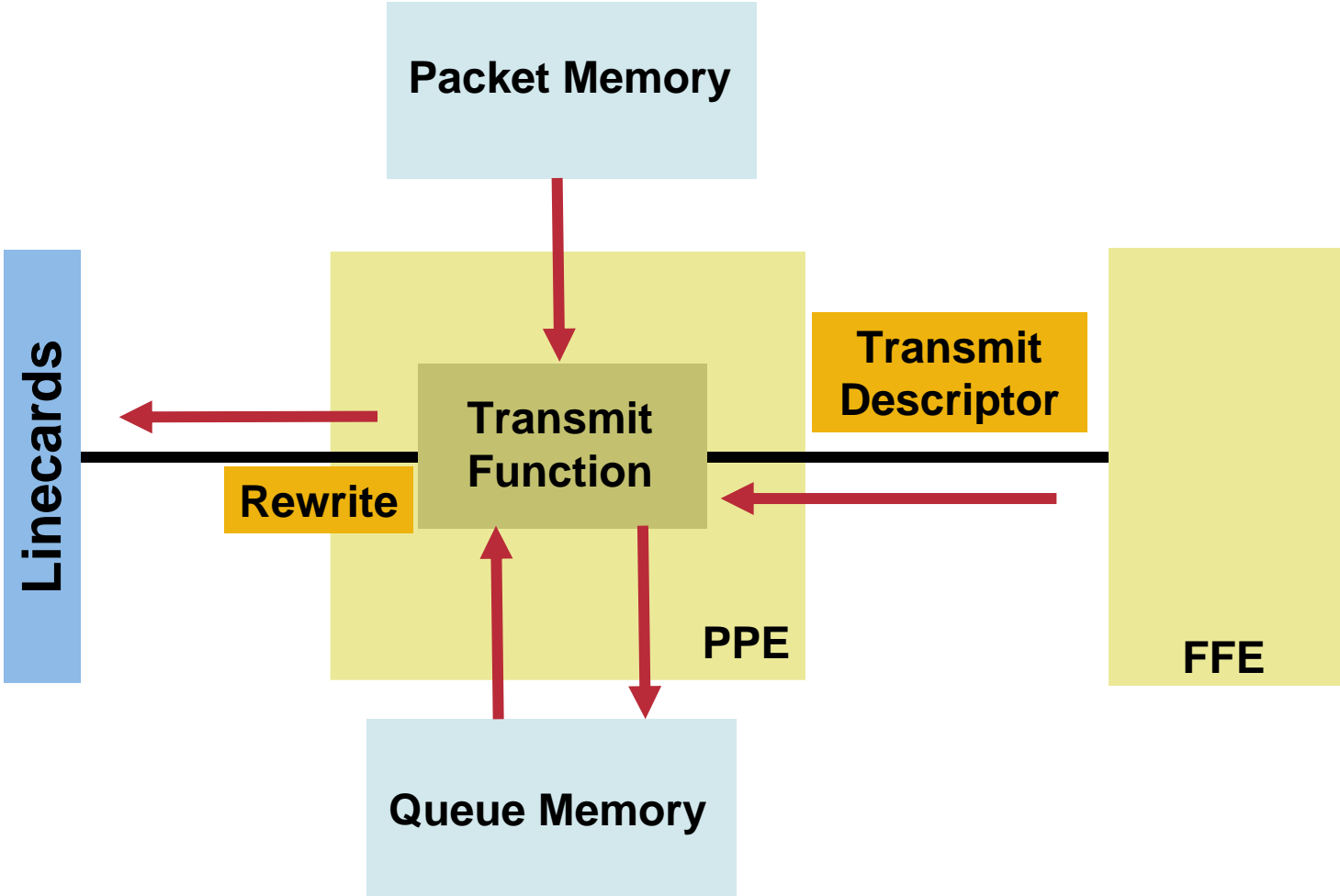
Efficient memory utilization

Hardware support for up to 9 KB routed or switched jumbo packets

Forwarding Decision at the FFE



Packet Transmission at the PPE



Catalyst 4500 Multicast Scalability

Multicast Routing/Features Implemented in Hardware

Supervisor	Supervisor II+/II+TS	Supervisor IV/V/V-10GE
IP multicast routes (PIM Dense mode)	12,000	28,000
IP multicast routes (PIM Sparse mode)	6,000	14,000
IGMP snooping group entries	8,000	16,000
QoS support for IP multicast packets	Full, including four queues per port	Full, including four queues per port
TCAM entries	32,000 (shared by IP unicast, mcast entries)	128,000 (shared by IP unicast, mcast entries)

- **Multicast Routing Features**—PIM-SM, PIM-DM, MSDP, MBGP, IGMP (v3), SSM, PGM, DVMRP, and SSM
- **Multicast Switching Features**—IGMP Snooping (V1,2,3) and CGMP server

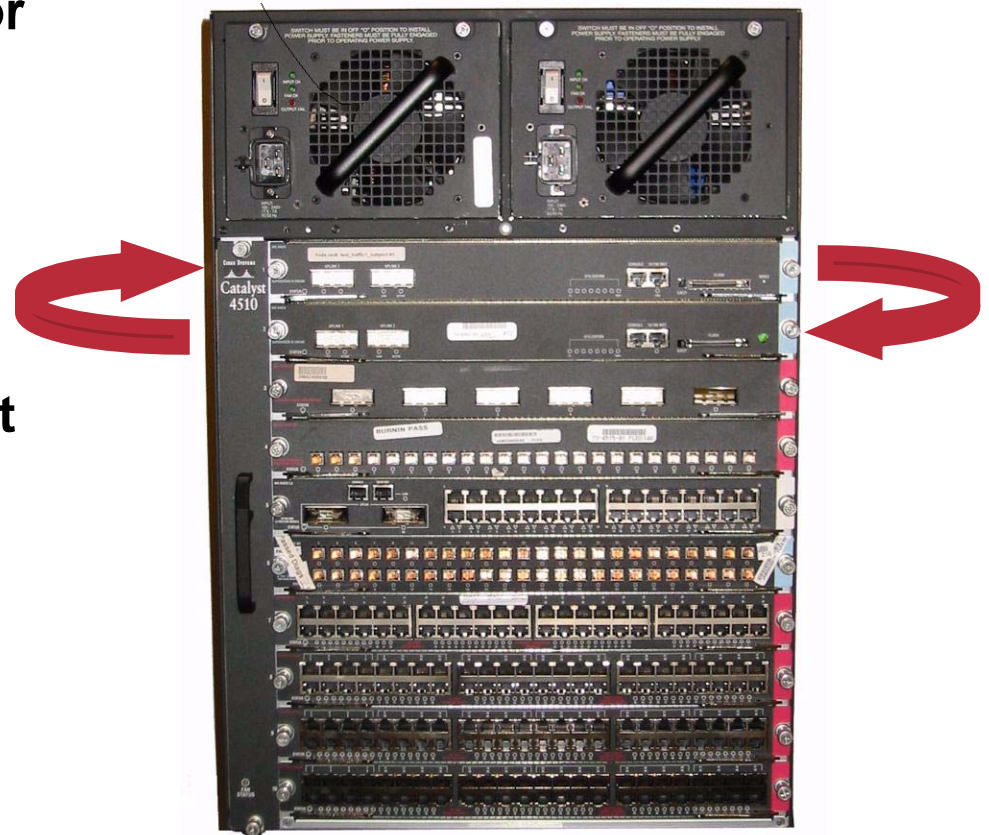
HIGH AVAILABILITY



High Availability: Supervisor Redundancy

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- **Stateful SwitchOver (SSO)** supersedes Route Processor Redundancy (RPR) mode
- **SSO supports sub-second (<200ms) stateful failover** from active to standby supervisor engine
- **Protocol state database built on active supervisor engine and synced to standby at all times**
- **Non-Stop Forwarding (NSF) aware—Graceful restart of routing protocols with NSF capable peers**



SSO on Catalyst 4500

Key Points of Catalyst 4500 SSO

- **Near-zero interruption to Layer 2 switched packets**
- **Modules do not reset**
- **All links stay up and pass traffic without interruption even on the uplink of the supervisor which reset**
- **Phones maintain inline power and calls through switchover**
- **L2 protocols synced**
- **L3 protocols are restarted**

SSO: Protocols That Are Synced

802.3 (Ethernet)	IP Source Guard
802.3u (Fast Ethernet)	IGMP snooping (versions 1 and 2)
802.3x (Flow Control)	Dynamic Trunk Protocol (802.1q and ISL)
802.3ab (GE)	MST (Multiple Spanning Tree)
802.3z (GE including CWDM)	PVST + (Per-VLAN) Spanning Tree plus
802.3ad (LACP)	Rapid-PVST
802.1p (Layer 2 QoS)	PortFast/UplinkFast/BackboneFast
802.1q	BPDU guard and filtering
802.1X (Authentication)	Voice VLAN
802.1D (Spanning Tree Protocol)	Port security
802.3af (Inline power)	Unicast MAC filtering
PAgP (Port Aggregation Protocol)	ACL (VACLs, PACLS, RACLs)
VTP (Virtual Trunking Protocol)	QoS (Dynamic Buffer Limiting)
Dynamic ARP inspection	Broadcast storm control
DHCP snooping	Multicast storm control

Checking Redundancy Status

```
Switch# show module
Chassis Type : WS-C4507R
```

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

Mod	Ports	Card Type	Model	Serial No.
1	6	Sup V-10GE 10GE (X2), 1000BaseX (SFP)	WS-X4516-10GE	JAE090433AA
2	6	Sup V-10GE 10GE (X2), 1000BaseX (SFP)	WS-X4516-10GE	JAE090423KA
6	34	10/100BaseTX (RJ45), 1000BaseX (GBIC)	WS-X4232-GB-RJ	JAE064501KF

M	MAC addresses	Hw	Fw	Sw	Status
1	000b.fd42.9540 to 000b.fd42.9545	1.0	12.2(25r)EW	12.2(25)EWA	Ok
2	000b.fd42.9546 to 000b.fd42.954b	1.0	12.2(25r)EW	12.2(25)EWA	Ok
6	0009.e81d.1678 to 0009.e81d.1699	2.4			Ok

Mod	Redundancy role	Redundancy mode	Redundancy status
1	Standby Supervisor	SSO	Standby hot
2	Active Supervisor	SSO	Active

Displaying Redundancy Details





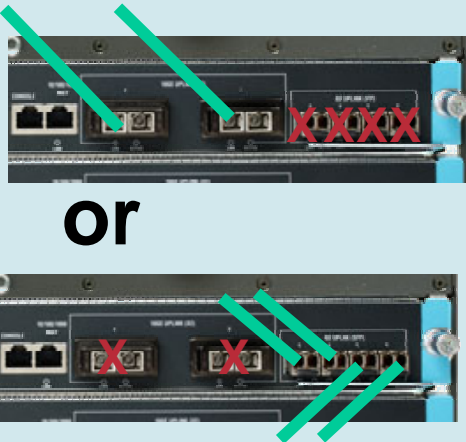
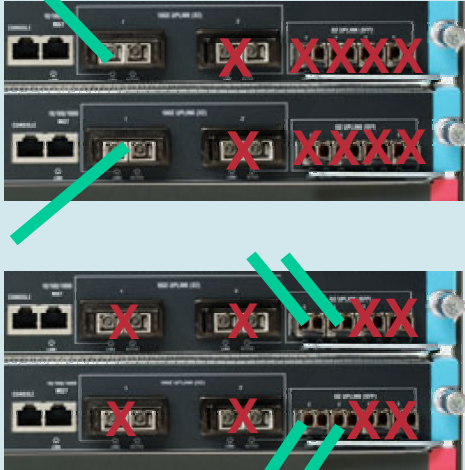
```
Switch# show redundancy
Redundant System Information :
-----
    Available system uptime = 3 weeks, 22 hours,
    50 minutes
Switchovers system experienced = 2
    Standby failures = 0
    Last switchover reason = user forced

    Hardware Mode = Duplex
    Configured Redundancy Mode = Stateful Switchover
    Operating Redundancy Mode = Stateful Switchover
    Maintenance Mode = Disabled
    Communications = Up
```

```
Current Processor Information :
-----
    Active Location = slot 2
    Current Software state = ACTIVE
    Uptime in current state = 3 weeks, 22
    hours, 49 minutes
    Image Version = Cisco IOS
    Software, Catalyst 4000 L3 Switch Software
    (cat4000-I5S-M), Version 12.2(25)EWA SOFTWARE
    BOOT =
    bootflash:cat4000-i5s-mz.122-25.EWA.bin,1;
    Configuration register = 0x2102



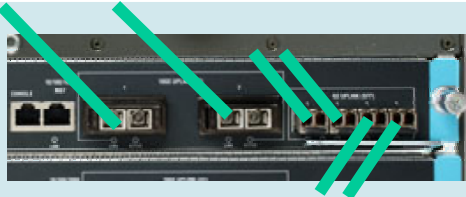

Peer Processor Information :
-----
    Standby Location = slot 1
    Current Software state = STANDBY HOT
    Uptime in current state = 3 weeks, 22
    hours, 50 minutes
    Image Version = Cisco IOS
    Software, Catalyst 4000 L3 Switch Software
    (cat4000-I5S-M), Version 12.2(25)EWA,
    SOFTWARE
    BOOT =
    bootflash:cat4000-i5s-mz.122-25.EWA.bin,1;
    Configuration register = 0x2102
```

Catalyst 4500 Supervisor Uplink Redundancy

Supervisor Module	Non-Redundant	Redundant
Supervisor II+ and IV		
Supervisor V		
Supervisor V-10GE	 <p style="text-align: center;">or</p>	 <p style="text-align: right;">or</p>

— Active Link X Inactive Port

Catalyst 4500 Supervisor Uplink Redundancy

Supervisor V-10GE (combined uplink mode)	Non-Redundant	Redundant
<p>WS-C4503</p> <p>WS-C4506</p> <p>WS-C4507R</p>		 <p>(on WS-C4507R)</p>
<p>WS-C4510R</p>	 <p>Slot 10 is put in Flex Slot Mode</p>	 <p>Slot 10 is put in Flex Slot Mode</p>

Upcoming

— Active Link X Inactive Port

Redundant Supervisor Uplink

- **Directly driven by the active Supervisor**
- **Standby uplink port is active and forward traffic as long as standby Supervisor is fully inserted**
- **Valid standby Supervisor states**
 - Redundant state (normal mode)
 - Standby Supervisor in ROMmon mode
 - Rebooting standby Supervisor
 - Faulty standby Supervisor
- **In SSO mode, the active uplink on both supervisors does not flap even during switchover**

If Either Active or Standby Uplink Port(s) Link Go Down, Other In-active Uplink Port(s) Will **Not Become Active**

Other High Availability Features

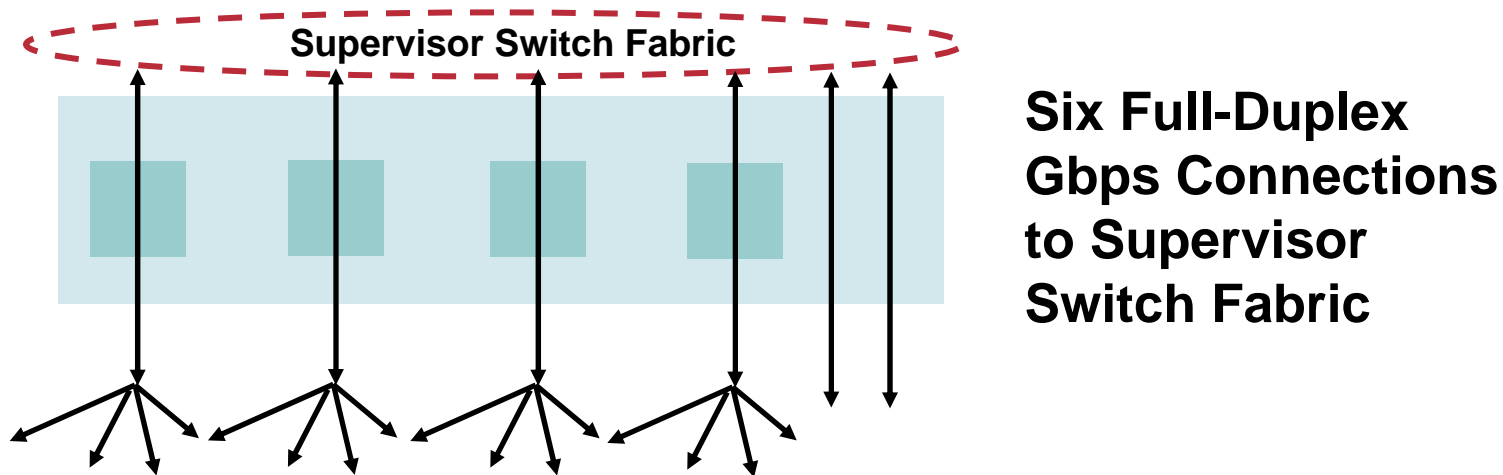
- **Power supply redundancy (1+1 redundancy)**
Two modes—combined vs. redundant
- **Gateway redundancy (HSRP and MHSRP)**
256 unique group IDs
- **Link redundancy—port channel (PAgP/LACP)**
Up to 8 Links and 64 different port channels

SWITCHING MODULE ARCHITECTURE

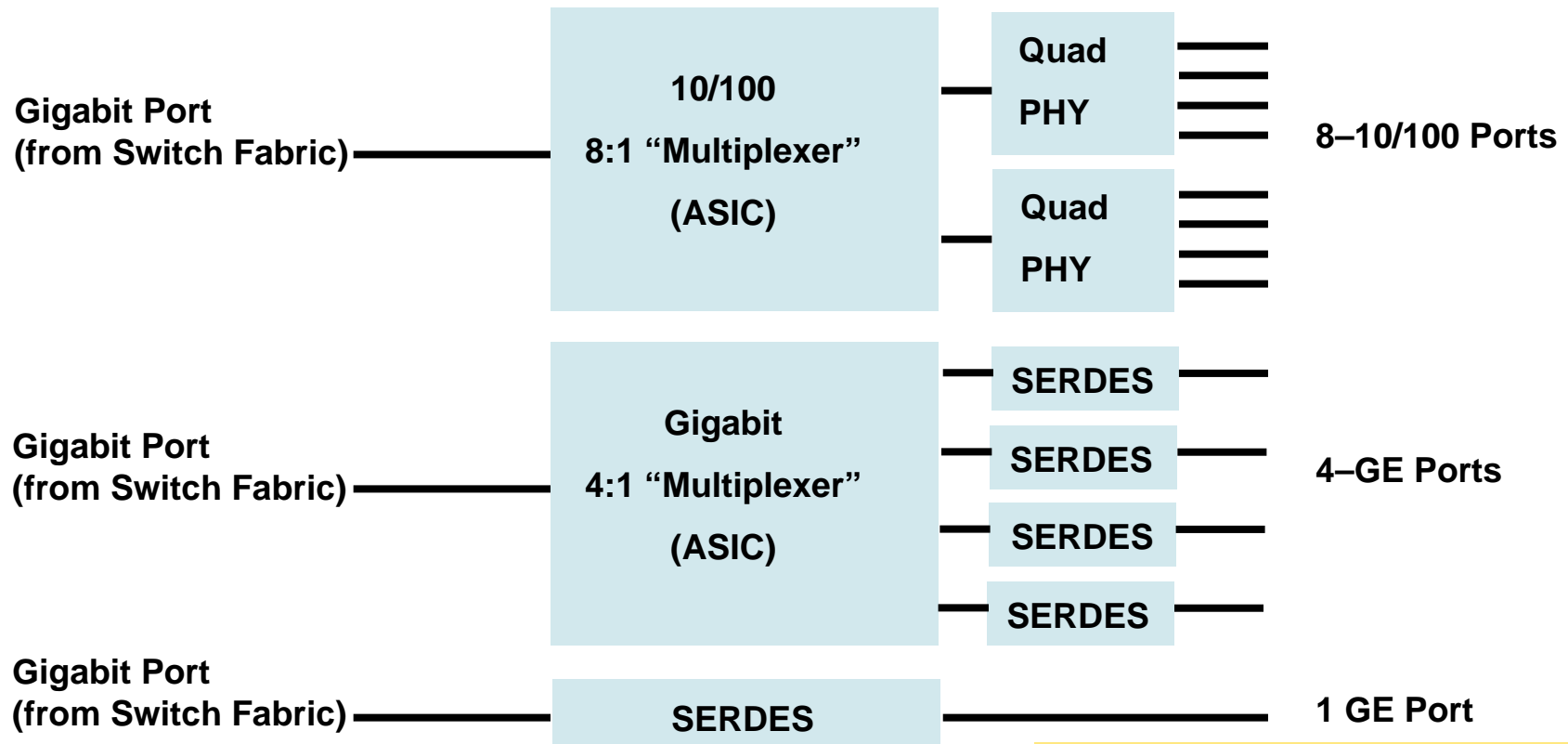


Cisco Catalyst 4000/4500 Linecards

- **Dedicated Six full-duplex Gigabit connections to switch fabric**
- **Transparent**
 - No local forwarding—all packets go to supervisor
- **Gigabit connections from switch fabric straight to front-panel port or connect to stubs**



Stubs ASIC



SERDES—SERializer-DESerializer

- Up to eight front-panel ports; 10/100, 1000-only, or 10/100/1000
- **Not always oversubscribed e.g., 10/100**
- Ports can be used in an EtherChannel
- Flow control on GE interfaces

Over-Subscription on GE Ports

- **A port that does not oversubscribe access to the switching fabric is a non-blocking GE port**
- **A port that oversubscribes access to the switching fabric is a blocking GE port**
- **On over-subscribed GE ports, each of the front-panel port can burst up to one Gigabit**
- **On transmit and receive side of Stub ASIC, each of the front panel port is serviced round-robin on a per-packet basis**
- **Guaranteed rate per-port, if all of them are bursting at same packet size:**
 - 8:1—125 Mbps**
 - 4:1—250 Mbps**

Blocking and Non-Blocking GE Ports

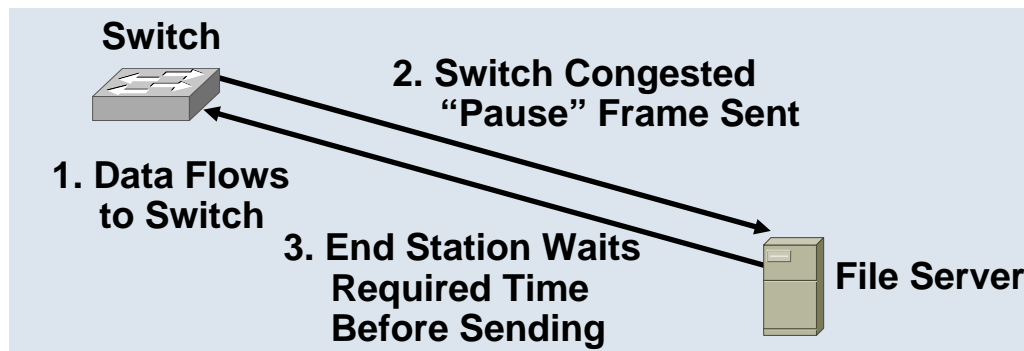
Non-Blocking GE Line Cards/Chassis	Blocking GE Line Card	Oversubscription Ratio for Blocking Line Cards
Supervisor Uplink Ports		
All Ports on the following WS-X4302-GB WS-X4306-GB WS-X4506-GB-T WS-X4013+TS WS-C4948 WS-C4948-10GE	All Ports on the following WS-X4424-GB-RJ45 WS-X4524-GB-RJ45V	4:1
Two 1000 Base-X Ports on the WS-X4232-GB-RJ	All Ports on the following WS-X4448-GB-RJ45 WS-X4448-GB-SPF WS-X4448-GB-LX WS-X4548-GB-RJ45 WS-X4548-GB-RJ45V	8:1
First Two Ports on WS-X4418-GB	Last 16 Ports on the WS-X4418-GB	4:1
	1000 Base-T Ports on the WS-X4412-2GB-TX	4:1

Jumbo Frames (up to 9216 byte) Are Supported Only on Non-blocking Ports

- Oversubscribed GE modules are ideal for deployments that are more bursty in nature such as GE to the Desktop and Servers
- **These interfaces are not recommended for uplinks or sustained connections**

IEEE 802.3 Flow Control

- Standards-based mechanism used to control data flow
- Flow control operation steps
 1. Data flows to switch
 2. Switch congested so “pause” frame sent
 3. End station waits required time before sending
- Catalyst 4500 supervisors support both Tx and Rx pause frames



```
Switch# show interface GigabitEthernet 4/7 counters detail
<output skipped>
Port          Rx-No-Pkt-Buff  RxPauseFrames  TxPauseFrames  PauseFramesDrop
Gi4/7         0                35648          4854           0
```

Flow Control Setting

Type of Interface	Send	Receive
Stub GE (blocking)	On	Desired
Non-Stub GE (non-blocking)	Off (not needed)	Desired
Ten GE (non-blocking)	Off (not needed)	On

Recommended Configuration Is Default

```
4500(config)# interface GigabitEthernet 3/1
4500(config-if)# flowcontrol send on
4500(config-if)# flowcontrol receive desired
```

Checking Capabilities of an Interface

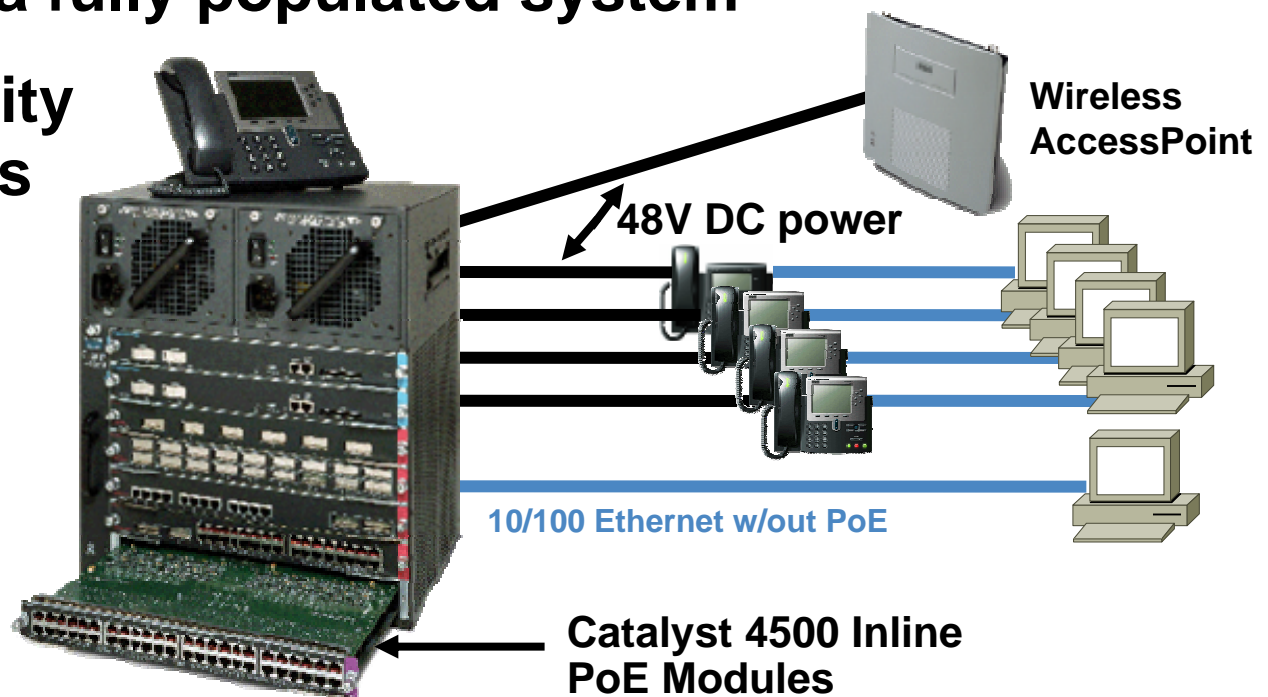
```
Switch# show interfaces GigabitEthernet 1/1 capabilities
GigabitEthernet1/1
  Model:                WS-X4013+TS-RJ-45
  Type:                 10/100/1000-TX
  Speed:                10,100,1000,auto
  Duplex:                half,full,auto
  Trunk encap. type:    802.1Q,ISL
  Trunk mode:           on,off,desirable,nonegotiate
  Channel:              yes
  Broadcast suppression: percentage(0-100), hw
  Flowcontrol:          rx-(off,on,desired),tx-(off,on,desired)
  VLAN Membership:     static, dynamic
  Fast Start:           yes
  Queuing:              rx-(N/A), tx-(lp3qlt, Sharing/Shaping)
  CoS rewrite:          yes
  ToS rewrite:          yes
  Inline power:         yes (Cisco Voice Protocol/IEEE Protocol 802.3af)
  SPAN:                 source/destination
  UDLD:                 yes
  Link Debounce:        no
  Link Debounce Time:   no
  Port Security:        yes
  Dot1x:                yes
  Maximum MTU:          9198 bytes (Jumbo Frames)
```

POWER OVER ETHERNET ON CATALYST 4500



Catalyst 4500 and Power Over Ethernet

- Catalyst 4500 series offers fully integrated solution with integrated data/voice power supplies
- Can provide 15.4W of power simultaneously on every port in a fully populated system
- Multiple density PoE line cards available



Budgeting Power (Focus on What's Needed)

7W x 240 ports=1618W

17.3W x 240 ports= 4152W



**IEEE 802.3af:
Class 1**

**IEEE 802.3af:
Class 2**

**IEEE 802.3af:
Class 0 and
Class 3**



- Using CDP, a Cisco Power Device (PD) can signal precise power requirements to the switch
- Due to DC/DC isolation, switch needs to draw higher power from power supply with 89% efficiency

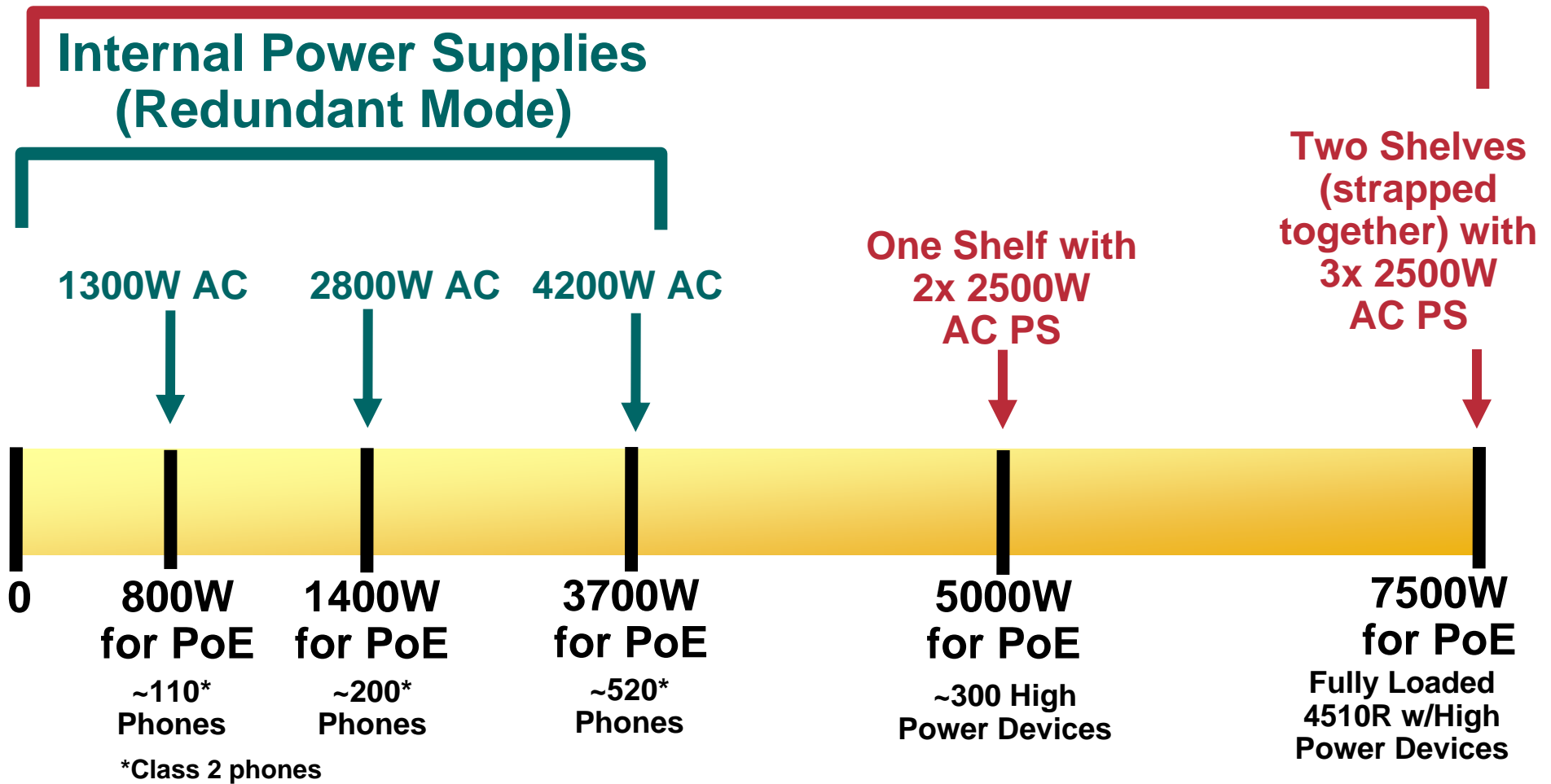
17.3W needed from power supply for Class 0 or 3 devices

Catalyst 4500 Power Supply Options

Power Supply	Redundant Mode		Combined Mode	
	System (W)	PoE (W)	System (W)	PoE (W)
PWR-C45-1000AC	1000	0	1667	0
PWR-C45-1300ACV	1000 (max)	800 (max)	1667 (max) 767 (min)	1333 (max) 533 (min)
PWR-C45-1400DC with Ext Power shelf	1367(max)	7500 (max)	2267 (max)	7280 (max)
PWR-C45-1400AC	1360	0	2473	0
PWR-C45-1400DC-P (400W/500W/500W)	400-1360	0	824-2450	0
PWR-C45-2800ACV	1360	1400	2473	2333
PWR-C45-4200ACV	1360 (max)	3700 (max)	2472 (max)	6800 (max)

Catalyst 4500 PoE Power Supplies

External Power Shelf



FAULT HANDLING ON CATALYST 4500



Fault Handling

Power on Diagnostics

Supervisor

Backplane connections

PPE ASIC

FFE ASIC

Memory

Ports

On-line Diagnostics

Power Supply

Fan Tray

Modules

On-Going Health Checks

Module ASICs

Supervisor Memory

Supervisor Redundancy

Software-Hardware State
Consistency (e.g., L3 table
consistency)

Temperature

Power-Supply

Fan Tray

**User Notified via Console/Syslog Error Messages
and Crash Information for Development Analysis**

Checking Diagnostics

- Detailed diagnostics results including on-going memory tests on Supervisor

```
show diagnostic result module <slot_id> detail
```

- Diagnostics test result saved in bootflash device if the diagnostics has failed on bootup
- Reset active or standby supervisor or other modules using the following command

```
hw-module module <slot_id> reset
```

- Resetting modules force the switch to perform online diagnostics

Catalyst 4500 Cisco IOS Crashdump

- Slightly different behavior from Cisco IOS routers
- Currently crashinfo is not saved in bootflash device
 - `show platform crashdump`—To display crashinfo file on active supervisor
 - `more slavecrashinfo:data`—To display crashinfo file from standby supervisor
- Use `platform clear crashdump` command to clear the crashdump
- Crashdump does NOT have to be cleared to create a new crashdump; switch will automatically over-write
- Crashinfo should be sent to Cisco TAC for evaluation

Fan Tray Fault Handling

- **One fan failure**

Log message to replace fan tray

- **More than one fan failure**

Shutdown chassis after five minutes if fan tray not replaced

```
%C4K_IOSMODPORTMAN-4-FANTRAYBAD: Fan tray has failed
```

```
%C4K_CHASSIS-2-INSUFFICIENTFANSDETECTED: Too few  
working fans in fan tray, the chassis will overheat; if not resolved,  
in five minutes all line cards will be placed into Reset-Mode
```

**Beware of Erroneous Fan Tray Failure Error
Message **Prior** to 12.2(25)EWA**

FAN Tray Failure

```
Switch# show module
```

```
Chassis Type : WS-C4503
```

```
Power consumed by backplane : 0 Watts
```

Mod	Ports	Card Type	Model	Serial No.
1	2	1000BaseX (GBIC) Supervisor(active)	WS-X4515	JAB062604L2
2	0	Over temperature or fantray failure	WS-X4448-GB-LX	JAB05190CTQ
3	0	Over temperature or fantray failure	WS-X4148-RJ45V	JAE065003RH

M	MAC addresses	Hw	Fw	Sw	Status
1	0005.9a38.5400 to 0005.9a38.5401	0.4	12.1(19r)EW	12.2(25)EWA	Ok
2	0005.9a3c.9690 to 0005.9a3c.96bf	0.1			Env Shut
3	0050.3e7e.1a70 to 0050.3e7e.1a9f	0.0			Env Shut

```
System Failures:
```

```
-----
```

```
Fan Tray : removed (see 'show environment')
```


Power-Supply Failure Handling

- **All Power Supply in redundant mode will be able to provide Data power**
 - 1400 W AC or greater is required for 4510R chassis
- **Failure handling relevant in PoE scenario in combined mode**

Switch Acts Immediately if System Has Less Power Than Needed

- **First priority is to make sure ALL modules stay powered up for Data**
- **Power transferred from PoE to Data (system power) if needed up to maximum for Data (in variable Power Supplies scenario)**
- **Starting from the bottom slot module, PDs lose power starting from port 48 → 1 on any given module if necessary**

SECURING NETWORK USING CATALYST 4500



Security Features on Catalyst 4500

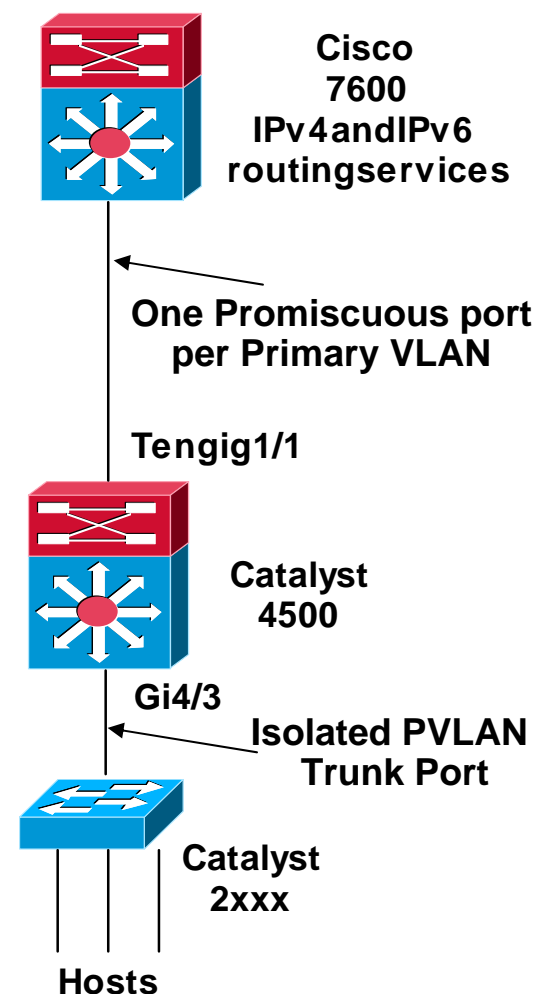
- **Private VLANs**
- **Port Security**
- **802.1X Port-based authentication**
- **DHCP Snooping/Dynamic ARP inspection/
IP Source Guard**
- **QoS Trusted Boundary**
- **Broadcast/Multicast Suppression (Storm Control)**
- **Unicast/Multicast Flood Block**
- **Access Control Lists**

Isolated Private VLAN Trunk Ports

Cisco.com

```
interface gi4/3
// Primary 2 secondary 200 (isolated)
switchport private-vlan association trunk 2 200
// Primary 3 secondary 300 (isolated)
switchport private-vlan association trunk 3 300
// Allow other normal VLANs. Default - No VLANs
switchport private-vlan trunk allowed vlan 5-30
switchport private-vlan trunk native vlan 5
switchport mode private-vlan trunk secondary
!
```

Isolation Between Customers in the Aggregation Layer Catalyst 4500

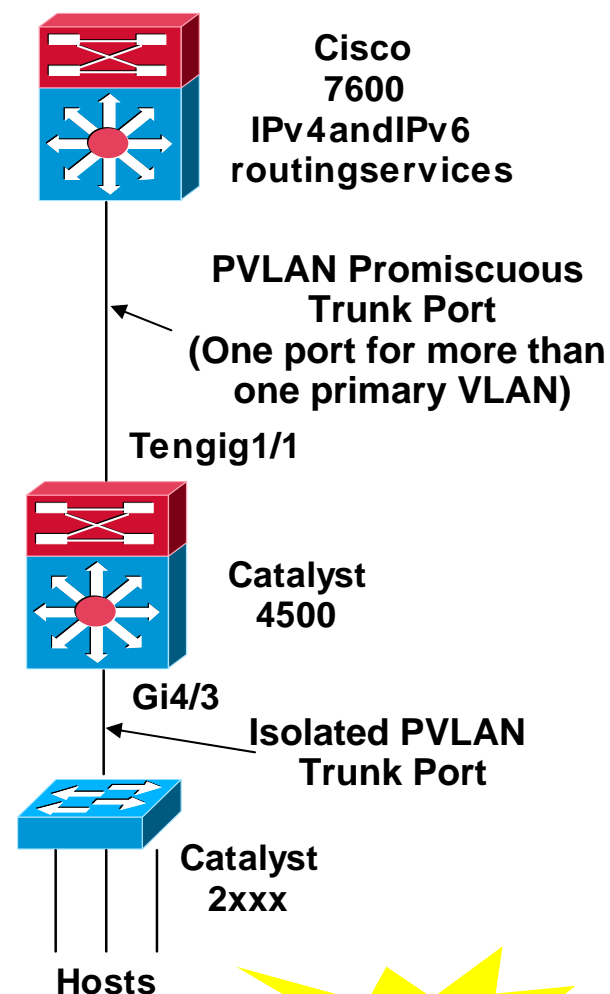


Promiscuous Private VLAN Trunk Ports

Cisco.com

```
interface Tengig1/1
// Primary 10 secondary 101 & 102
switchport private-vlan mapping trunk 10 101,202
// Primary 20 secondary 200 & 201
switchport private-vlan mapping trunk 20 201,202
// Allow other normal VLANs. Default - No VLANs
switchport private-vlan trunk allowed vlan 5-30
switchport private-vlan trunk native vlan 50
switchport mode private-vlan trunk promiscuous
!
```

- Ability to use single uplink to carry multiple Primary VLAN
- No need for single physical port per primary VLAN



Upcoming

Port Security

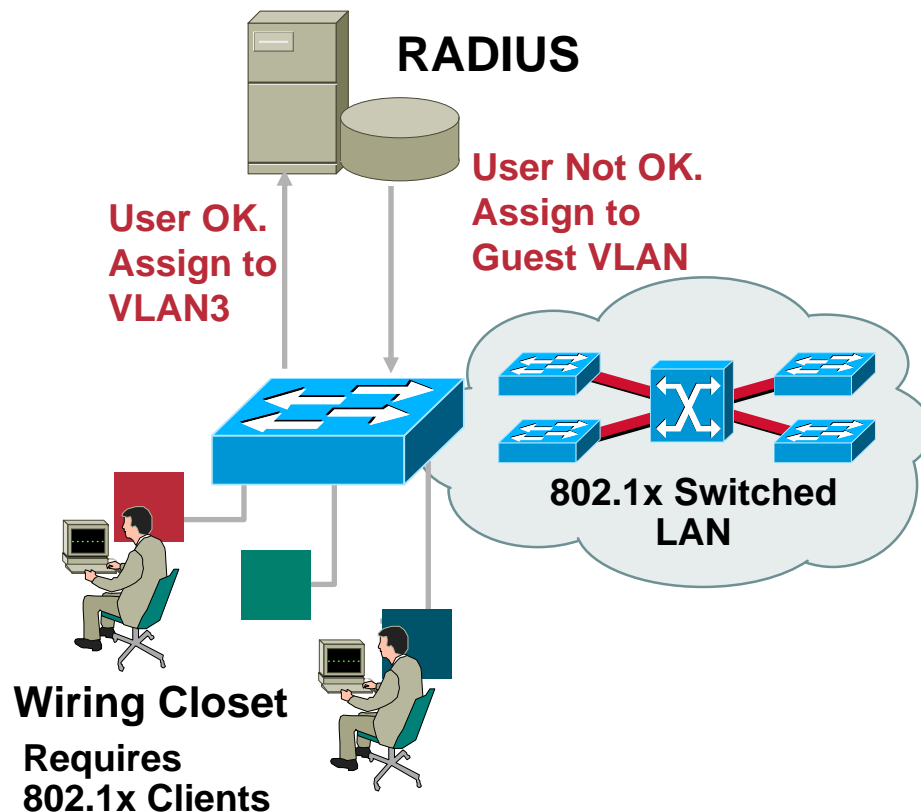
- Prevents MAC spoofing attack and MAC flooding attack
- Allows to specify MAC addresses for each port, or to learn a certain number of MAC addresses per port
- Secure port generate violation when an incoming packet
 - Is not one of the configured secure MAC address
 - Exceeds configured maximum number of MAC address on that port
- Port can be configured to drop the packet in hardware or err-disable the port upon violation
- Sticky Port Security is supported
- Trunk Port Security is supported with per-VLAN limit of maximum MAC addresses
- Catalyst 4500 supports can secure up to **1 MAC per port + 3000 MAC address supported**

An Incoming Bogus Packet That Has a Source Address of Already Secure Address on Another Port (on the Same device) Is **Dropped in Hardware**; Port Is **Not** Err-Disabled

802.1x Port-Based Authentication

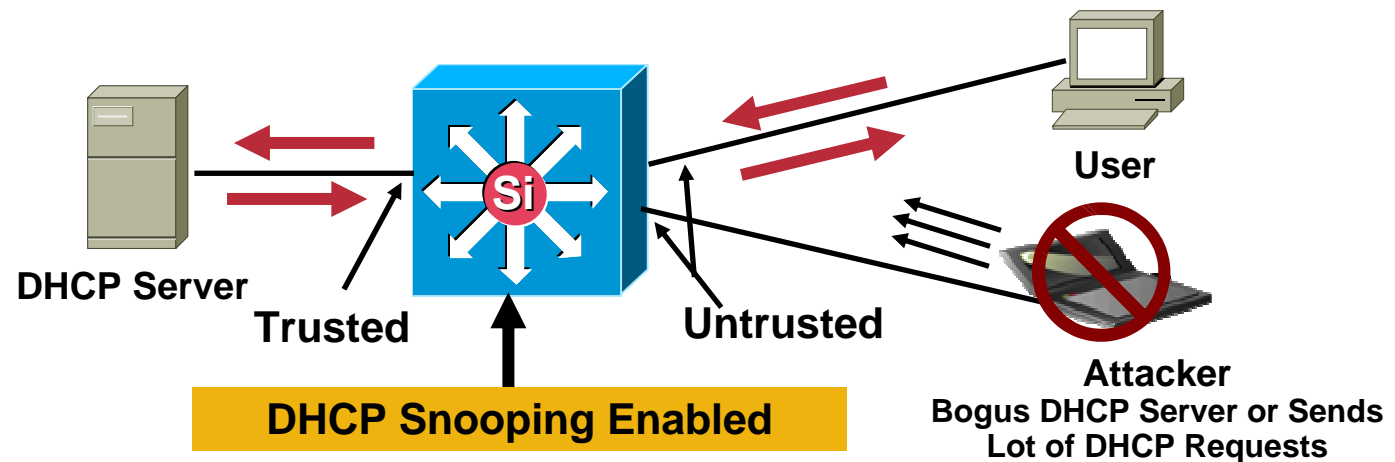
Catalyst 4500 Currently Supports the Following

- 802.1x VLAN or PVLAN assignment
- 802.1x Guest VLAN or PVLAN
- 802.1x with VVID
- 802.1x with Port Security
- 802.1x Accounting



Catalyst 4500 Will Support Network Admission Control (NAC) 2.0 Features

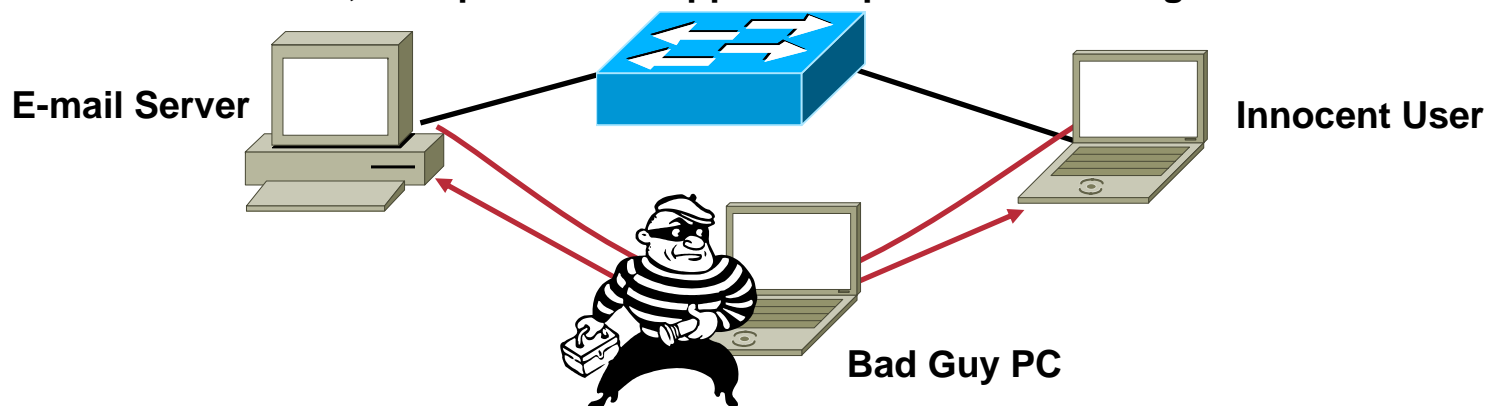
DHCP Snooping



- DHCP snooping provides DHCP based DOS attack against malicious or un-intentional user device or rogue DHCP server
- Switch can prevent DoS attack by rate limiting the DHCP packets on access ports
- DHCP Snooping provides DHCP broadcast isolation; if the server is not local to the Catalyst 4500 Switch, trust the uplink port
- Configure TFTP database agent to store bindings in case of supervisor switchover in SSO mode or Metro Ethernet scenario
- Catalyst 4500 supports up to **2000 IP DHCP snooping entries** on all Sups (**SupV-10GE supports up to 8000 bindings**)

Dynamic ARP Inspection (DAI)

- DAI is used prevent ARP spoofing attacks (man-in-the-middle attacks)
- DAI configuration and operation steps
 1. DAI is enabled per VLAN
 2. Use ARP ACLs for hosts with Static IP addresses
 3. ALL ARP packets are captured by the switch in that VLAN
 4. DAI uses DHCP snooping binding table to validate the incoming ARP reply for the MAC-IP Pair via a dynamic ACL
 1. If valid, ARP table is populated and packet is switched
 2. If invalid, ARP packet is dropped and port can be configured to err-disable



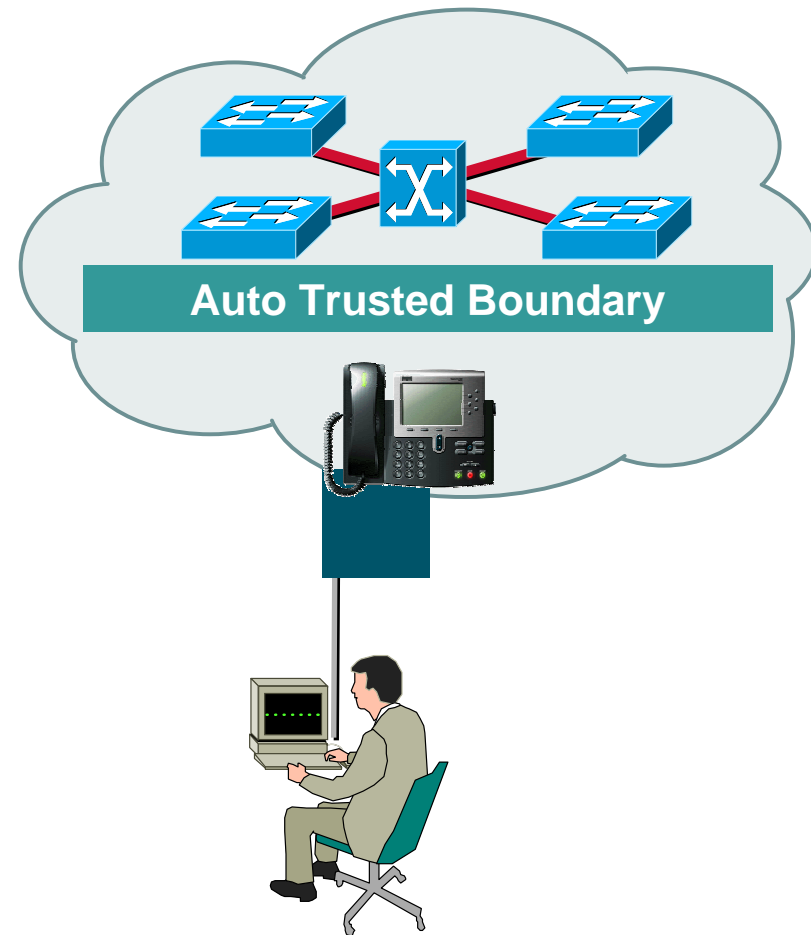
IP Source Guard

Prevent Denial of Service (DoS) Attacks Based on IP Address Spoofing

- **Malicious or Mis-configuration—users change their IP address to a static one from DHCP assigned**
- **Changing source IP address enables device spoofing, bypassing ACLs, and results in anonymous DoS attacks**
 - In Metro Ethernet scenario, spoofed address could be the address of another customer from the same subnet**
- **Similar to DAI, requires enabling DHCP snooping for dynamic IP source guard or requires static entries**
- **With DHCP snooping, IPSG automatically configures a port ACL for IP address and adds MAC address to port security list for the port**
- **ACL and Port security entry is removed when lease expires**

Trusted Boundary with IP Phones

- Provides ability to trust QoS priority settings only when an IP phone is present
- Switch disables the trust setting if the phone is removed
- Preventing malicious users from overriding prioritization policies in the network
- CDP is required to detect Cisco IP Phone



Configuring Trust Boundary

Use **qos trust device cisco-phone** command along with **qos trust cos** command to configure Trust Boundary

```
Switch# show qos interface gig 1/20
QoS is enabled globally
Port QoS is enabled
Administrative Port Trust State: 'cos'
Operational Port Trust State: 'untrusted'
Trust device: cisco-phone
Default DSCP: 0 Default CoS: 0
```

No Cisco IP Phone Detected

// Cisco IP Phone Plugged here

```
Switch# show qos interface gig 1/20
QoS is enabled globally
Port QoS is enabled
Administrative Port Trust State: 'cos'
Operational Port Trust State: 'cos'
Trust device: cisco-phone
Default DSCP: 0 Default CoS: 0
```

Switch Sees Cisco IP Phone Through CDP

Broadcast and Multicast Storm Control

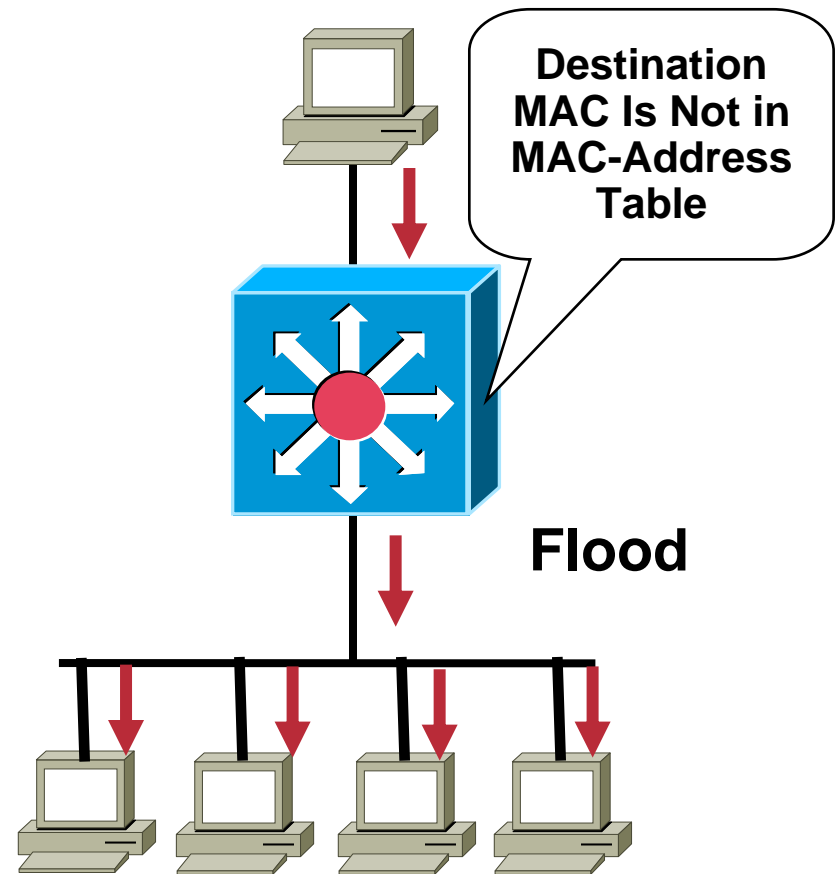
- Prevents LAN interfaces from Broadcast/Multicast storms
- Shut down interface or sends SNMP Traps upon detection
- Use `show interface <interface-id> capabilities` to check for support

Supervisors	Broadcast Suppression	Multicast Suppression
Supervisor II+ / II+TS / IV	HW—Non-blocking ports SW—Stub ports	Not supported
Supervisor V / V-10GE / Cat4948/Cat4948-10GE	HW	HW

```
4500(config)# interface fa3/1
4500(config-if)# storm-control broadcast level 50
4500(config)# storm-control broadcast include multicast
```

Unknown Unicast and Multicast Flood Blocking

- Normally switch floods unknown unicast and multicast packets to ALL ports in the same VLAN
- Possibly lead to congestion or bandwidth usage on all ports
- Exaggerated in scenario of asymmetric routing
- Unicast/Multicast Flood blocking feature blocks flooded traffic to the configured port



```
4500(config)# interface fa3/1
4500(config-if)# switchport block unicast
4500(config-if)# switchport block multicast
```

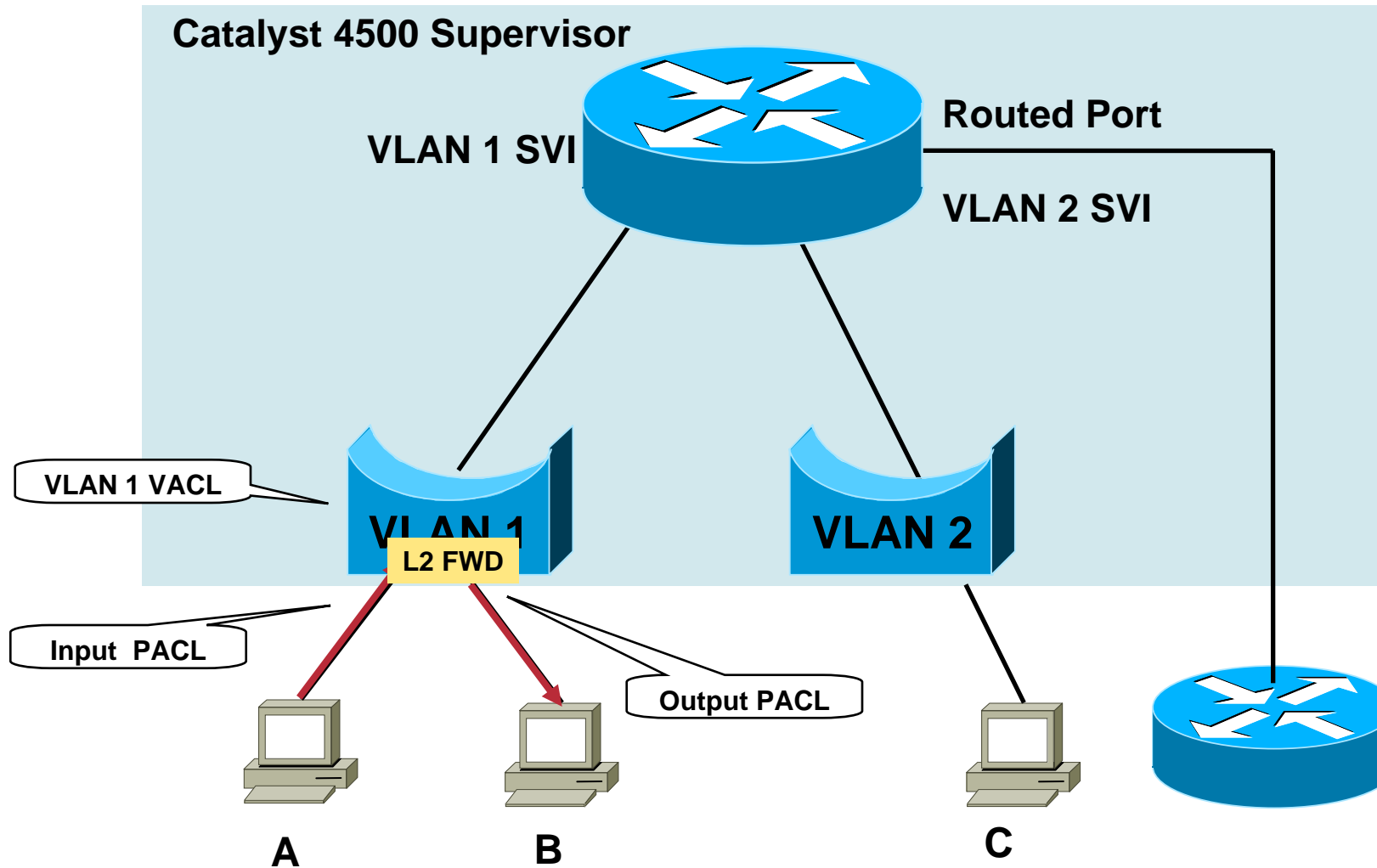
Access Control Lists (ACLs)

Catalyst 4500 Supports Different Types of ACL for Security and QoS

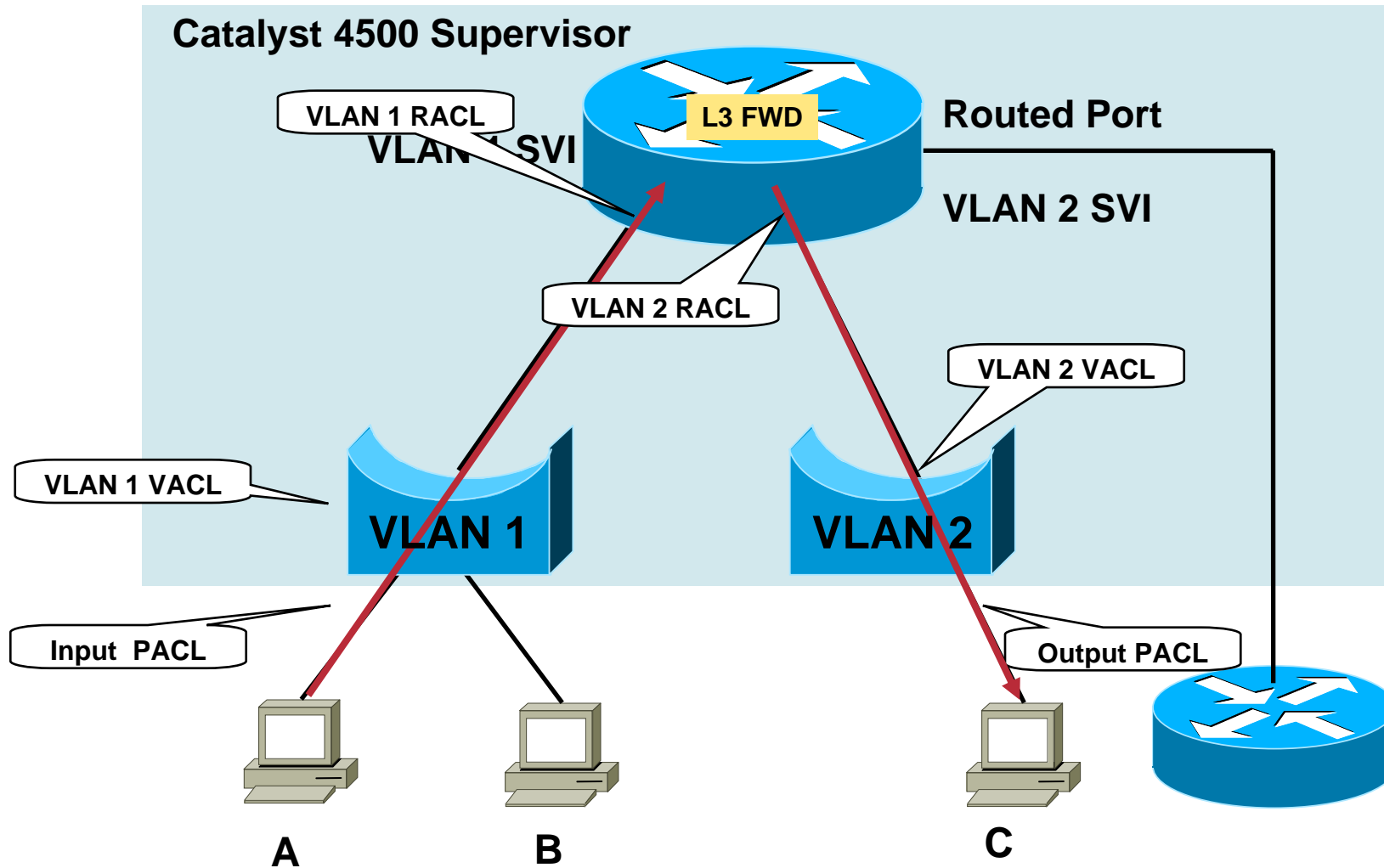
ACL Type	Where Applied	Controlled Traffic	Direction
Router ACL (RACL)	L3 Port/Channel or SVI	Routed IP traffic	Inbound Outbound
VLAN ACL (VACL)	VLAN (via <code>vlan-map</code> command)	All IP packets that are routed into/out of a VLAN or bridged within a VLAN	Directionless
Port ACL (PACL)	L2 Port/Channel	All IP traffic and non-IPv4 (via MAC ACL)	Inbound Outbound

- ACLs are stored in TCAMs for line-rate performance
- TCAMs are used for Security and QoS ACLs
- Catalyst 4500 uses two types of TCAM—TCAM 2 and TCAM 3

Logical Packet Forwarding: Layer 2



Logical Packet Forwarding: Layer 3



TCAM 2

- 1 Mask per 8 Entries
- Example

```
access-list 101 permit ip host
8.1.1.1 any
access-list 101 deny ip 8.1.1.0
255.255.255.0 any
```

Number of Masks Used = 2
Number of Masks Available = 0
 Number of Entries Used = 2
 Number of Entries Available = 14
 (for the 2 mask defined)

Mask 1 Match: All 32 Bits of Source IP Address	Src IP = 8.1.1.1
	Empty 2
	Empty 3
	Empty 4
	Empty 5
	Empty 6
	Empty 7
	Empty 8
Don't Care: All Remaining Bits	
Mask 2 Match: Most Significant 24 Bits of Source IP Addr	Src IP = 8.1.1.0
	Empty 2
	Empty 3
	Empty 4
	Empty 5
	Empty 6
	Empty 7
	Empty 8
Don't Care: All Remaining Bits	

Mask

Patterns

TCAM 3

- 1 Mask per 1 Entry
- Example

```
access-list 101 permit ip host  
8.1.1.1 any  
access-list 101 deny ip 8.1.1.0  
255.255.255.0 any
```

Number of Masks Used = 2
Number of Masks Available = 14
Number of Entries Used = 2
Number of Entries Available = 14

Additional TCAM Masks Left = 87.5 %
Optimized for Security/QoS Features
Such as IPSG/pvQoS

Mask 32 bits for IP1	Src IP = 8.1.1.1
Mask 24 bits for IP2	Src IP = 8.1.1.0
Empty Mask 3	Empty 3
Empty Mask 4	Empty 4
Empty Mask 5	Empty 5
Empty Mask 6	Empty 6
Empty Mask 7	Empty 7
Empty Mask 8	Empty 8
Empty Mask 9	Empty 9
Empty Mask 10	Empty 10
Empty Mask 11	Empty 11
Empty Mask 12	Empty 12
Empty Mask 13	Empty 13
Empty Mask 14	Empty 14
Empty Mask 15	Empty 15
Empty Mask 16	Empty 16

Masks

Patterns

Supervisor ACL Resources Comparison

Product	TCAM	Feature TCAM (Per Direction)	QoS TCAM (Per Direction)	L4 Operators (GT, LT, NEQ, Range)
Supervisor II+/II+TS	2	8K Entries 1K Masks	8K Entries 1K Masks	64 (6 per ACL)
Supervisor III/IV/ V and WS-C4948	2	16K Entries 2K Masks	16K Entries 2K Masks	64 (6 per ACL)
Supervisor V-10GE and WS-C4948- 10GE	3	16K Entries 16K Masks	16K Entries 16K Masks	128 (8 per ACL)

Feature TCAM—IPSG, DAI, and Security ACL
QoS TCAM—Classification and Policer Policies

TCAM2 vs. TCAM3

Supervisor IV

```
4507R#sh platform hardware acl statistics utilization brief
                        Entries/Total (%)  Masks/Total (%)
-----
Input  Acl (PortAndVlan)  0 / 8112 ( 0)    0 / 1014 ( 0)
Input  Acl (PortOrVlan)  10 / 8112 ( 0)   10 / 1014 ( 0)
Input  Qos (PortAndVlan)  0 / 8144 ( 0)    0 / 1018 ( 0)
Input  Qos (PortOrVlan)  0 / 8144 ( 0)    0 / 1018 ( 0)
Output Acl (PortAndVlan)  0 / 8112 ( 0)    0 / 1014 ( 0)
Output Acl (PortOrVlan)  0 / 8112 ( 0)    0 / 1014 ( 0)
Output Qos (PortAndVlan)  0 / 8144 ( 0)    0 / 1018 ( 0)
Output Qos (PortOrVlan)  1 / 8144 ( 0)    1 / 1018 ( 0)
```

8 ACEs
to One Mask
TCAM2

1,000 IPSG
Addresses

Supervisor V-10GE

```
4507R#show platform hardware acl stat utilization brief
                        Entries/Total (%)  Masks/Total (%)
-----
Input  Acl (PortAndVlan)  0 / 8112 ( 0)    0 / 8112 ( 0)
Input  Acl (PortOrVlan)  10 / 8112 (0.8)  10 / 8112 (0.8)
Input  Qos (PortAndVlan)  0 / 8144 ( 0)    0 / 8144 ( 0)
Input  Qos (PortOrVlan)  0 / 8144 ( 0)    0 / 8144 ( 0)
Output Acl (PortAndVlan)  0 / 8112 ( 0)    0 / 8112 ( 0)
Output Acl (PortOrVlan)  0 / 8112 ( 0)    0 / 8112 ( 0)
Output Qos (PortAndVlan)  0 / 8144 ( 0)    0 / 8144 ( 0)
Output Qos (PortOrVlan)  0 / 8144 ( 0)    0 / 8144 ( 0)
```

1 ACE
to One Mask
TCAM3

5,000 IPSG
Addresses

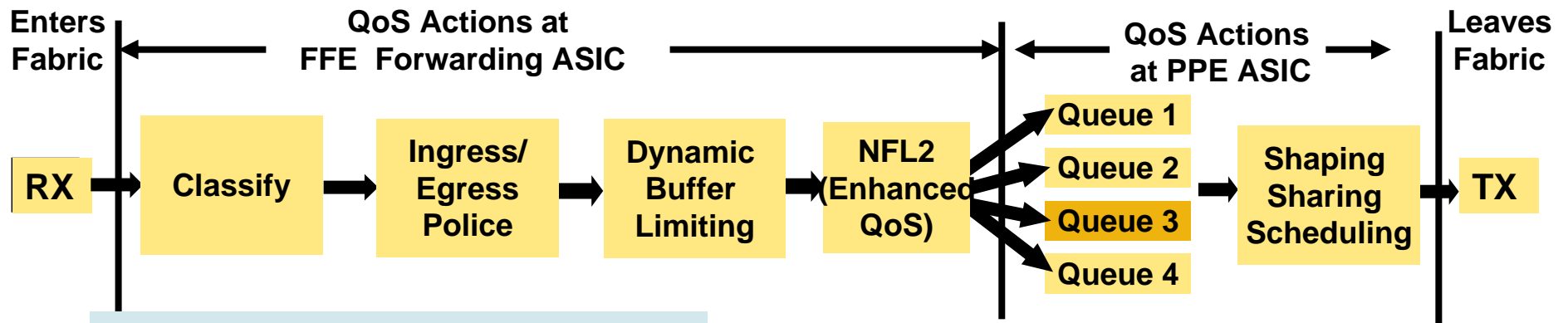
QUALITY OF SERVICE ON CATALYST 4500



Catalyst 4500 QoS Feature Summary

Traffic Classification, Marking, and Policing

Based on Default Port CoS or Layer 2/3/4 ACL Policy
Ingress and Egress Policers



DBL

Flow-based congestion avoidance on four queues/port

NFL2 (Sup V-10GE)

UBRL (Microflow Policing)

Egress Sharing/Shaping

Strict priority scheduling

“bandwidth” command configures sharing per queue

“shape” command configures traffic shaping per tx-queue

Types of Policers on Catalyst 4500

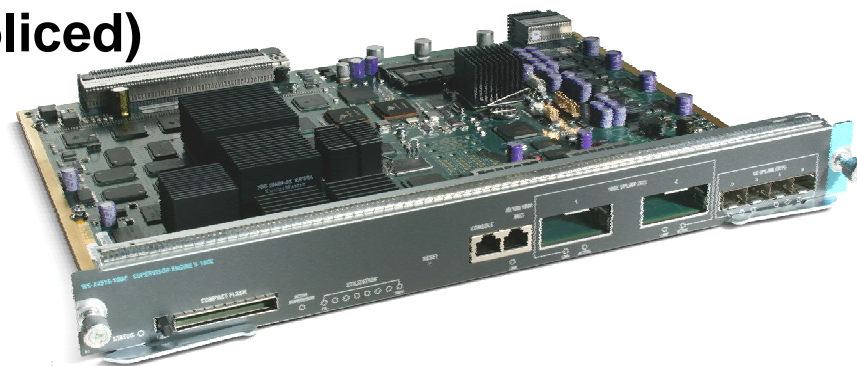
Interface	Aggregate	Flow
<pre> policy-map test class test police 1 mbps 13 kbyte !</pre>	<pre> qos aggregate-policer sample 1 mbps 13 kbyte conform-action transmit exceed-action drop ! policy-map test class test police aggregate sample !</pre>	<pre> class-map match-all test match flow ip source- address ! policy-map test class test police 1 Mbps 10 kbps !</pre>
One policer for each interface applied per direction	One policer per direction for the applied interfaces	One policer per flow for the applied interface
Matches traffic on applied interface	Matches traffic on all applied interfaces	Matches traffic per flow per applied interface

Supervisors/Devices	Policers (Per Direction)
Supervisor II+/II+TS	512
Supervisor III/IV/V & Catalyst 4948s	1024
Supervisor V-10GE	8192

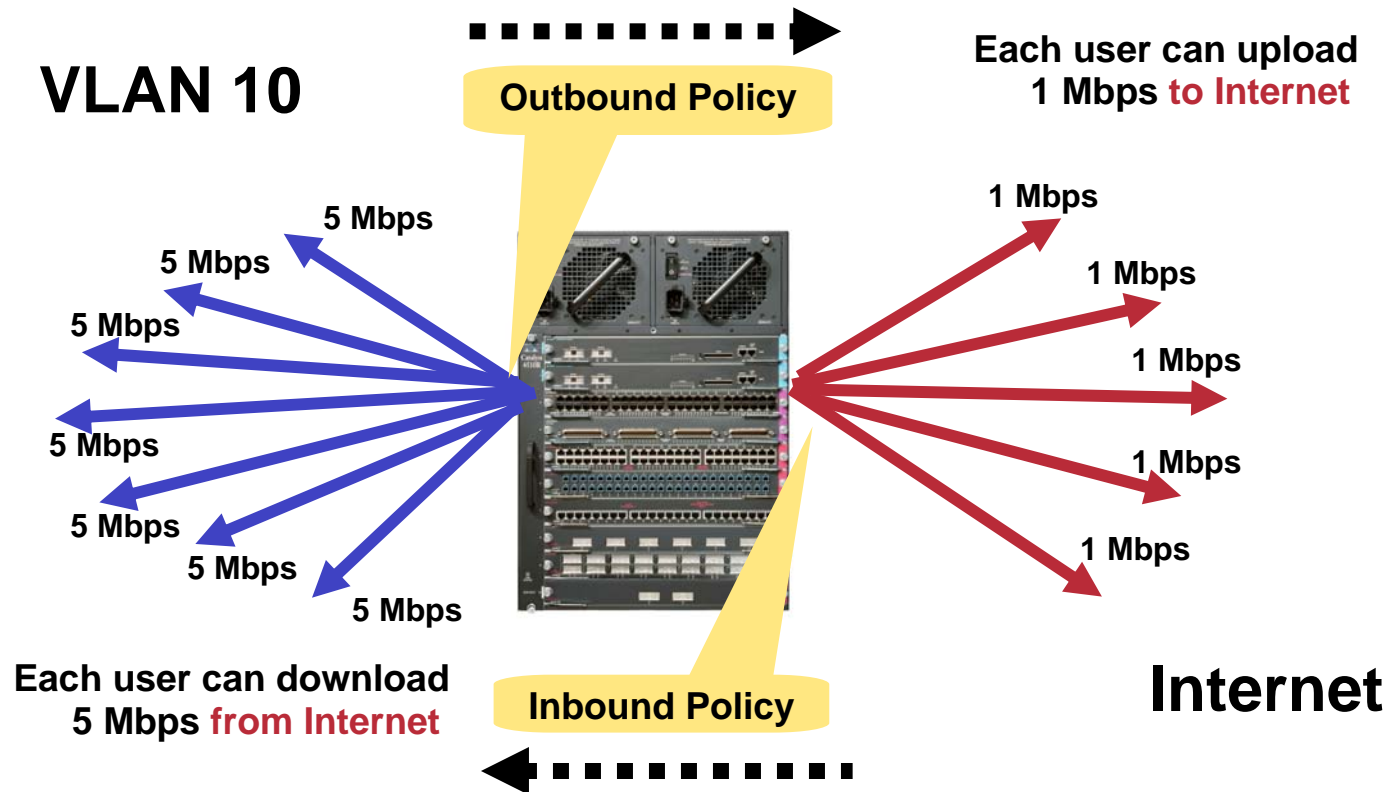
User Based Rate Limiting

- Police individual flow or User
- 511 unique Policer Rates
- Flow = {IP Source and destination address, IP header protocol field, Layer 4 source and destination ports}
- Both bridged and routed flows are policed
- Can be applied on both L2 and L3 interfaces
- Supported only in input direction
- UBRL and NetFlow share same flow table (up to 85000 flows can be policed)

**Only on
SupV-10GE**



UBRL Scenario



Problem Scenario: Limit Upstream Traffic to 1 Mbps and Downstream to 5 Mbps

Configuring UBRL

```
class-map match-all flow-upstream
  match flow ip source-address
!
policy-map upstream
  class flow-upstream
    police 1 Mbps 10 kbps
!
```

```
interface Vlan30
  ! users in 172.20.30.0 subnet
  service-policy input upstream
!
interface Gig1/2
  ! Connection to the Internet
  no switch-port
  service-policy input downstream
!
```

```
class-map match-all flow-downstream
  match flow ip destination-address
  match access-group Subnet30
!
policy-map downstream
  class flow-downstream
    police 5 Mbps 100 kbps
!
ip access-list extended Subnet10
  permit ip any 10.10.10.0 0.0.0.255
!
```

Checking Policer Utilization

```
Switch#show platform hardware qos policers utilization
```

	Used (%)	Free (%)	Total
	-----	-----	-----
Input Policers	5 (0.0)	8187 (99.9)	8192
Output Policers	4 (0.0)	8188 (99.9)	8192
Flow Policers	2 (0.4)	510 (99.6)	512

Hierarchical Policers

- **Flow Policers can be tied in with aggregate policers to create hierarchical policing**
- **Problem Scenario: Limit the traffic coming in to VLAN30 to 50 M bps and further limit each VLAN user to 1 M bps**

```
class-map match-all flow-upstream
  match flow ip source-address
!
policy-map upstream
  class flow-upstream
    police 1 Mbps 10 kbps
```

```
interface Vlan30
  ! users in 172.20.30.0 subnet
  service-policy input upstream
```

```
class-map match-all Subnet30
  match any
  !additional match statements
  !can be added as required
!
policy-map Subnet30Policy
  class Subnet30
    police 50 Mbps 100 kbps
    service-policy upstream
!
```

Service-policy Command Links in Flow-Based Policy-Map as a Child to Aggregate Policy-Map

Checking Hierarchical Policers

- Use **show policy-map** command to show the statistics for child policy-map
- Use **show ip cache flow** command to display per-flow statistics

```
Switch# show policy-map interface FastEthernet6/1

Service-policy input: Subnet30Policy

Class-map: Subnet30 (match-all)
 132537 packets
 Match: match any
 police: Per-interface
   Conform: 3627000 bytes Exceed: 0 bytes

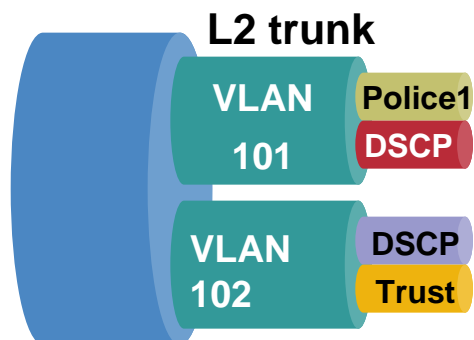
Service-policy : upstream

Class-map: flow-upstream (match-any)
 8867 packets
 Match: flow ip source-address
 police: Per-interface
   Conform: 1649262 bytes Exceed: 59601096 bytes

Class-map: class-default (match-any)
 5 packets
 Match: any
 5 packets
```

**Child Policy Match
Counters Only Shows
Packets that Are in Profile**

Per Port per VLAN QoS



- Separate service policy per VLAN per direction on an trunk interface
- Unique policy to suit enterprise VLAN traffic or customer VLANs in service provider network on a Trunk interface
- Available since 12.2(25)EWA

```
Policy-map cust101_policy
  Class cust101_data
    Police 200m 16k conform transmit
  exceed drop
  Class cust101_voice
    set ip dscp 46
Policy-map cust102_policy
  Class cust102_video
    set ip dscp 32
  Class cust102_voice
    trust dscp

Interface Gigabit 3/1
Switchport
Switchport trunk encapsulation dot1q
Switchport trunk allowed vlan 101-102
  Vlan range 101
    Service-policy input cust101_policy
    Service-policy output cust101_policy
  Vlan range 102
    Service-policy input cust102_policy
```

To display policy map per VLAN, use the following command
`show policy-map interface GigabitEthernet 6/1 vlan 102`

Dynamic Buffer Limiting

- Congestion avoidance technique (like WRED) but not random
- Flow-Based (like FRED) and maintains flow table per queue
- Flow is identified by source/destination/protocol fields in IP header by default
- Optionally can include Layer4 ports and VLAN
- Tracks buffer usage and credits available of each flow on tracked interface
- Limits the amount of buffer used by per-flow on a per queue per interface basis
- Packets exceeding limit can either be dropped or marked Explicit Congestion Notification (ECN) bit in the ToS byte of IP header
- DBL is implemented in hardware and hence no performance impact

DBL: Flow Classification

- **DBL classifies the flows in to two categories**

Adaptive flows—respond to congestion notification (dropped packet, or ECN) by the switch by reducing the rate of transmission at the source

Aggressive flows—Do not take any such corrective action in response to a congestion notification

```
qos
qos dbl
class-map match-all vlan30
    match any
!
policy-map vlan30_policy
    class vlan30
        dbl
!
interface Vlan30
service-policy input vlan30_policy
```

DBL Allows Adaptive Flows a Fair Use of the Transmit Queue in Presence of Aggressive Flows

Checking DBL-Cisco IOS

```
Cat4500# sh int gig4/1 count detail  
( truncated )
```

Port	Tx-Bytes-Queue-1	Tx-Bytes-Queue-2	Tx-Bytes-Queue-3	Tx-Bytes-Queue-4
Gi4/1	11114432	0	64000	0

Port	Tx-Drops-Queue-1	Tx-Drops-Queue-2	Tx-Drops-Queue-3	Tx-Drops-Queue-4
Gi4/1	99925	0	0	0

Port	Db1-Drops-Queue-1	Db1-Drops-Queue-2	Db1-Drops-Queue-3	Db1-Drops-Queue-4
Gi4/1	73425	0	0	0

DBL Drops

DSCP:Tx-Queue Mapping

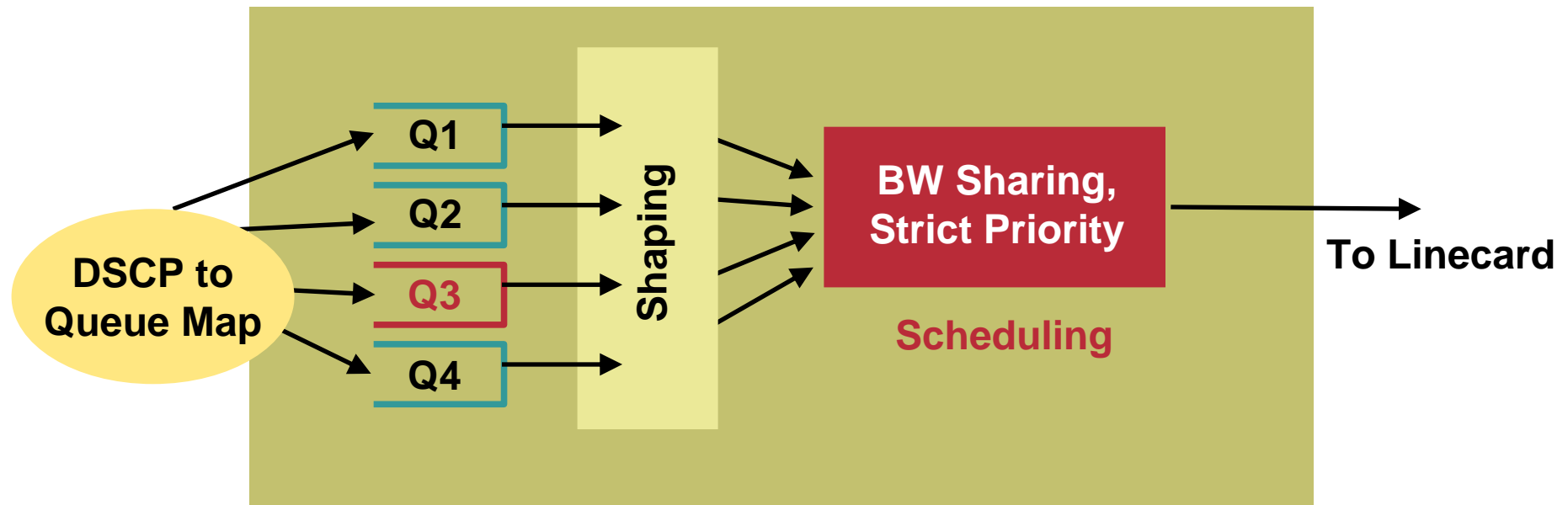
DSCP Is Derived from Either Ingress CoS/DSCP (Trust) or Interface Configuration or Policy-Based Marking or Mark-down by Policers

```
Cat4500#show qos maps dscp tx-queue
DSCP-TxQueue Mapping Table (dscp = d1d2)
d1 : d2  0  1  2  3  4  5  6  7  8  9
-----
0 :      01 01 01 01 01 01 01 01 01 01
1 :      01 01 01 01 01 01 02 02 02 02
2 :      02 02 02 02 02 02 02 02 02 02
3 :      02 02 03 03 03 03 03 03 03 03
4 :      03 03 03 03 03 03 03 03 04 04
5 :      04 04 04 04 04 04 04 04 04 04
6 :      04 04 04 04
```

```
Switch(config)# qos map dscp dscp-values to tx-queue queue-id
```

Catalyst 4500 Egress Process

Cisco.com



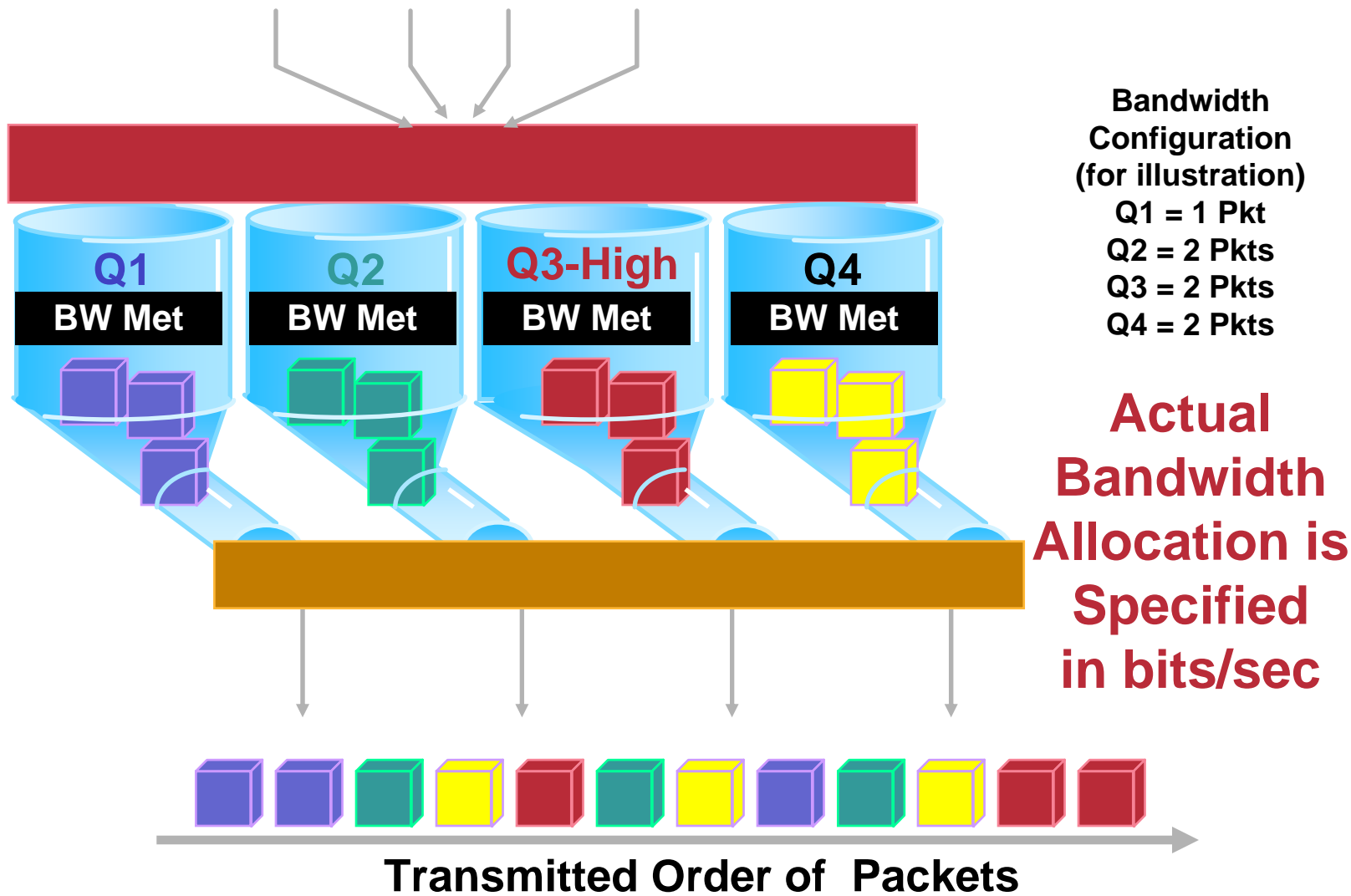
- Default round-robin with equal share for all queues
- Three types of queues at run-time

Strict Priority (configurable)—Queue which needs to **serviced first** (until it has met its bandwidth share)

High Priority (run-time)—Queue which is **yet to meet** its bandwidth values

Low Priority (run-time)—Queue which has **already met** its bandwidth value

Output Scheduling



TRAFFIC ANALYSIS USING NETFLOW ON CATALYST 4500

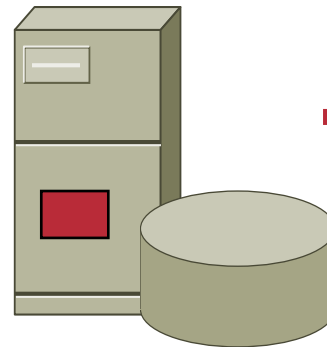


NetFlow with Catalyst 4500

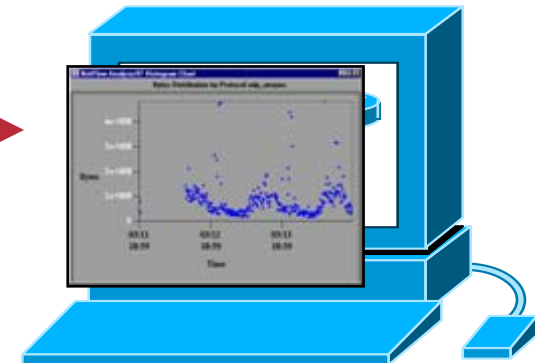
Catalyst 4500 Switch



**NetFlow
Collector**



**Cisco and Partner
Data Analyzer**



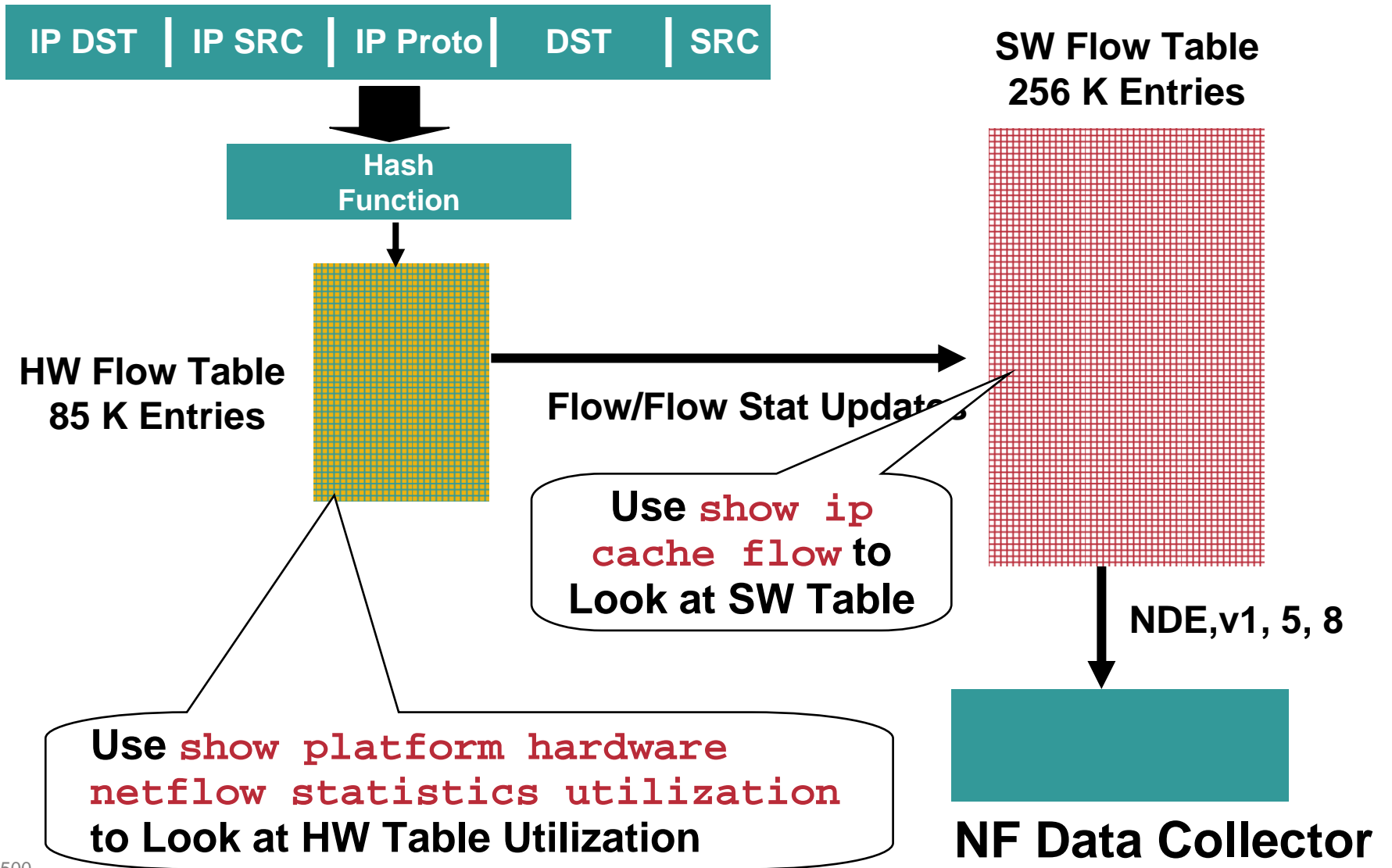
- **NetFlow data is collected and cached on Supervisor with NetFlow Services Card**
- **NetFlow data is automatically sent out to an external NetFlow Collector, kept for further aggregation and analysis**
- **Data Analyzer will pull data from NetFlow Collector to graphically represent in custom reports**

NetFlow Support on Catalyst 4500

- **NetFlow feature card required to collect statistics on the hardware-based forwarded flows on Catalyst 4500**
- **No performance impact and provides line-rate statistics**
- **Statistics includes switched and routed traffic as well as software switched packets**
- **NDE versions 1, 5, and 8 are supported**

	NFL1	NFL2
Supervisors	Sup IV and V	SupV-10GE
Optional	Yes	Included
UBRL	No	Yes
Total Entries	128K	128K
Effective Entries	64k	85k

NetFlow HW-SW Cache Interaction



TROUBLESHOOTING TOOLS AND COMMANDS ON CATALYST 4500



Monitoring the CPU on Cisco Catalyst 4500

Cisco.com

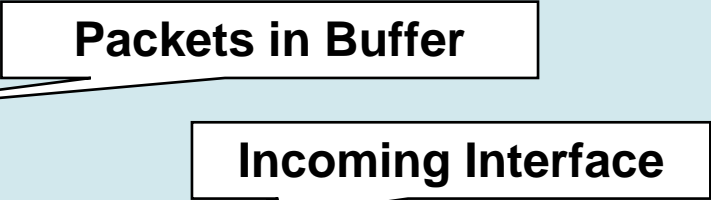
```
Switch #sh monitor session 1
Session 1
-----
Type           : Local
Session
Source Ports   :
  RX Only      :
CPU(Queues: 32)
Destination Ports : Fa3/37
  Encapsulation : Native
  Ingress       : Disabled
  Learning      : Disabled
```

```
Switch(config)# monitor session 1 source cpu queue ?
<1-32>          SPAN source CPU queue numbers
acl             Input and output ACL [13-20]
adj-same-if     Packets routed to the incoming interface [7]
all            All queues [1-32]
bridged        L2/bridged packets [29-32]
control-packet Layer 2 Control Packets [5]
mtu-exceeded   Output interface MTU exceeded [9]
nfl           Packets sent to CPU by netflow (unused) [8]
routed        L3/routed packets [21-28]
rpf-failure    Multicast RPF Failures [6]
span          SPAN to CPU (unused) [11]
unknown-sa     Packets with missing source address [10]
```

- **SPAN/RSPAN—Multiple sessions (2rx, 4 tx)**
- **SPAN Filters—Filters traffic out the destination port via ACL**

Built-in Sniffer: Debug Packets Hitting the CPU

```
Switch# debug platform packet all receive buffer
platform packet debugging is on
Switch#show platform cpu packet buffered
Total Received Packets Buffered: 36
-----
Index 0:
7 days 23:6:32:37214 - RxVlan: 99, RxPort: Gi4/48
Priority: Crucial, Tag: Dot1Q Tag, Event: Control Packet, Flags: 0x40, Size: 68
Eth: Src 00-0F-F7-AC-EE-4F Dst 01-00-0C-CC-CC-CD Type/Len 0x0032
Remaining data:
 0: 0xAA 0xAA 0x3  0x0  0x0  0xC  0x1  0xB  0x0  0x0
10: 0x0  0x0  0x0  0x80 0x0  0x0  0x2  0x16 0x63 0x28
20: 0x62 0x0  0x0  0x0  0x0  0x80 0x0  0x0  0x2  0x16
30: 0x63 0x28 0x62 0x80 0xF0 0x0  0x0  0x14 0x0  0x2
40: 0x0  0xF  0x0  0x0  0x0  0x0  0x0  0x2  0x0  0x63
Index 1:
7 days 23:6:33:180863 - RxVlan: 1, RxPort: Gi4/48
```



Safe to Use During High CPU Troubleshooting

Packets Hitting CPU per Ingress Interface

```
Switch# debug platform packet all count
platform packet debugging is on
Switch# show platform cpu packet statistics
```

<output skipped>

Packets **Transmitted** from CPU per Output Interface

Interface	Total	5 sec avg	1 min avg	5 min avg	1 hour avg
-----	-----	-----	-----	-----	-----
Gi4/48	50	1	0	0	0

Packets **Received** at CPU per Input Interface

Interface	Total	5 sec avg	1 min avg	5 min avg	1 hour avg
-----	-----	-----	-----	-----	-----
Gi4/48	30	0	0	0	0

Safe to Use During High CPU Troubleshooting

Troubleshooting Auto-Negotiation

First Step: Check Cisco IOS State

```
Switch# show interfaces gigabitEthernet 1/7 status
```

Port	Name	Status	Vlan	Duplex	Speed	Type
Gi1/7		connected	trunk	a-full	a-100	10/100/1000-TX

Second Step: Check HW State

```
Switch# show platform software interface gigabitEthernet 1/7 all
```

```
<output skipped>
```

```
GrandpripPortMan Grandprip 1-2() ( 7 ):
```

```
Gigabit PHY 7 Registers - IEEE
```

```
Control Reg      : 0x1000( AutoNegEnabled )
```

```
Status Reg       : 0x796D( LinkStatusUp AutonegComplete MfPreambleSuppression )
```

```
Phy Id           : 0x002062F1
```

```
AutonegAdv. Reg  : 0x0DE1( 10Half 10Full 100Half 100Full SymmPause AsymmPause )
```

```
LinkPartnerAdv. Reg : 0x45E1( 10Half 10Full 100Half 100Full SymmPause Ack )
```

Displays What Link Partner Is Advertising !!

Integrated Time Domain Reflectometer

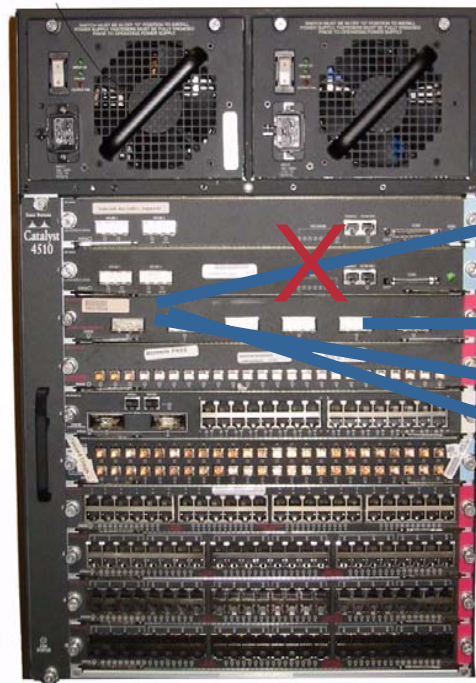
Simplifies Network Management and Operational Control

Cisco.com

Catalyst 4500 Integrated TDR Shows

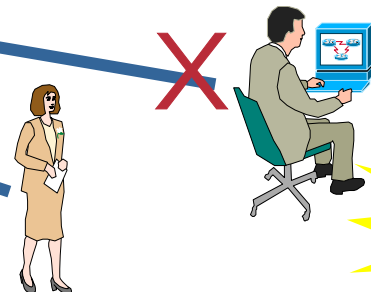
(Top to Bottom)

- Cable Unplugged from Catalyst 4500
- Cable Unplugged from Patch Panel
- Cable Unplugged from End Station
- Cable Broken at 55 Meters from Catalyst 4500



Supported on
10/100/1000T Ports

- WS-X4548-GB-RJ45
- WS-X4548-GB-RJ45V
- WS-X4524-GB-RJ45V
- WS-X4506-GB-T
- WS-C4948
- WS-C4948-10GE
- WS-X4013+TS

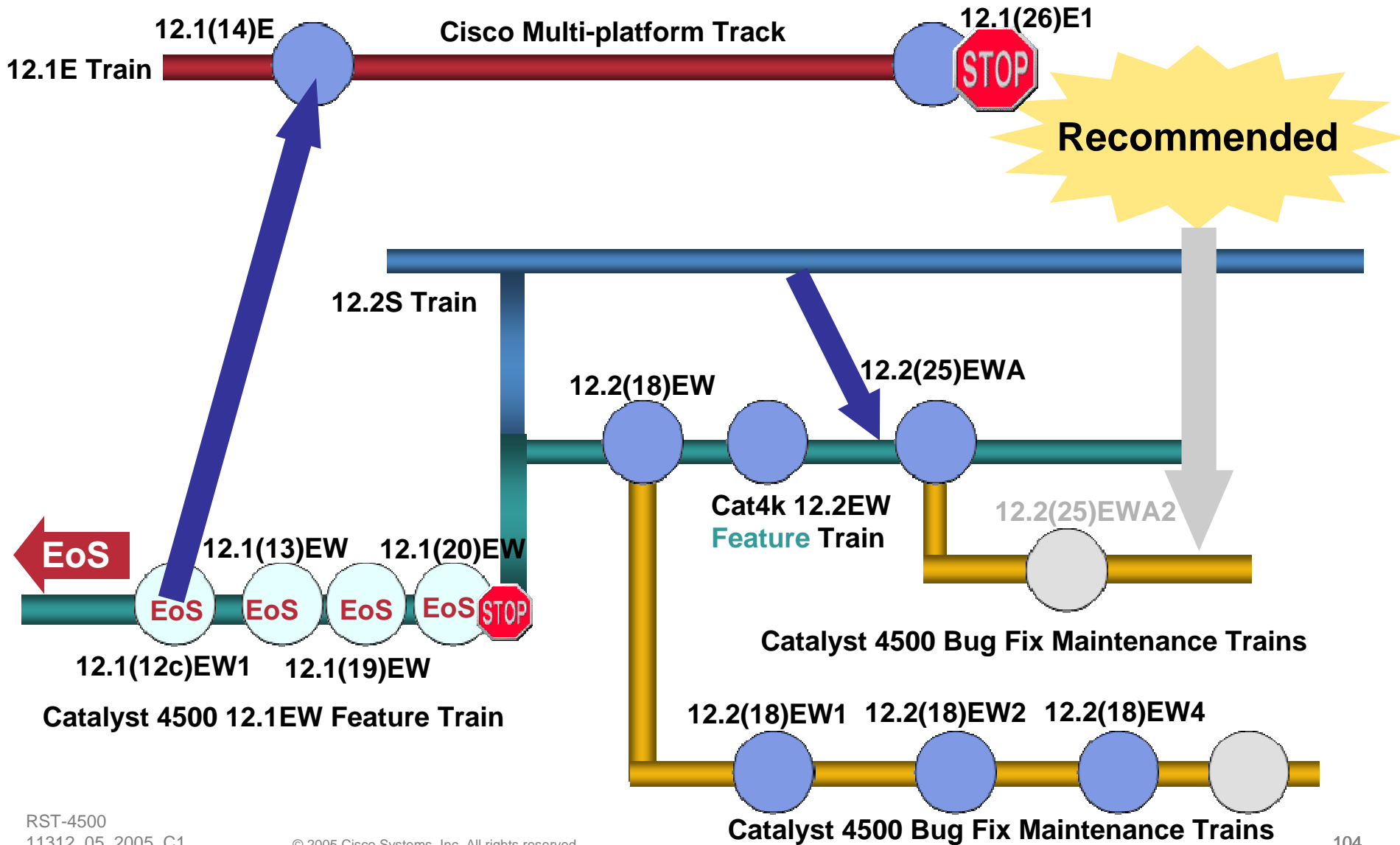


Upcoming

SOFTWARE RELEASE FOR CATALYST 4500



Catalyst 4500 Cisco IOS Release Trains



Conclusion

Cisco.com

You should now have a thorough understanding of the Catalyst 4500 switching architecture, packet forwarding architecture, and key forwarding engine functions...

ANY QUESTIONS?



Related Networkers Sessions

Cisco.com

- **RST-3042**
Troubleshooting Cisco Catalyst 4000 and 4500 Series Switches
- **SEC-2002**
Understand and Preventing Layer 2 Attacks

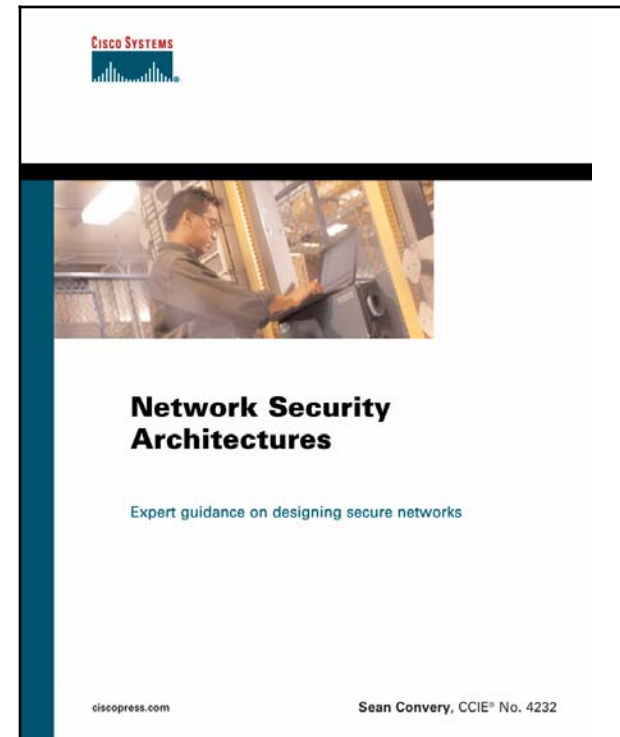
More Information

- **Catalyst 4500 Power over Ethernet Capabilities White Paper**
http://www.cisco.com/en/US/partner/products/hw/switches/ps4324/products_white_paper09186a00801f44be.shtml
- **Catalyst 4500 Security Features Best Practices For Supervisors**
http://www.cisco.com/en/US/partner/products/hw/switches/ps4324/products_white_paper09186a00801faa79.shtml
- **Catalyst 4500 Series Overview for Service Providers**
http://www.cisco.com/en/US/partner/products/hw/switches/ps4324/products_white_paper09186a0080103dd4.shtml
- **Understanding and Troubleshooting Catalyst 4500 High CPU Utilization (upcoming)**
- **Best Practices for Catalyst 6500/6000 Series and Catalyst 4500/4000 Series Switches Running Cisco IOS Software**
http://www.cisco.com/en/US/partner/products/hw/switches/ps700/products_white_paper09186a00801b49a4.shtml

Recommended Reading

Cisco.com

- Continue your Networkers learning experience with further reading for this session from Cisco Press
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- **Winners will be posted on the Internet stations and digital plasma screens**
- **Drawings will be held in the World of Solutions**

Monday, June 20 at 8:45 p.m.

Tuesday, June 21 at 8:15 p.m.

Wednesday, June 22 at 8:15 p.m.

Thursday, June 23 at 1:30 p.m.



CISCO SYSTEMS

