

Catalyst 6500



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Introduction To The Catalyst 6500



Introduction

Catalyst 6500



CATALYST 6500

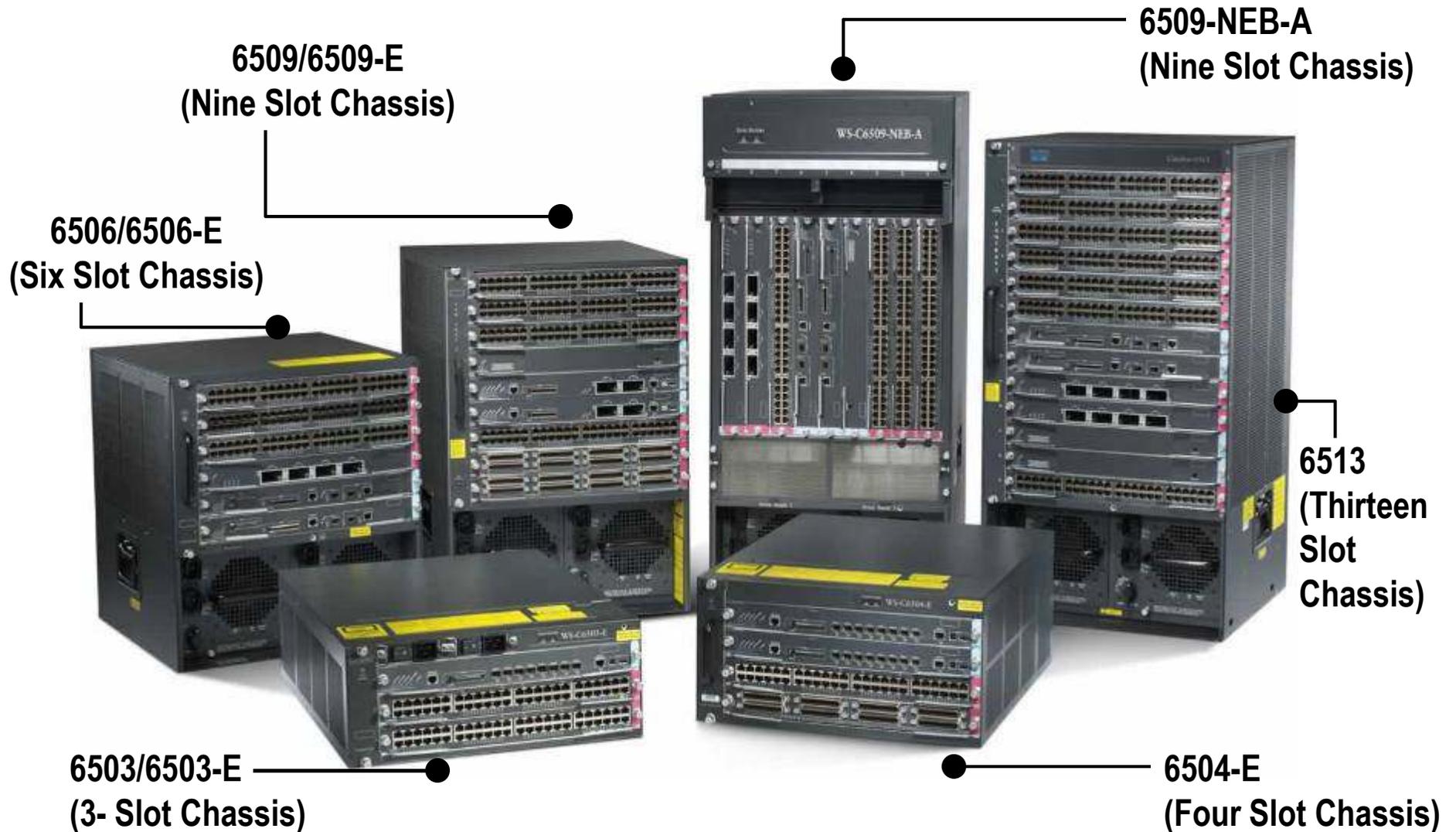
The Catalyst 6500 is both a Switch and a Router. It is a family of modular chassis based networking devices that provide a multitude of Layer 2 through Layer 7 services in one device.

Its versatility allows it to be deployed across Enterprise, Service Provider and Commercial customers.

Its breadth of technology support includes Ethernet, WAN, Firewall, VPN, IDS/IPS, Load Balancing, and much more...

Introduction

Catalyst 6500 Chassis Family



Introduction

The “E” Series Chassis

Four “E” Series chassis are designed to support much higher loads of power across the backplane - ideally suited for large deployments of inline powered devices...



New Catalyst 6500 “E” Series Chassis Benefits			
80Gb per slot capable	Support up to ~14500W of power	Chassis is S/W transparent	Same Pricing as existing chassis

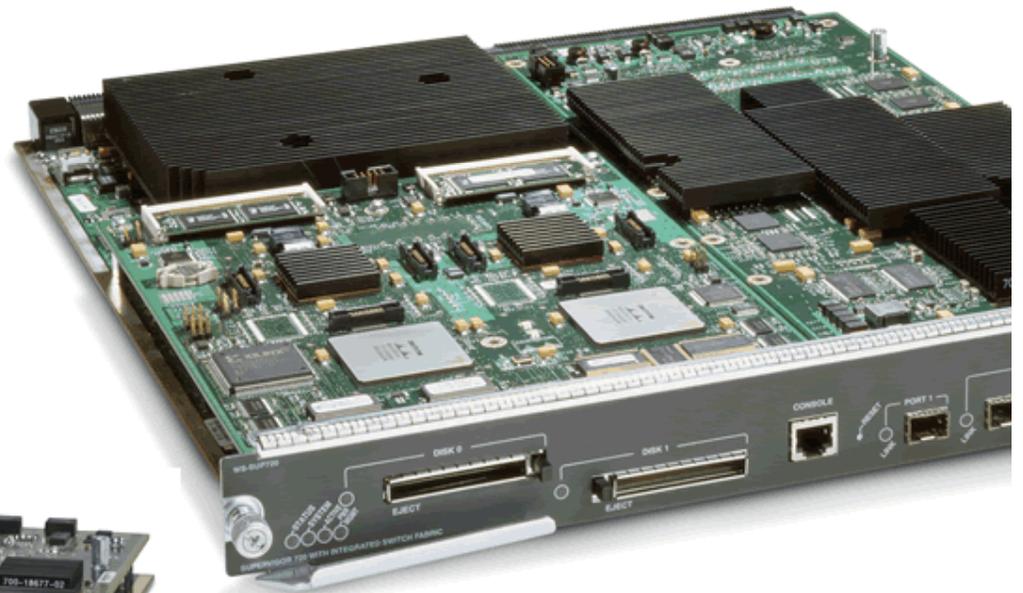
Introduction

Catalyst 6500 Supervisor Family



Sup32-10GE - 2 x 10GE ports, 15Mpps, Integrated PFC3B, MSFC2a, Access Layer Deployments...

Sup720 - 2 x GE ports, Integrated PFC3/3B/3BXL, MSFC3, 720Gb Switch Fabric, Core/Distribution Deployments



Sup32-8GE - 8 x GE SFP ports, 15Mpps, Integrated PFC3B, MSFC2a, Access Layer Deployments...



Introduction

Catalyst 6500 Linecard Family

Classic Linecards

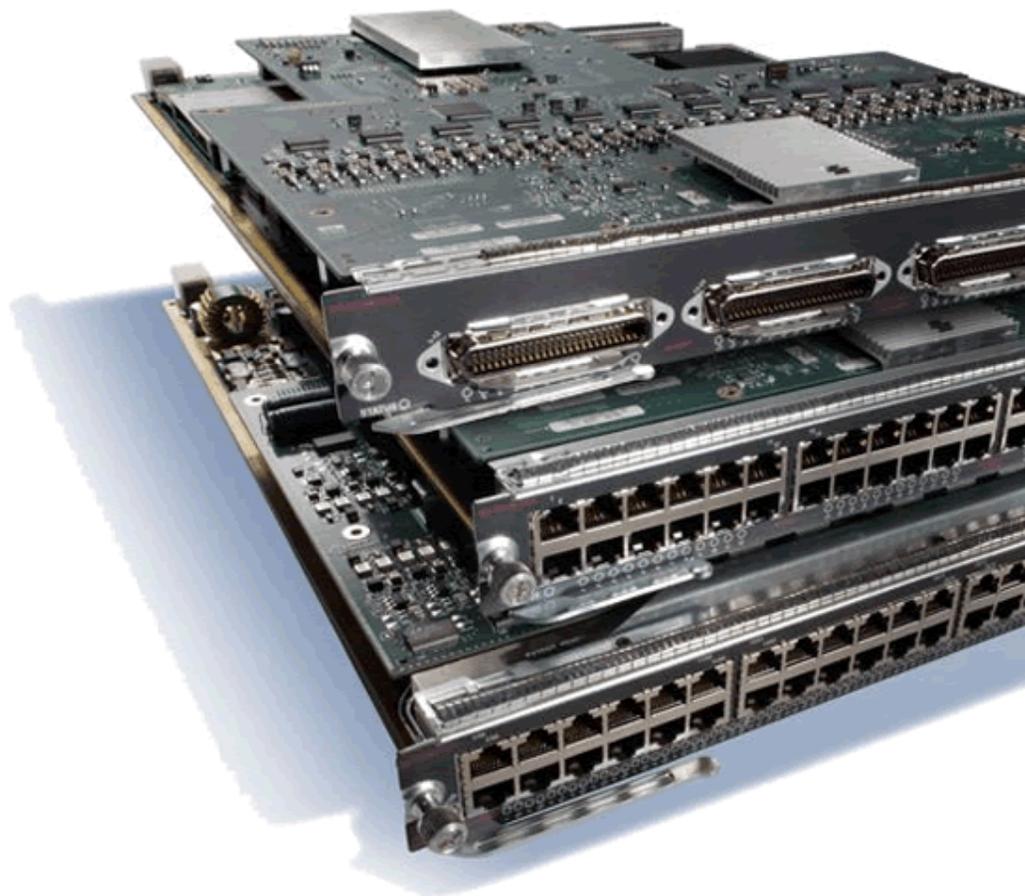
Examples include...
WS-X6148-RJ45, WS-X6148-SFP, WS-X6148-GETX,
WS-X6148A-GETX

CEF256/dCEF256 Linecards

Examples include...
WS-X6548-GETX, WS-X6516-GBIC, WS-X6516-GETX,
WS-X6516A-GBIC, WS-X6816-GBIC

CEF720 Linecards

WS-X6724-SFP, WS-X6748-SFP, WS-X6748-GETX,
WS-X6704-10GE, WS-X6708-10GE-3C,
WS-X6708-10GE-3CXL



Introduction

Catalyst 6500 Software

The Catalyst 6500 has supported 4 streams of software...

Catalyst OS (CatOS)	This is the original OS that was derived from the earlier Catalyst 5000 platform - this is a Layer 2 only OS - current version is 8.x CatOS now has a defined end of life in sight and as such we are encouraging customers to begin planning for migration to IOS
Native IOS	This is a Layer 2 and Layer 3 OS - it was introduced to move the Catalyst 6500 towards using a consistent OS in line with other Switch BU's
Hybrid	This is a combination of CatOS and IOS - was used to provide CatOS customers with Layer 3 functionality - moving towards being deprecated...
IOS with Software Modularity	This is also a Layer 2 and Layer 3 IOS image that supports a number of running processes in their own protected memory space - this is the platform on which all future development will take place and is the strategic platform for customers to move forward with...

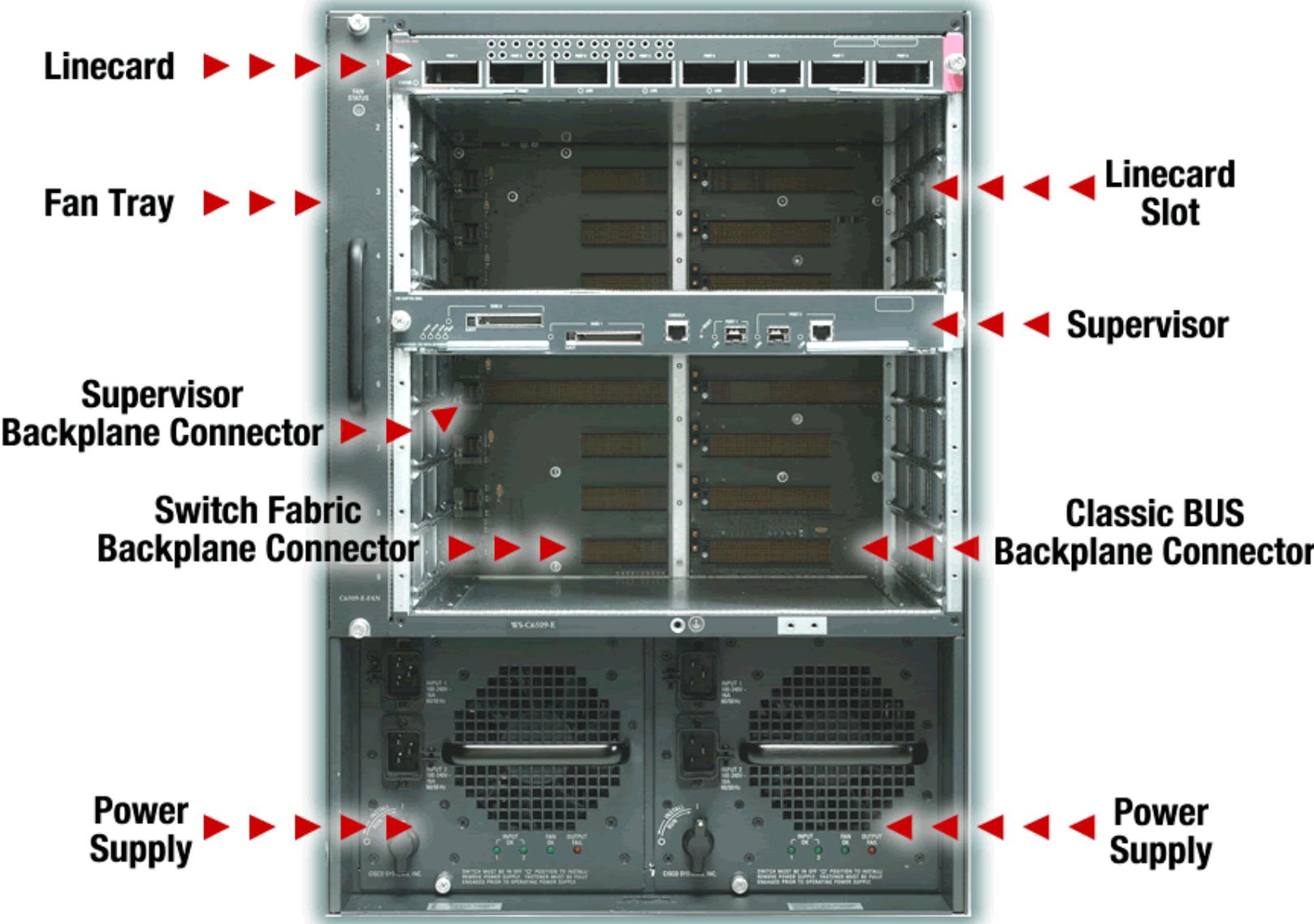


Chassis, Fan Tray, Power Supply



Chassis, Fan, Power Supply

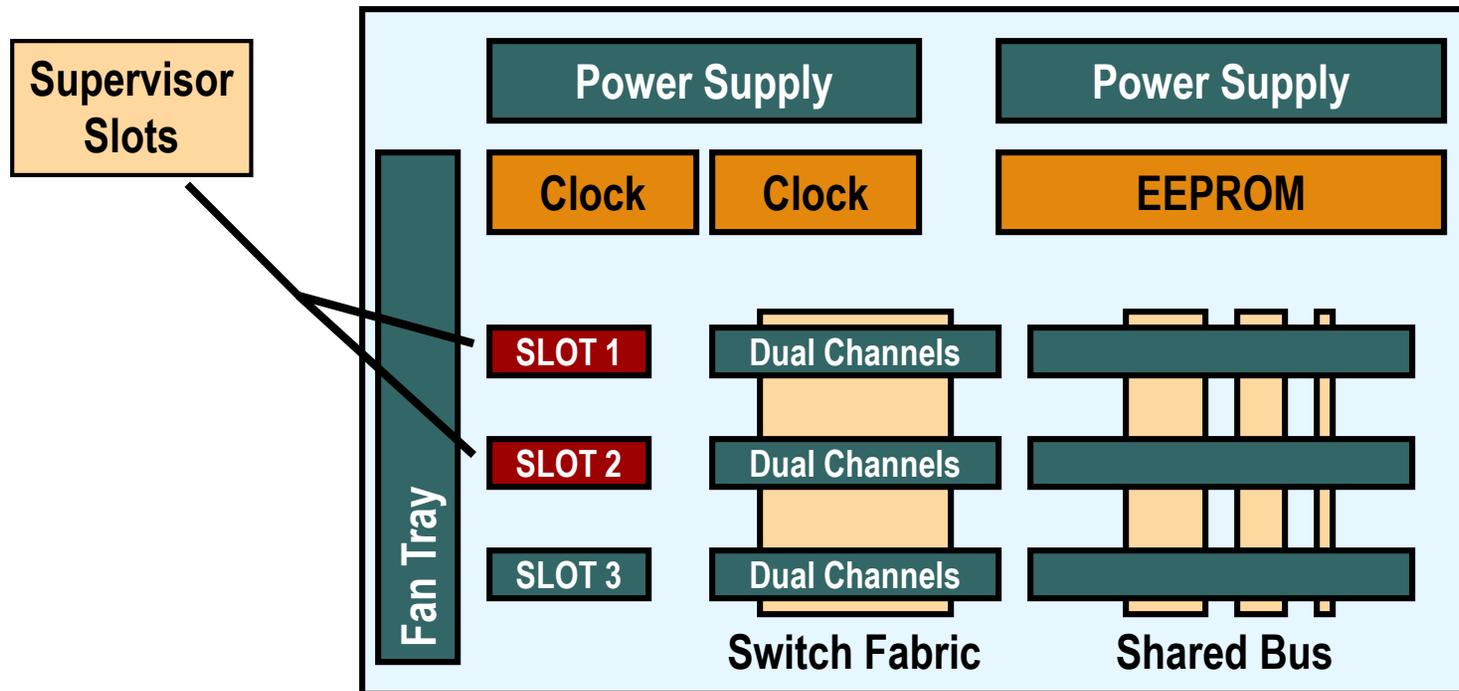
The Chassis



Chassis, Fan, Power Supply

Chassis Architecture - 6503/6503-E

The three slot chassis supports a Supervisor in either Slot 1 or 2 - Power supplies are installed into the rear of the chassis - a power entry module (PEM) is used at the front of the chassis to provide an interface from the power cable to the power supplies at the back of the chassis...

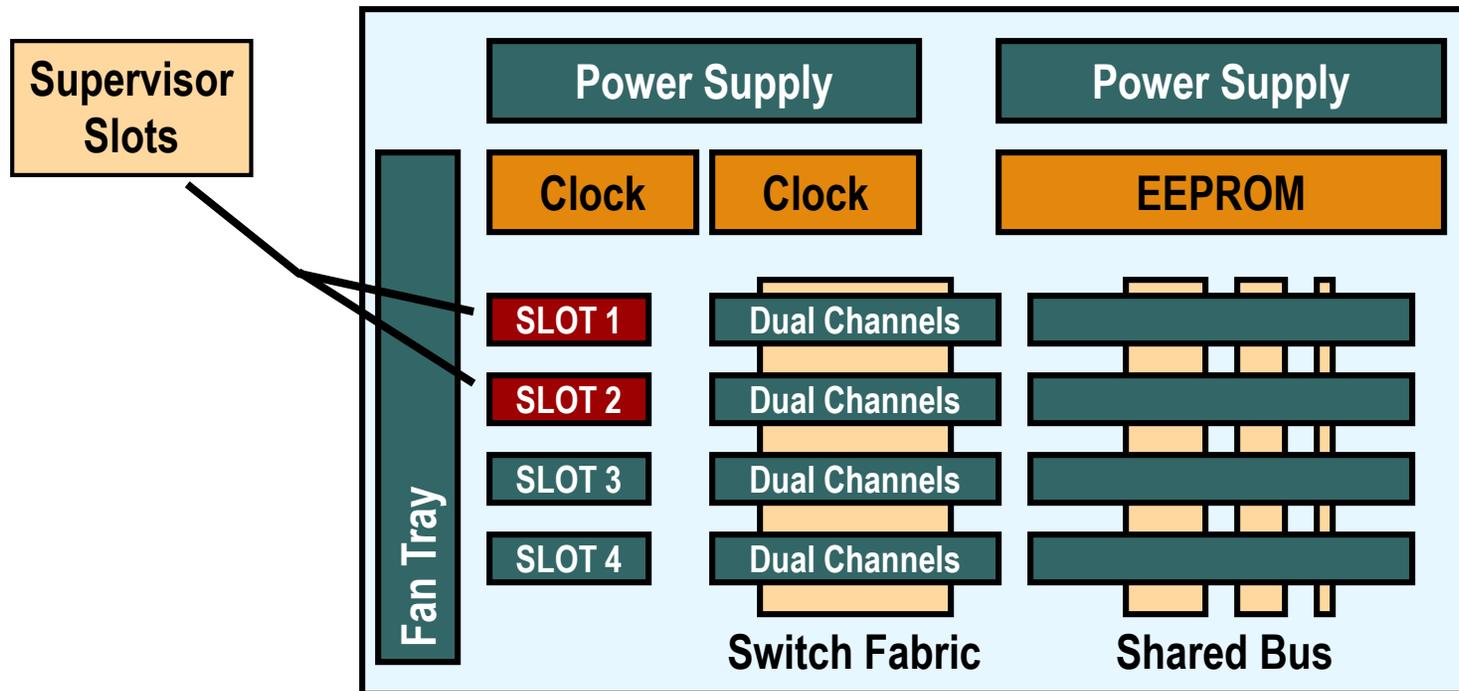


NOTE: A Different PEM is used for the 1400W Power Supply to the 950W Power Supply

Chassis, Fan, Power Supply

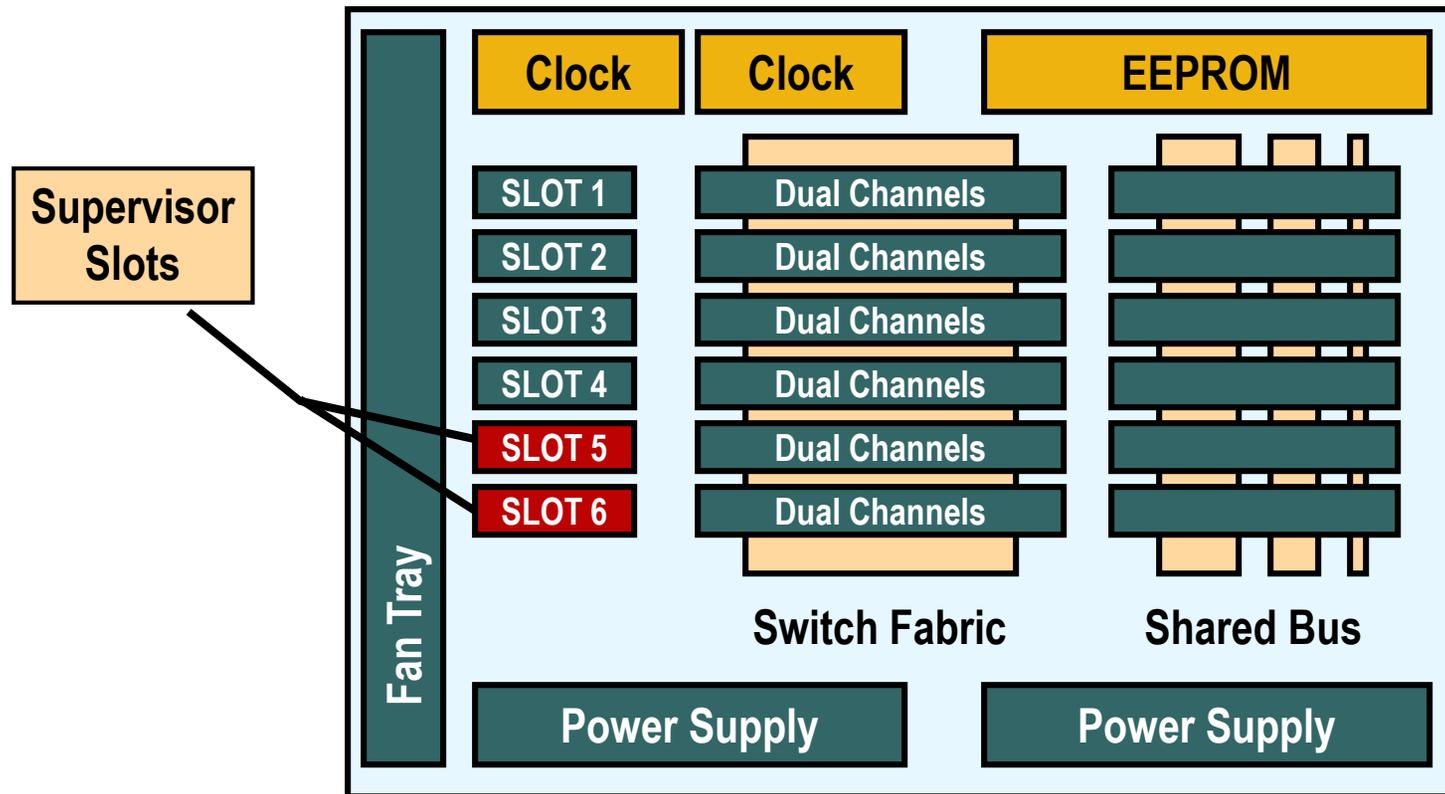
Chassis Architecture - 6504-E

The four slot chassis supports a Supervisor in either Slot 1 or 2 - Power supplies are installed into the rear of the chassis...



Chassis, Fan, Power Supply

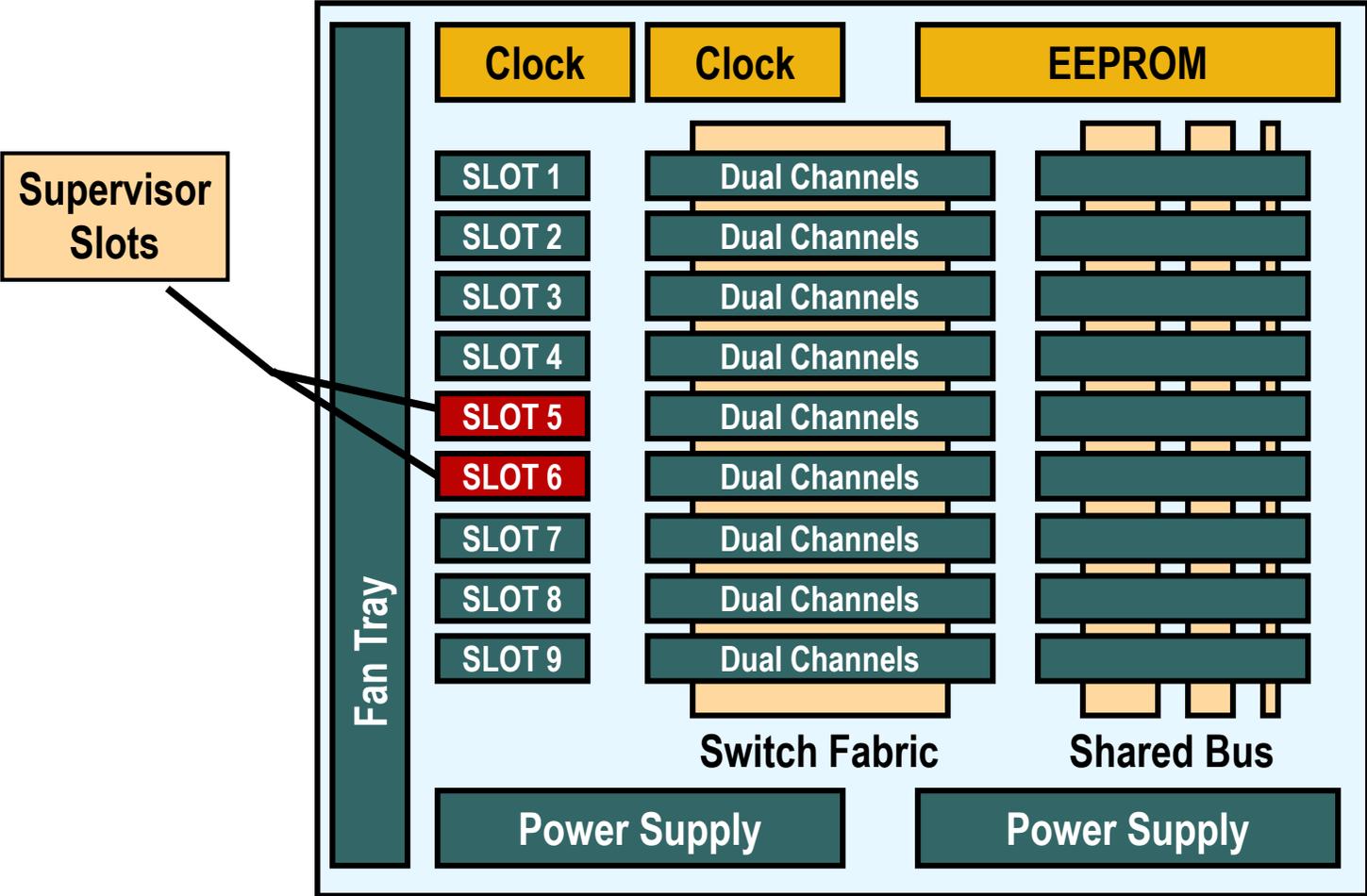
Chassis Architecture - 6506/6506-E



The six slot chassis supports a Supervisor in either Slot 5 or 6 - Power supplies are installed in the bottom of the chassis...

Chassis, Fan, Power Supply

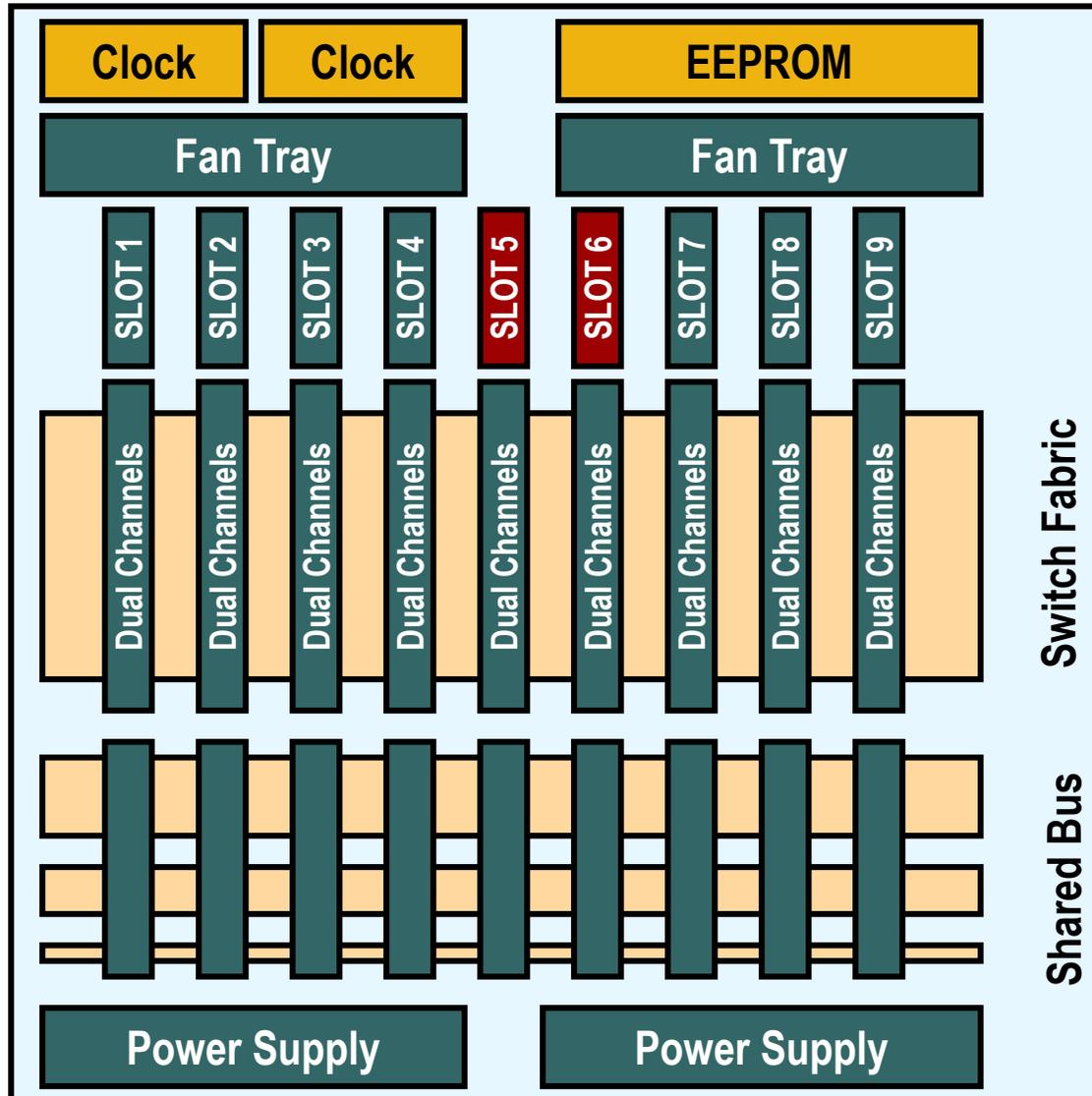
Chassis Architecture - 6509/6509-E



The nine slot chassis supports a Supervisor in either Slot 5 or 6 - Power supplies are installed in the bottom of the chassis...

Chassis, Fan, Power Supply

Chassis Architecture - 6509-NEB-A



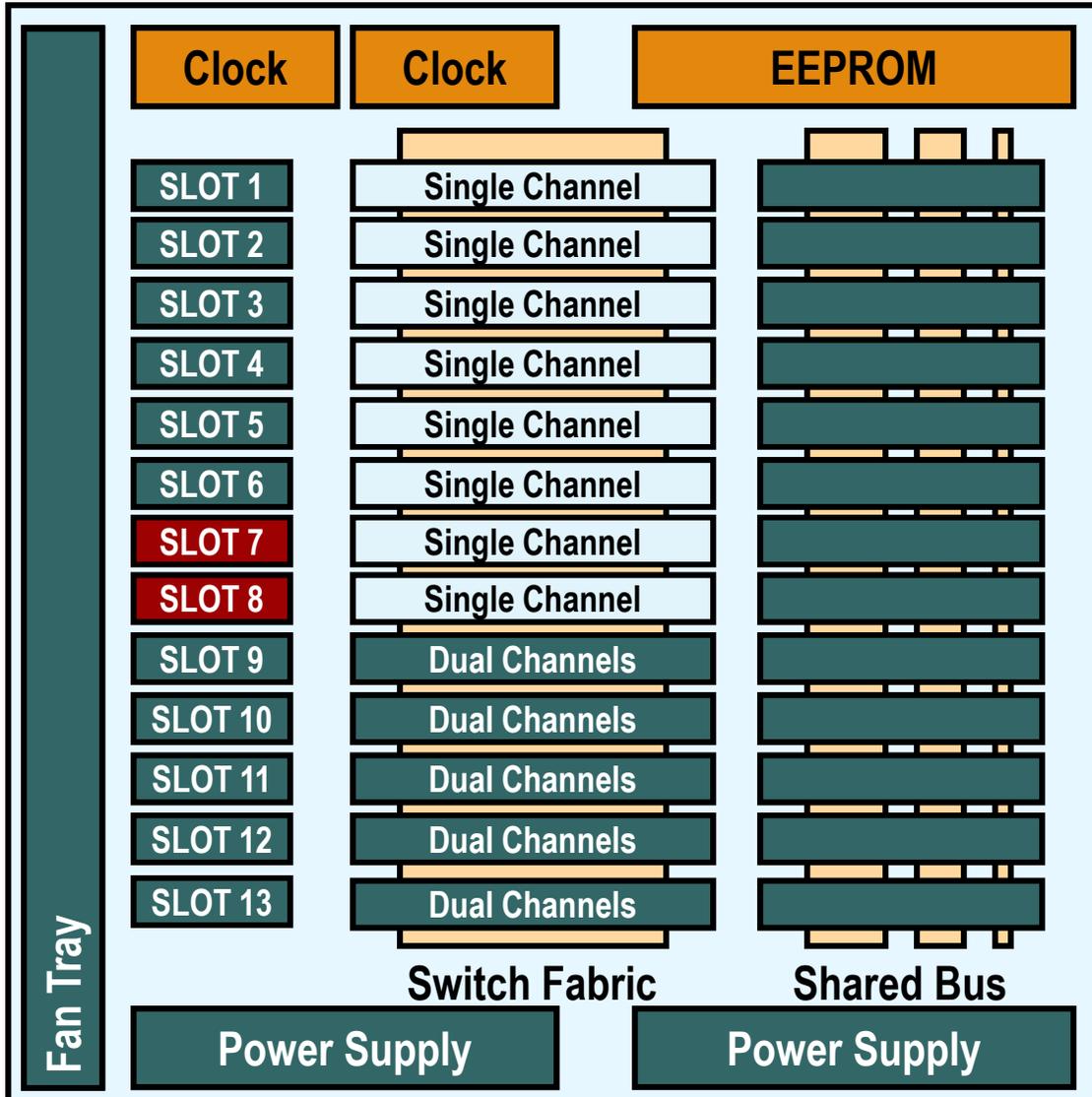
The nine slot vertical chassis supports a Supervisor in either Slot 5 or 6

Power supplies are installed in the bottom of the chassis

This chassis incorporates redundant fan trays

Chassis, Fan, Power Supply

Chassis Architecture - 6513



The thirteen slot chassis supports a Supervisor in either Slot 7 or 8

Power supplies are installed in the bottom of the chassis

Slots 1-8 have a single fabric channel

Slots 9-13 have dual fabric channels

Chassis, Fan, Power Supply

The Fan Tray

Fan Trays are used to draw cool air into chassis to cool components

- Typically mounted vertically down left side of chassis (6509-NEB-A is exception)
- Left to right airflow
- Three Fan Tray Types

Standard Fan Tray

Used in base Catalyst 6500 Chassis

High Speed Fan (Fan2)

Used in base Catalyst 6500 Chassis with Supervisor 720 and Supervisor 32

E Series FAN

Use in Catalyst 6500 E series Chassis

Fan Tray Types **ARE NOT** interchangeable outside of their supported chassis types



Chassis, Fan, Power Supply

Fan2

Fan Tray 2 is a new HIGH SPEED fan for non “E” series chassis...

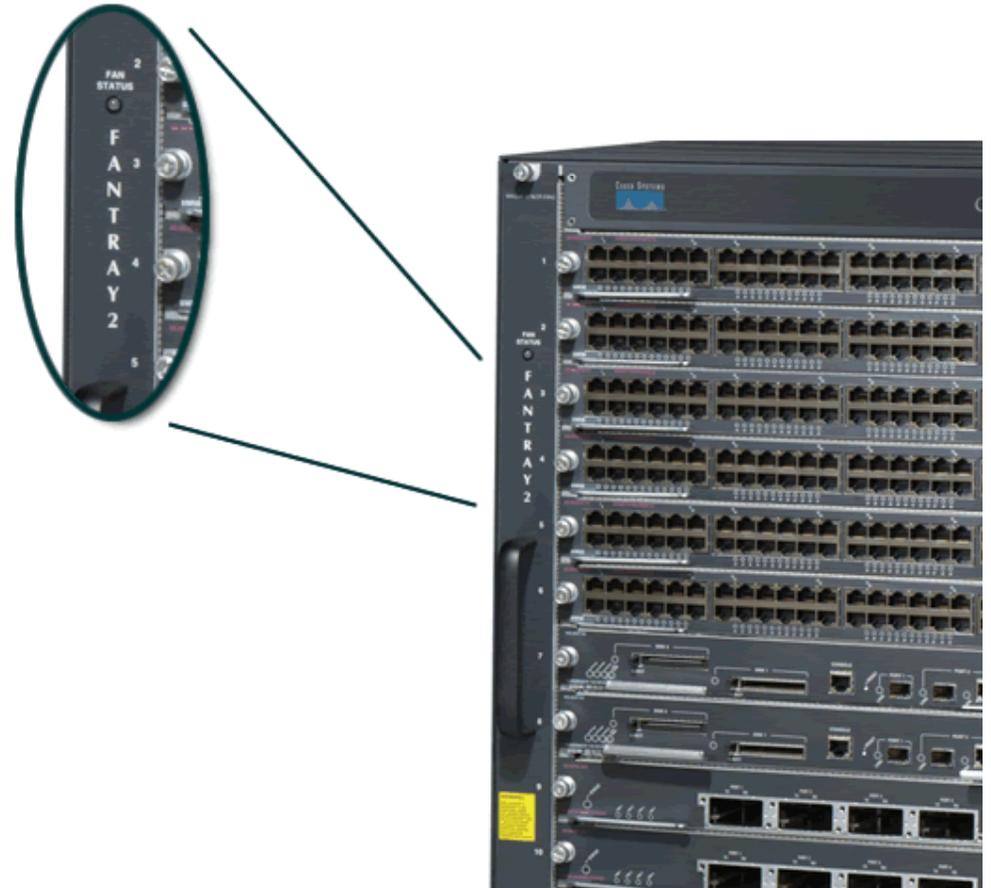
Fan2 is designated for use in the following chassis

- Catalyst 6503
- Catalyst 6506
- Catalyst 6509
- Catalyst 6509-NEB-A
- Catalyst 6513

Fan designation in chassis is noted on the FAN

Mandatory for use in chassis running a **Supervisor 720** or **Supervisor 32**

Also mandates a minimum power supply of **2500W** or higher



Chassis, Fan, Power Supply

Power Supplies



Power Supplies for six, nine and thirteen slot chassis are located at front bottom of chassis

Power Supplies for three and four slot chassis are located in the rear

AC Power Supplies

950W **
1000W **
1300W **
1400W
2500W **
2700W
3000W
4000W
6000W
8700W

DC Power Supplies

950W
1300W
2500W
2700W
4000W

** Now EOS

Chassis, Fan, Power Supply

6000W Power Supply

6000 Watt Power Supply (WS-CAC-6000W)

Currently there is only an AC version of the 6000W Power Supply

All inputs to the power supply are single phase

Each input supports a max of 17.6A

Max chassis heat dissipation ~ 24K BTU/hr

Supported in the six, nine and thirteen slot chassis

In non E series 6506 and 6509, only 4000W can be obtained from this power supply (due to backplane limitation)



1 x 110V Input = No Power
2 x 110V Input = 2900W
1 x 220V Input = 2900W
2 x 220V Input = 6000W

Chassis, Fan, Power Supply

8700W Power Supply

1 x 110V Input = No Power
2 x 110V Input = 2800W
3 x 110V Input = 4200W
1 x 220V Input = 2800W
2 x 220V Input = 5800W
3 x 220V Input = 8700W



8700 Watt Power Supply (WS-CAC-8700W)

Expected to FCS towards the end of 2006

There will only be an AC version of the 8700W Power Supply

All inputs to the power supply are single phase

Each input supports a max of 17.6A (3 inputs)

Max chassis heat dissipation ~ 37K BTU/hr

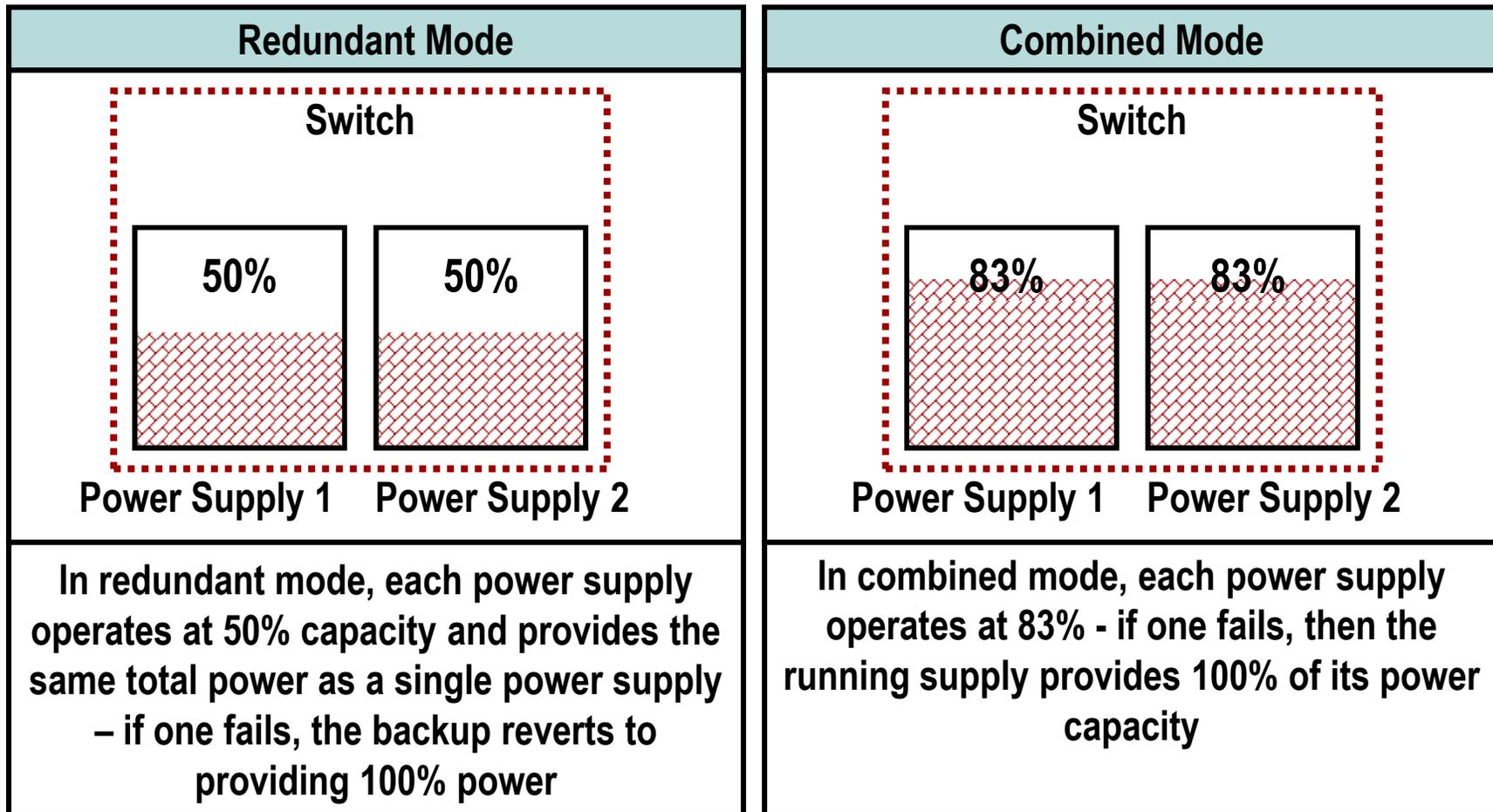
Supported in the six, nine and thirteen slot chassis

In non E series 6506 and 6509, only 4000W can be obtained from this power supply (due to backplane limitation)

Chassis, Fan, Power Supply

Understanding Power Redundancy

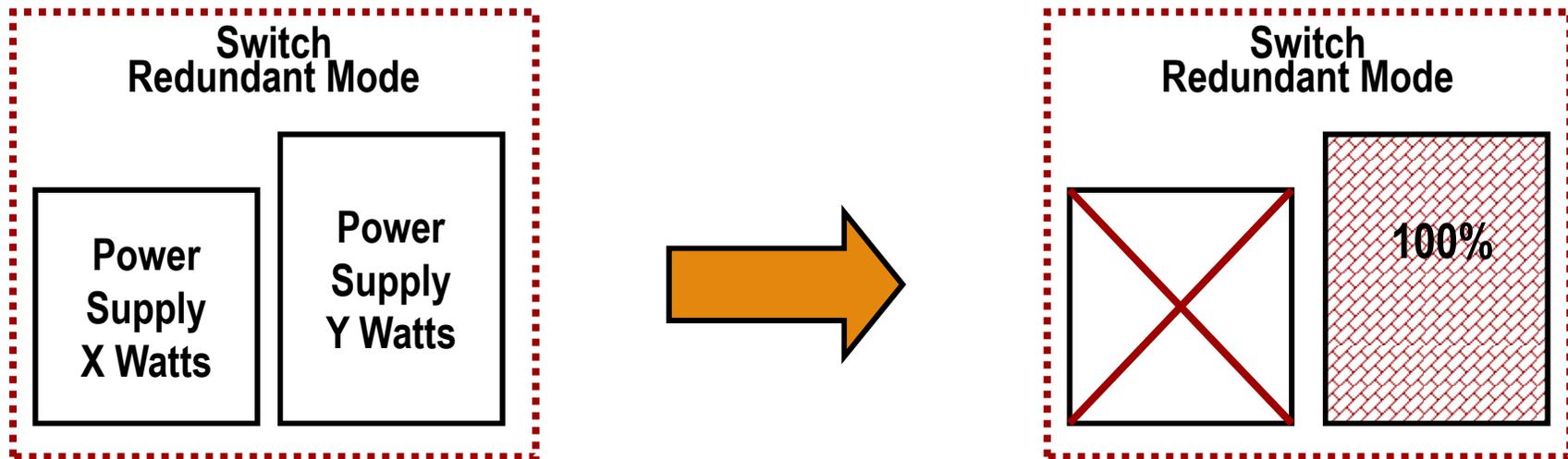
The 6500 can utilize two power supplies to work in either combined or redundant mode



Chassis, Fan, Power Supply

Booting with Unequal PSU in Redundant configuration

When booting with unequal power supplies in redundant mode, the following occurs

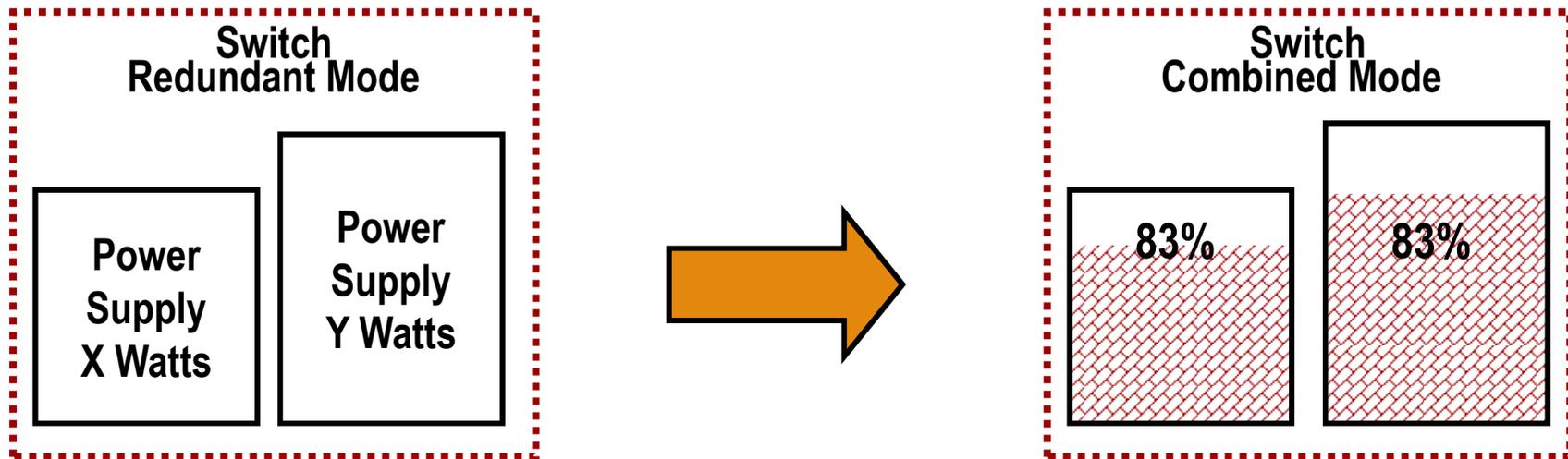


1. System log and SYSLOG messages generated
2. System does not allow different sized power supplies to be booted in redundant mode
3. Smaller Power Supply is shut down
4. Only the larger power supply is booted – this is run at 100% capacity

Chassis, Fan, Power Supply

Booting with Unequal PSU in Combined configuration

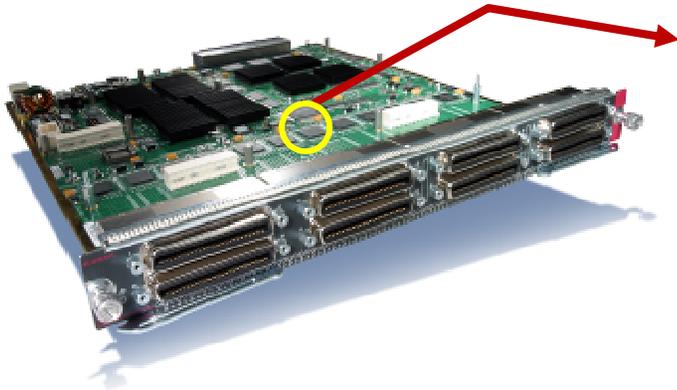
When booting with unequal power supplies in combined mode, the following occurs



1. System log and SYSLOG messages generated
2. System allows different sized power supplies to be booted in combined mode
3. Both Supplies run up at 167%

Chassis, Fan, Power Supply

Power Management



All Supervisors and Linecards have power value preprogrammed in EPROM - this is used to identify how much power reserved in chassis...

Use the Power Calculator on CCO to determine the power supply and minimum power requirements - <http://www.cisco.com/go/powercalculator>



If insufficient power available, system powers down Power Devices, then switching modules, then services modules
Powered Devices and modules powered off from highest numbered to lowest numbered (port or slot)

Chassis, Fan, Power Supply CPC - Cisco.com Power Calculator

The screenshot shows a web browser window titled "Cisco Power Calculator" with the URL <http://tools.cisco.com/cpc/>. The page features the Cisco Systems logo, a search bar, and a navigation menu. The main content area is titled "Large Enterprise Cisco Power Calculator" and includes a "Tool Overview" section. A calculator image is displayed next to the text. A red banner at the bottom of the screenshot contains the URL <http://www.cisco.com/go/powercalculator>.

Large Enterprise
Cisco Power Calculator

Tool Overview

The Cisco® Power Calculator enables you to calculate the power supply requirements for a specific Power over Ethernet (PoE) configuration. The results will show output current, output power, and system heat dissipation. The Cisco Power Calculator supports the following Cisco product series: Cisco Catalyst® 6500, Catalyst 4500, Catalyst 3750, and Catalyst 3560 series switches, and the Cisco 7600 Series Router.

The calculator is an educational resource and a starting point in planning your power requirements; it does not provide a final power recommendation from Cisco. To determine the power requirements and software most appropriate for your company, we suggest you work with a Cisco representative, Cisco channel partner, or a solutions provider.

[Launch Cisco Power Calculator](#)

The Cisco Power Calculator will guide you through a series of selections for configurable products. If you want to change a previous selection, click the browser Back button. To return to the Product Family page, click the Start Over button. If you want to save a completed calculation on your hard disk, press ALT-F and A and then save the file as a

Toolkit: Roll over tools below
Feedback | Help

Related Links

Solutions
[Power over Ethernet Solutions Introduction](#)
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[Voice and IP Communications Introduction](#)
[Wireless Introduction](#)

Run script "openChildWindow('DS.cpc','childwin')"

Chassis, Fan, Power Supply CPC - Cisco.com Power Calculator

Cisco Power Calculator

http://tools.cisco.com/cpc/PDS.cpc

Apple (18) TKD News (574) Cisco Misc

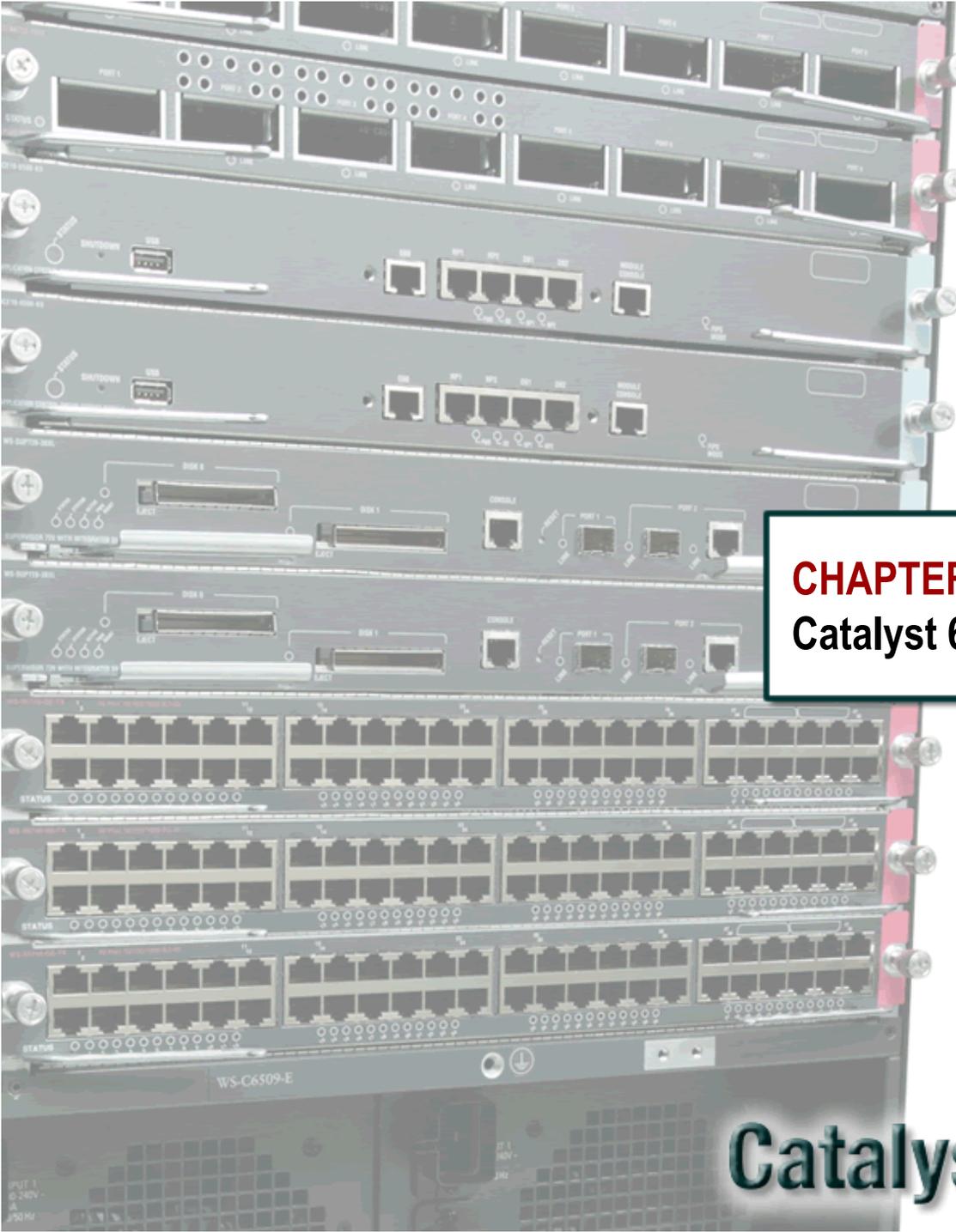
Power Consumption/Heat Dissipation Summary

Slot	Line Card	Optional DFC	Power over Ethernet Capabilities
1	WS-SUP32-GE-3B	--	--
2	WS-X6148A-GE-AF	--	IEEE PoE
3	-- EMPTY-SLOT --	--	--
Minimum Power Supply			Percentage of Power Used
Single/Redundant PWR-950-AC 950W			47.67%
First Alternative Power Supply			Percentage of Power Used
Single/Redundant PWR-1400-AC 1400W			31.99%
Total Output Current		Total Output Power	Total Heat Dissipation
10.44 Amps		438.29 Watts	1655.79 BTU/Hr

[Top]

Quick Facts

	Selected Supervisor Engine	WS-SUP32-GE-3B
	Selected Chassis	WS-C6503-E
	Selected Voltage	200-240 Volts AC
	Selected Fan Tray	WS-C6503-E-FAN
	Chassis Slots	3
	Power Supply Options	Single/Redundant PWR-950-AC 950W
		Single/Redundant PWR-1400-AC 1400W
Combined PWR-950-AC 950W		



CHAPTER 4
Catalyst 6500 Supervisors

Catalyst 6500 Bootcamp



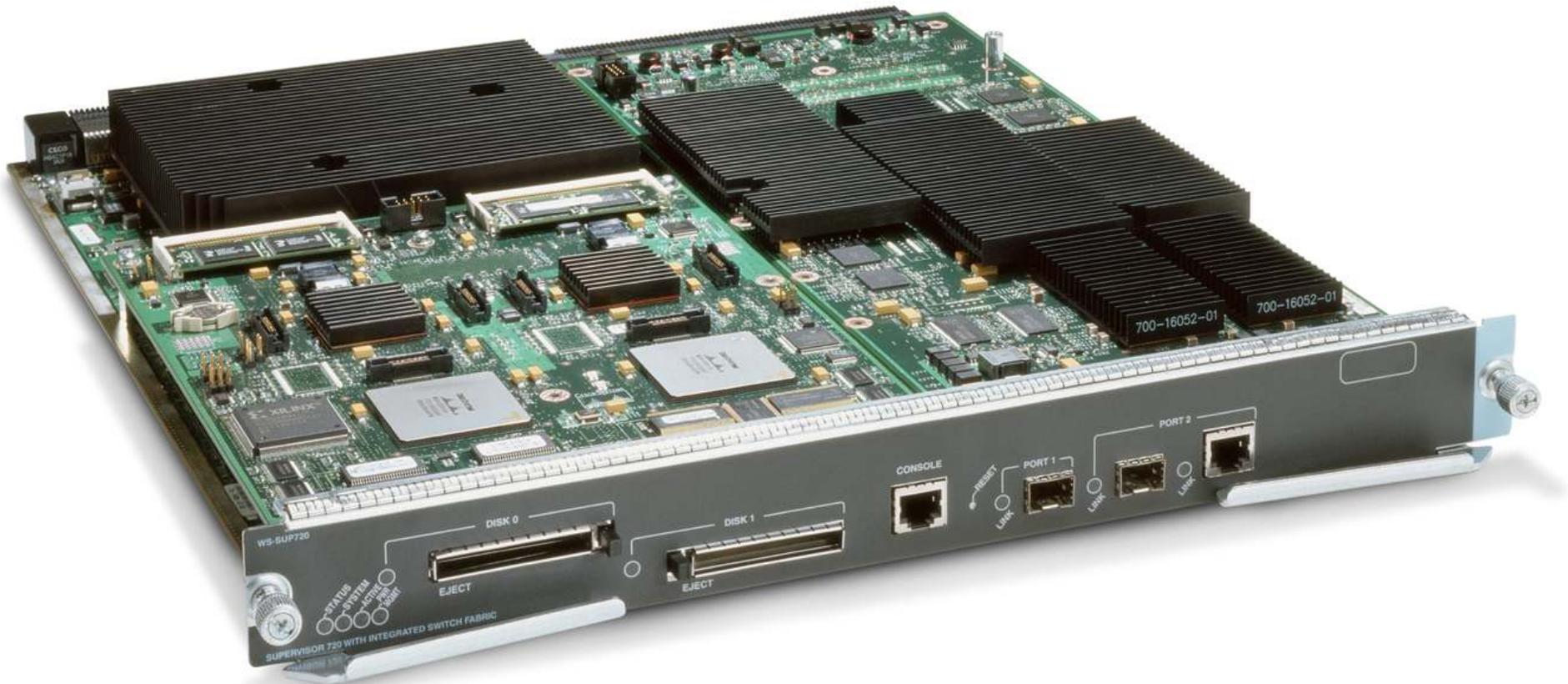
Catalyst 6500 Supervisors



Catalyst 6500 Supervisors

Supervisor 720

The Supervisor 720 is designed for deployment in the Core and Distribution Layers of the Network - it is the highest performing Supervisor option available for the Catalyst 6500 platform...



Catalyst 6500 Supervisors

Supervisor 720 - Some Facts

Supervisor 720 Quick Facts

Models are available

- Supervisor 720
- Supervisor 720-3B
- Supervisor 720-3BXL
- Supervisor 720-3C
- Supervisor 720-3CXL

Other Quick Facts

- Integrated 720Gb Switch Fabric
- Integrated Policy Feature Card 3 supporting hardware acceleration for select features
- Integrated Multilayer Switch Feature Card 3 supporting two CPU's for Layer 2 and Layer 3 functionality
- Uplink Ports

* The user tells the switch which media type to use



Catalyst 6500 Supervisors

Supervisor 720 - The Options



Original **Supervisor 720** announced in March 2003 - Added HW support for IPV6, GRE, NAT, PAT, Egress Policing and a host of other accelerated features...



Supervisor 720-3B - Integrated MSFC3 and PFC3B which incorporates some new hardware features like MPLS VPN, EoMPLS, ACL Counters, 4K ACL's, TCAM utilization improvements and more...



Supervisor 720-3BXL - Same hardware features as the Supervisor 720-3B with the additional support of up to 1 Million IPV4 routes and support for up to 256K Netflow table entries

Catalyst 6500 Supervisors

Supervisor 720 - The Elements

All Supervisor 720 models incorporates three main elements - the Multilayer Switch Feature Card 3 (MSFC3), the Policy Feature Card 3 (PFC3) and the Switch Fabric - each of which is highlighted below...



Catalyst 6500 Supervisors

Supervisor 32

The Supervisor 32 is designed for deployment in the Access Layer - there are two Supervisor 32 options, one with 8 GE SFP ports and the other with 2 10GE ports on the front panel...

Sup32-8GE



Sup32-10GE



Catalyst 6500 Supervisors

Supervisor 32 - Some facts



Supervisor 32 Quick Facts

Two Models are available

- Supervisor 32-8GE
- Supervisor 32-10GE

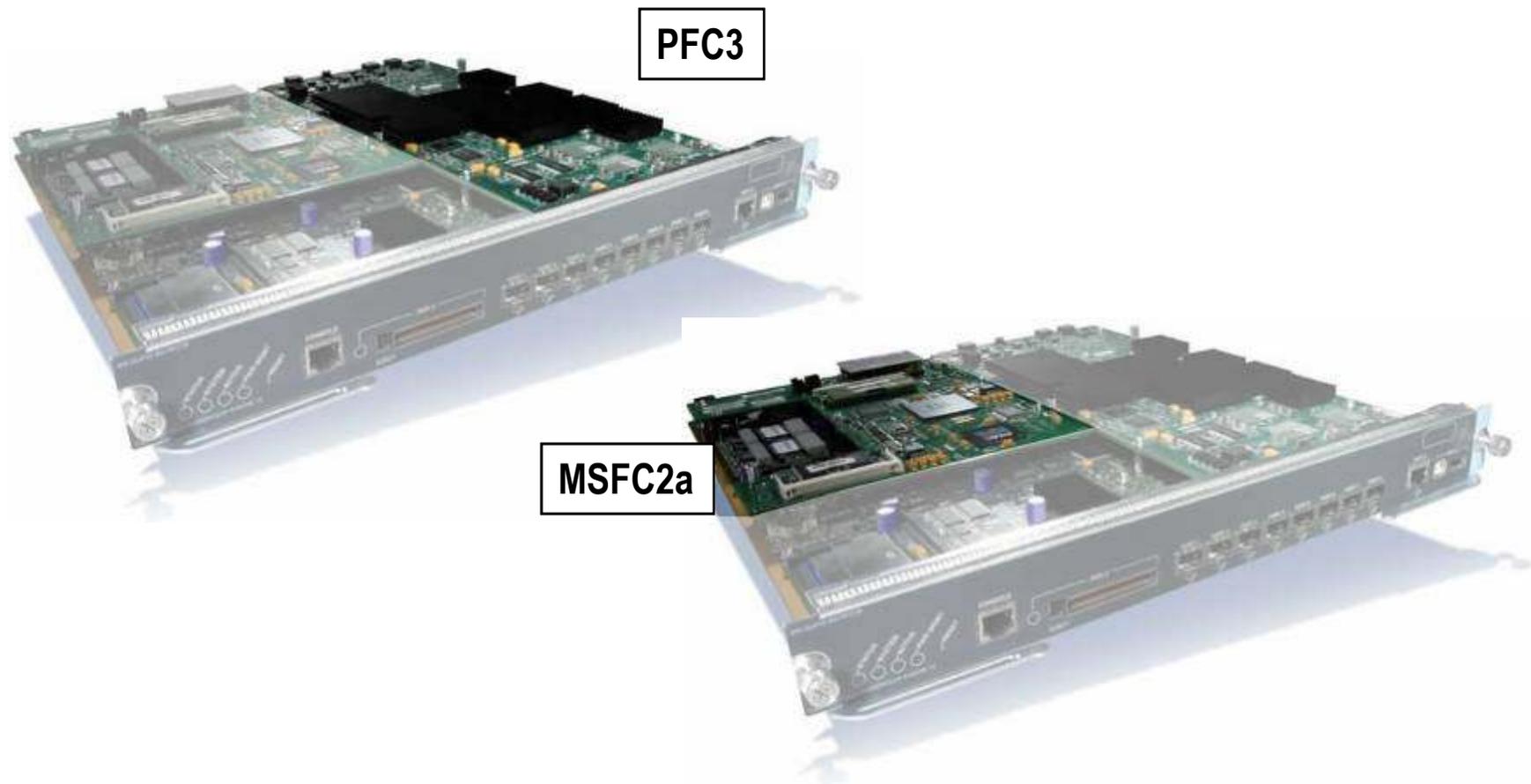
Other Quick Facts

- **NO** Switch Fabric
- Integrated Policy Feature Card 3 (PFC3B) supporting hardware acceleration for select features
- Integrated Multilayer Switch Feature Card 2a (MSFC2a) supporting two CPU's for Layer 2 and Layer 3 functionality
- One external compact flash slot
- Two 10GE ports OR Eight GE SFP port
- One 10/100/1000 port
- Console Port
- USB Ports

Catalyst 6500 Supervisors

Supervisor 32 - The Elements

Both Supervisor 32 models incorporates a Multilayer Switch Feature Card 2a (MSFC2a) and the Policy Feature Card 3 (PFC3) - each of which is highlighted below...



Catalyst 6500 Supervisors

MSFC and PFC in more detail

Lets look at the MSFC and PFC in more detail - what they are and what they do...

Multilayer Switch Feature Card (MSFC)



Provides Control Plane Functionality

Policy Feature Feature Card (PFC)



Provides Data Plane Functionality

So what is the Control Plane and the Data Plane???

Catalyst 6500 Supervisors

Control and Data Plane

There are two parts to the processing functionality of the Switch - the Control Plane and the Data Plane...



SWITCH CONTROL PLANE

Switch Features that are processed in **SOFTWARE** by a CPU...

There are two control planes

- the Switch Processor Control Plane (SP) which processes software based Layer 2 features
- the Route Processor Control Plane (RP) which processes software based Layer 3 features

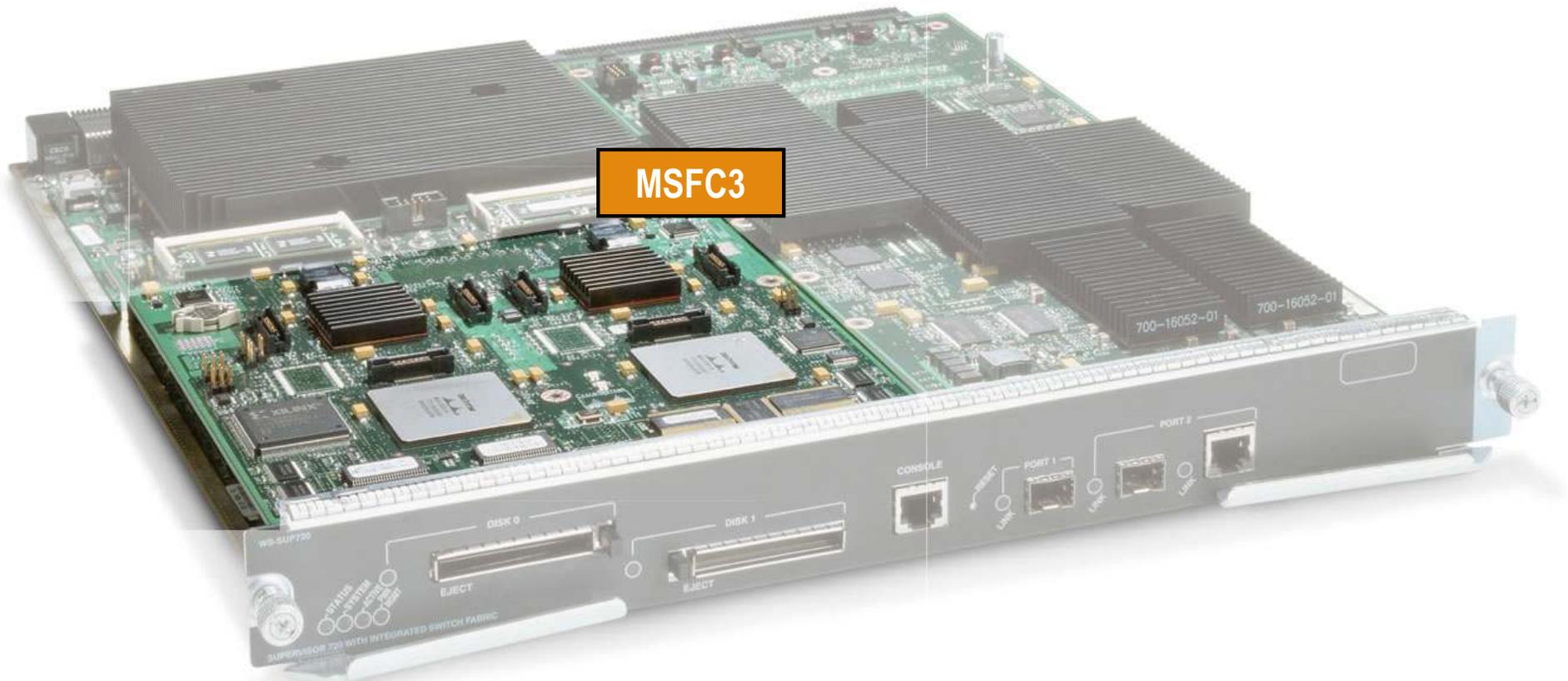
SWITCH DATA PLANE

Switch Features that are processed in **HARDWARE** by Application Specific Integrated Circuits (ASICs)

Feature performance usually ROCKS!!!!

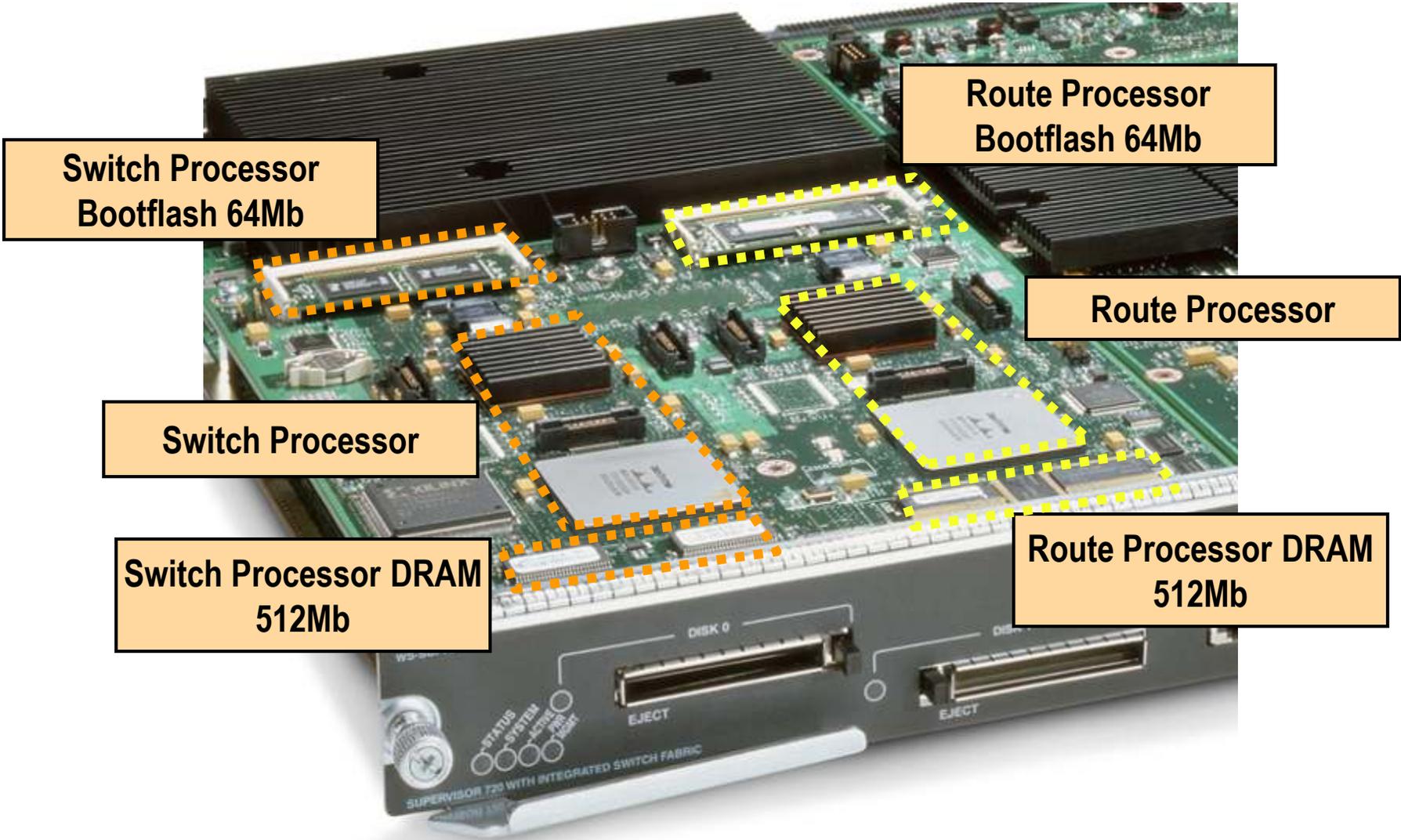
Catalyst 6500 Supervisors

MSFC3 Introduction



Catalyst 6500 Supervisors

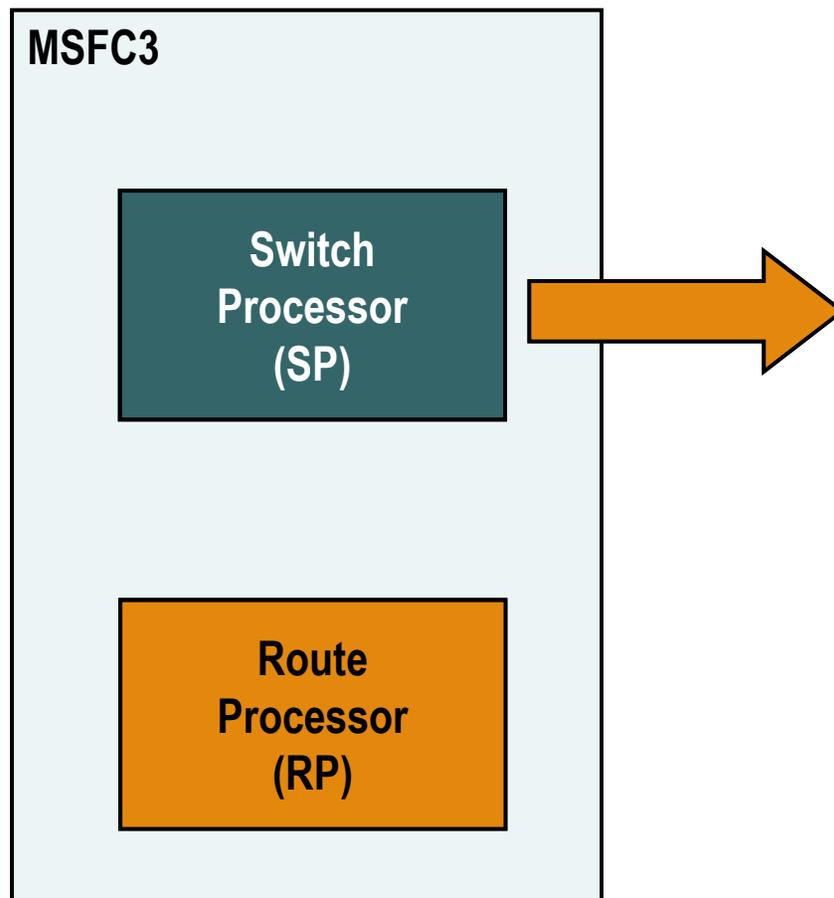
MSFC3 Components



Catalyst 6500 Supervisors

MSFC3 - Switch Processor

Both the RP and SP perform distinct functions during both the booting of the operating system and the ongoing operation of the switch...



The Switch Processor is physically located on the MSFC3

Logically considered as the Network Management Processor (NMP)

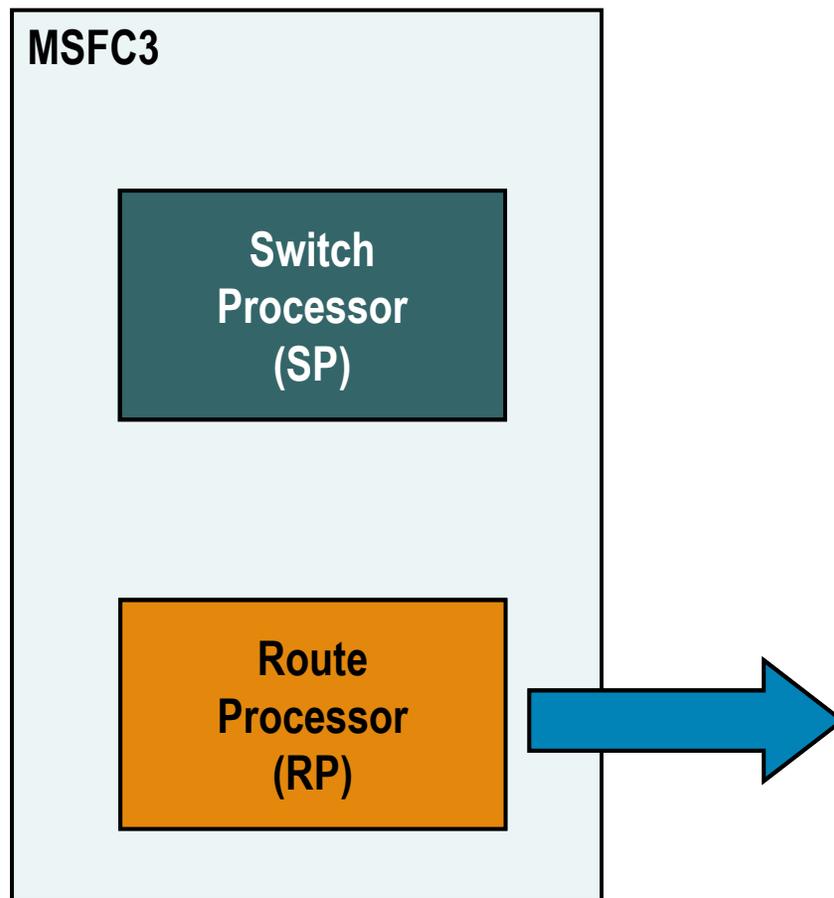
Dedicated CPU, DRAM, Flash and NVRAM

- The SP owns the switch at initial boot up before handing over to the RP
- The SP runs all layer 2 operations like VTP, Spanning Tree, Chassis and Power Management, etc
- Supports other Layer 2 features like CDP, SPAN, Broadcast Suppression, Etherchannel, etc

Catalyst 6500 Supervisors

MSFC3 - Route Processor

Both the RP and SP perform distinct functions during both the booting of the operating system and the ongoing operation of the switch...



The Route Processor is physically located on the MSFC

Logically considered as the MSFC

Dedicated CPU, DRAM, Flash and NVRAM

- The RP runs the Layer 3 routing protocols like OSPF, EIGRP, BGP, etc
- Other layer 3 features like IPX and Appletalk
- Manages the user interface (CLI)
- All show and configuration commands are processed on the RP then sent to the SP for execution

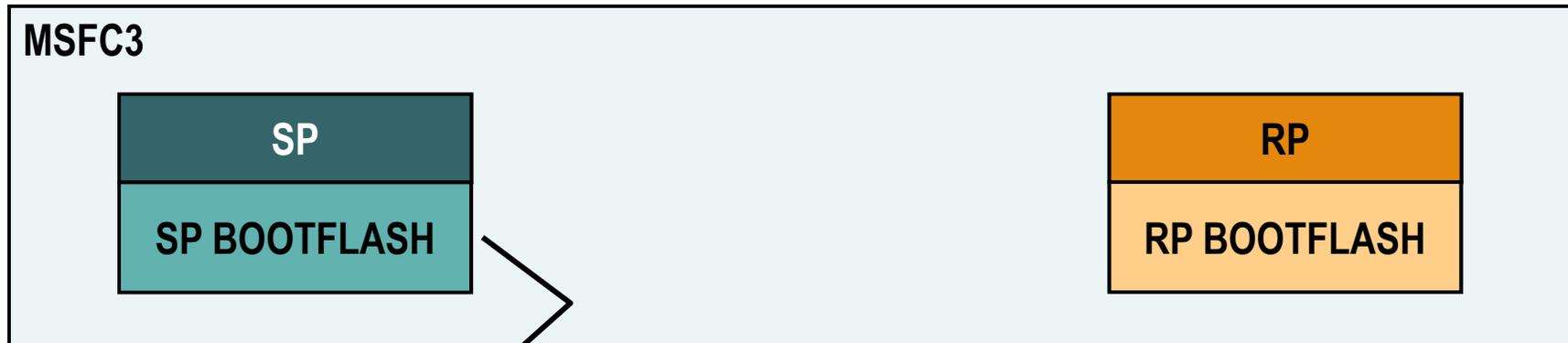
Catalyst 6500 Supervisors

MSFC3 - Bootflash

The RP and the SP both have their own set of Bootflash...

SP Bootflash is used to store the boot image and is referred to as SUP-BOOTFLASH during normal operation

RP Bootflash is referred to as BOOTFLASH during normal operation



```
6500# dir sup-bootflash:
Directory of sup-bootflash:/

   1  -rwx    78958736   May 4 2006 20:07:18 +00:00  s72033-advipservicesk9_wan-
vz.122-18.SXF4.bin

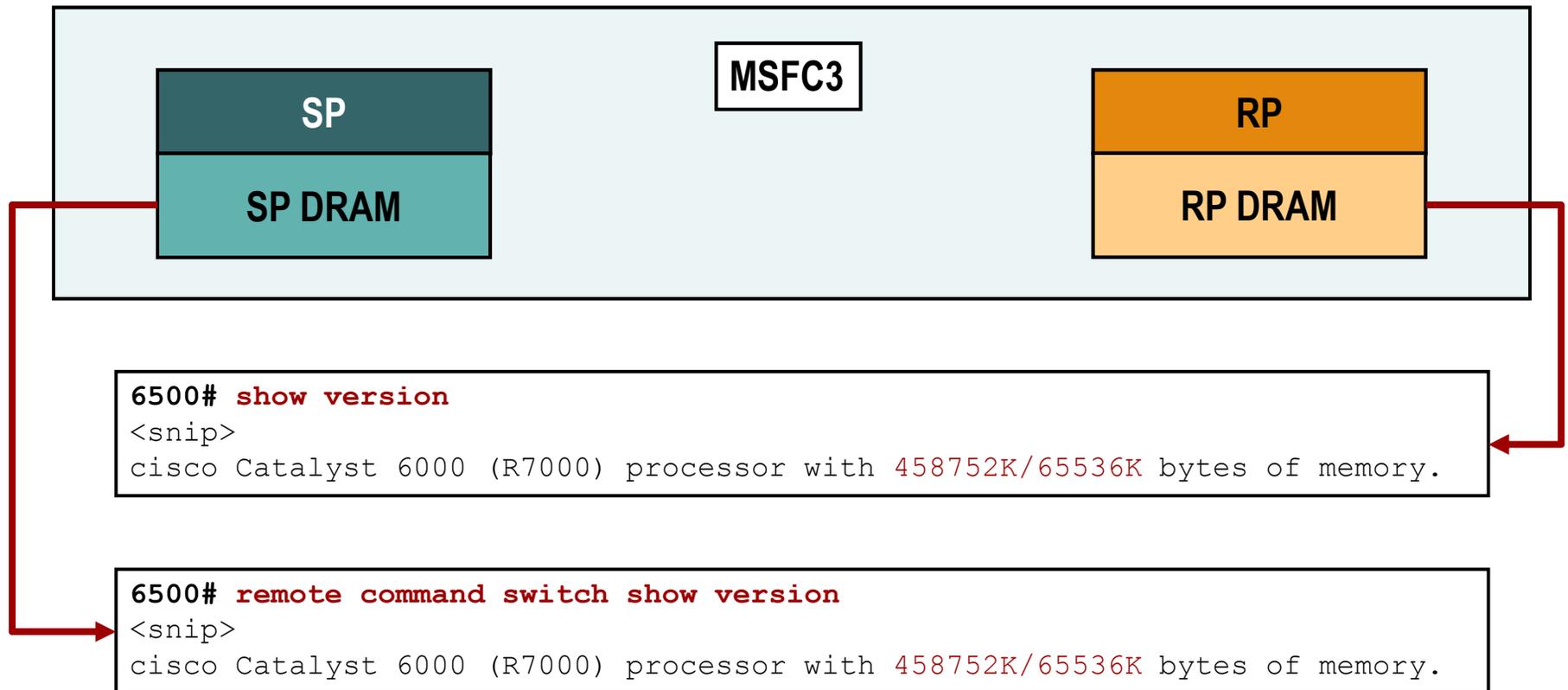
512040960 bytes total(433082224 bytes free)
```

Catalyst 6500 Supervisors

MSFC3 - RP and SP DRAM

The RP and the SP both have their own set of DRAM...

SP Bootflash (512MB) is used to store the running configuration, the running IOS image, the routing table, etc – the amount of SP and RP DRAM available can be seen using the following commands...



Catalyst 6500 Supervisors

MSFC3 New Bootflash Option

A new Compact Flash Adapter that can take the place of existing Bootflash on the Supervisor to alleviate current Bootflash size limitations...

COMPACT FLASH ADAPTER

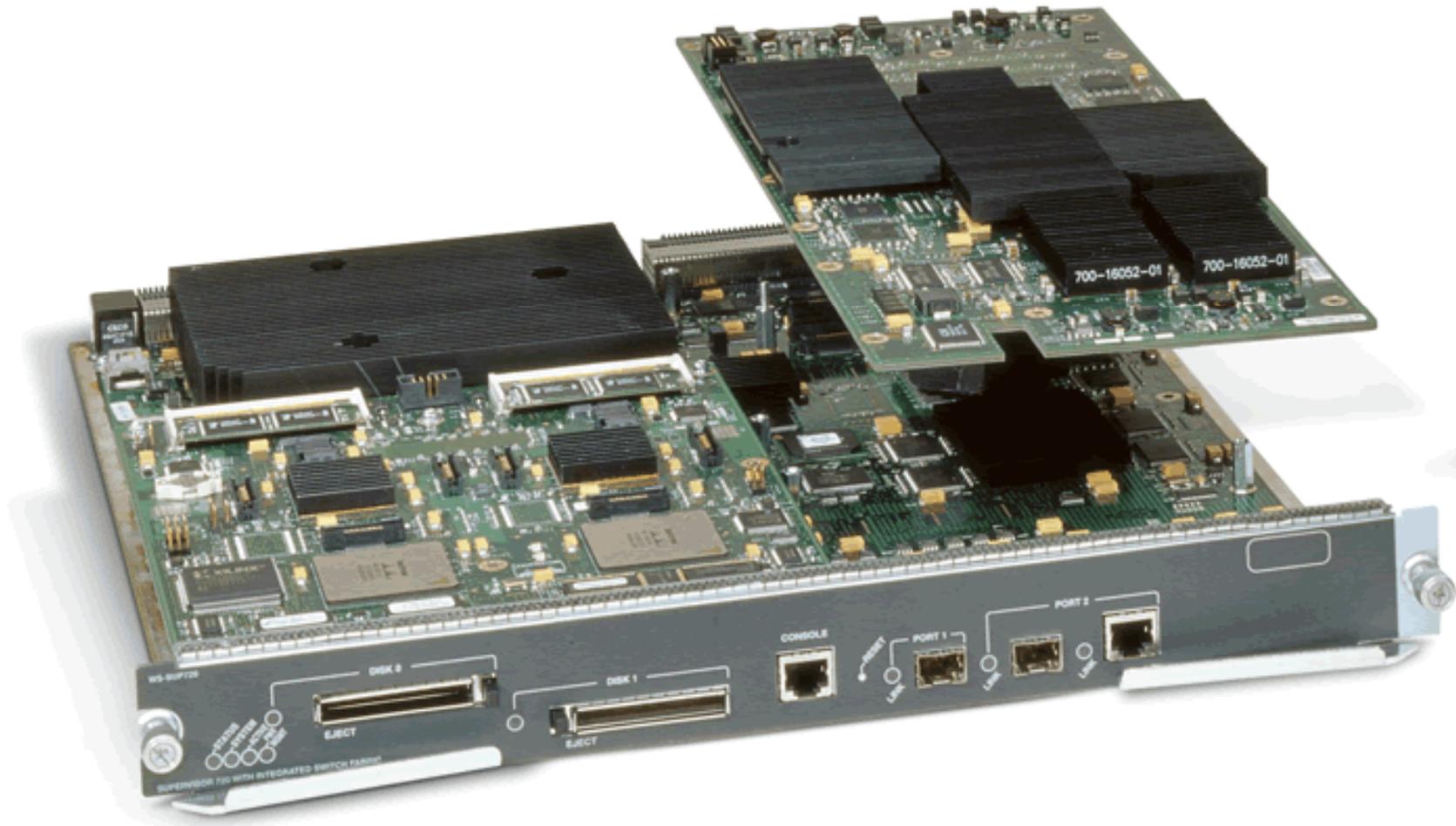


CF Adapter Specifications

- Part Number WS-CF-UPG=
- Supported in Sup720, Sup720-3B, Sup720-3BXL, Sup32 and Sup32-10GE
- WS-CF-UPG= comes by default with 512MB
- Support for 1GB CF under consideration
- CF Adapter is NOT OIR capable
- Requires IOS 12.2(18)SXE5
- LED located on CF Adapter which will flash green when CF is accessed; designed for use during troubleshooting

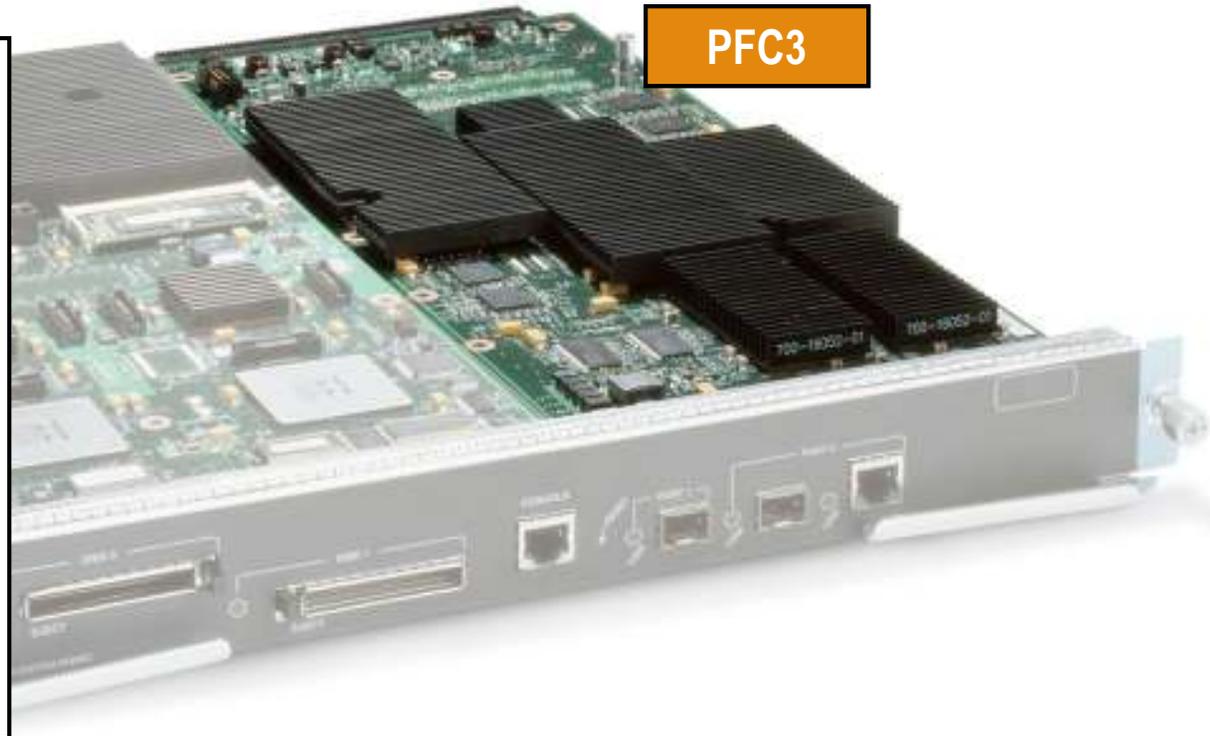
Catalyst 6500 Supervisors

PFC3 Introduction



Catalyst 6500 Supervisors

PFC3 Introduction



PFC3A - Base PFC

PFC3B - Adds MPLS, 4K ACL Labels, ACL Counters, improved hash algorithm for Netflow entries

PFC3BXL - Upgrades FIB to 1M entries and Netflow table to 256K Entries

PFC3x Hardware Features Summary

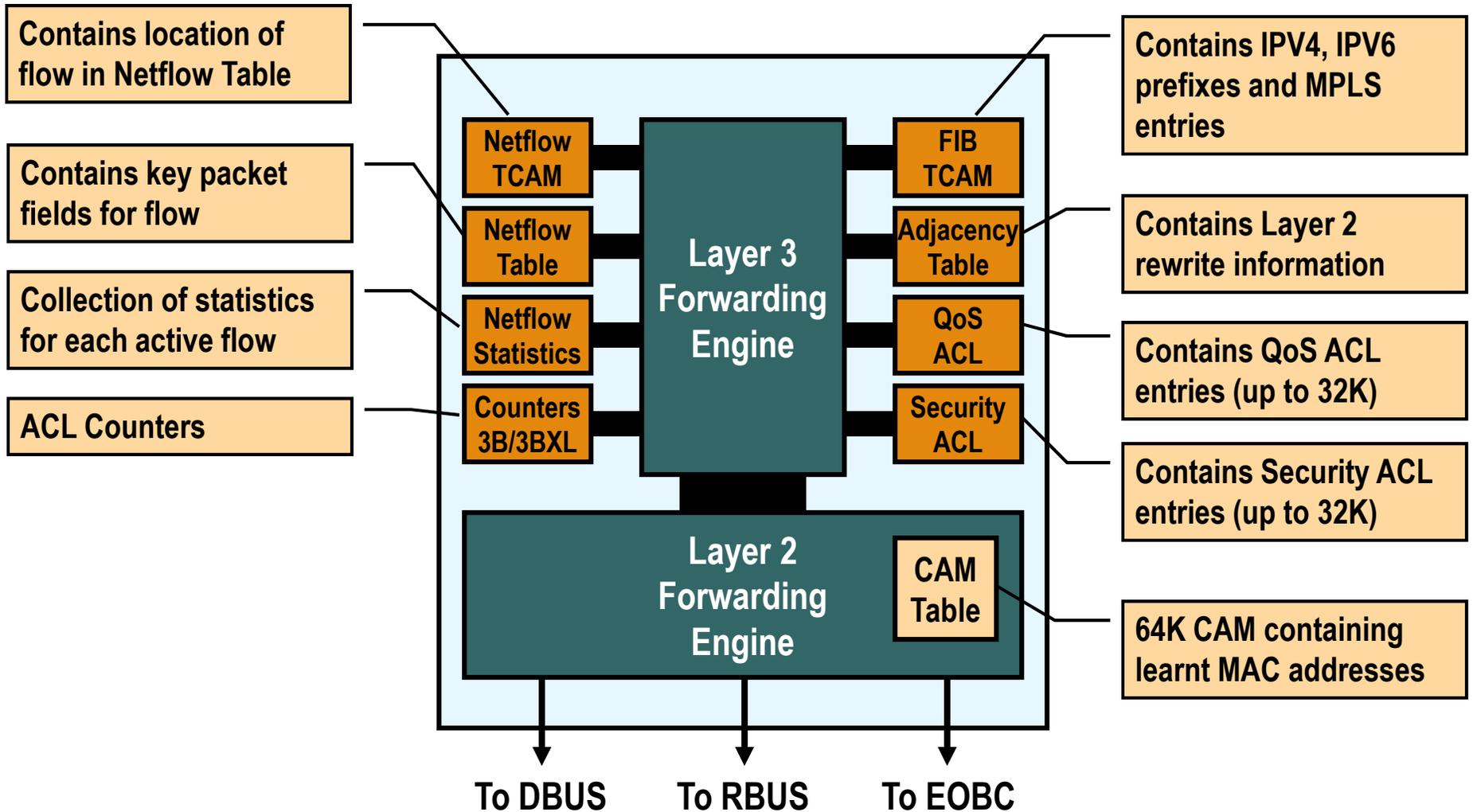
IPV4 and IPV6 CEF Switching
 IPV6 Tunneling
 IPV4 NAT/PAT in Hardware
 GRE and IP in IP Tunnels (HW)
 WCCP V2 enabled

From 256K-1M IPV4 Routes
 Ingress/Egress Policing
 User Based Rate Limiting
 Hardware based Classification
 Bi-Directional PIM

From 128K-500K IPV6 Routes
 Port Access Control Lists
 Multi-path URPF
 4K ACL Labels (3B/3BXL only)
 ACL Counters (3B/3BXL only)

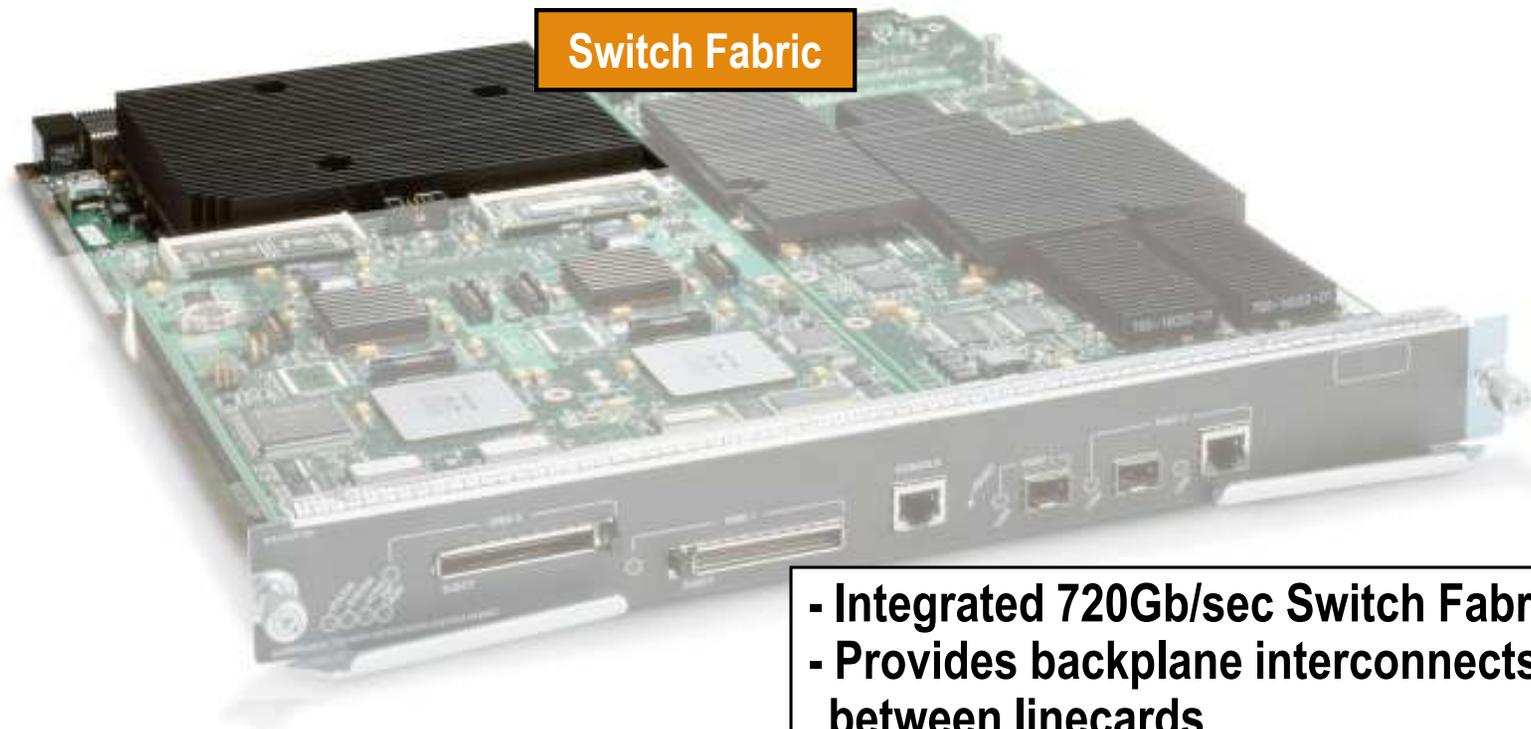
Catalyst 6500 Supervisors

PFC3 Components



Catalyst 6500 Supervisors

The 720Gb Switch Fabric



- Integrated 720Gb/sec Switch Fabric
- Provides backplane interconnects between linecards
- Consists of 18 Fabric Traces which are distributed across each linecard slot
- Each Fabric Trace can run at 8Gb/sec **OR** 20Gb/sec

Catalyst 6500 Supervisors

The Backplanes

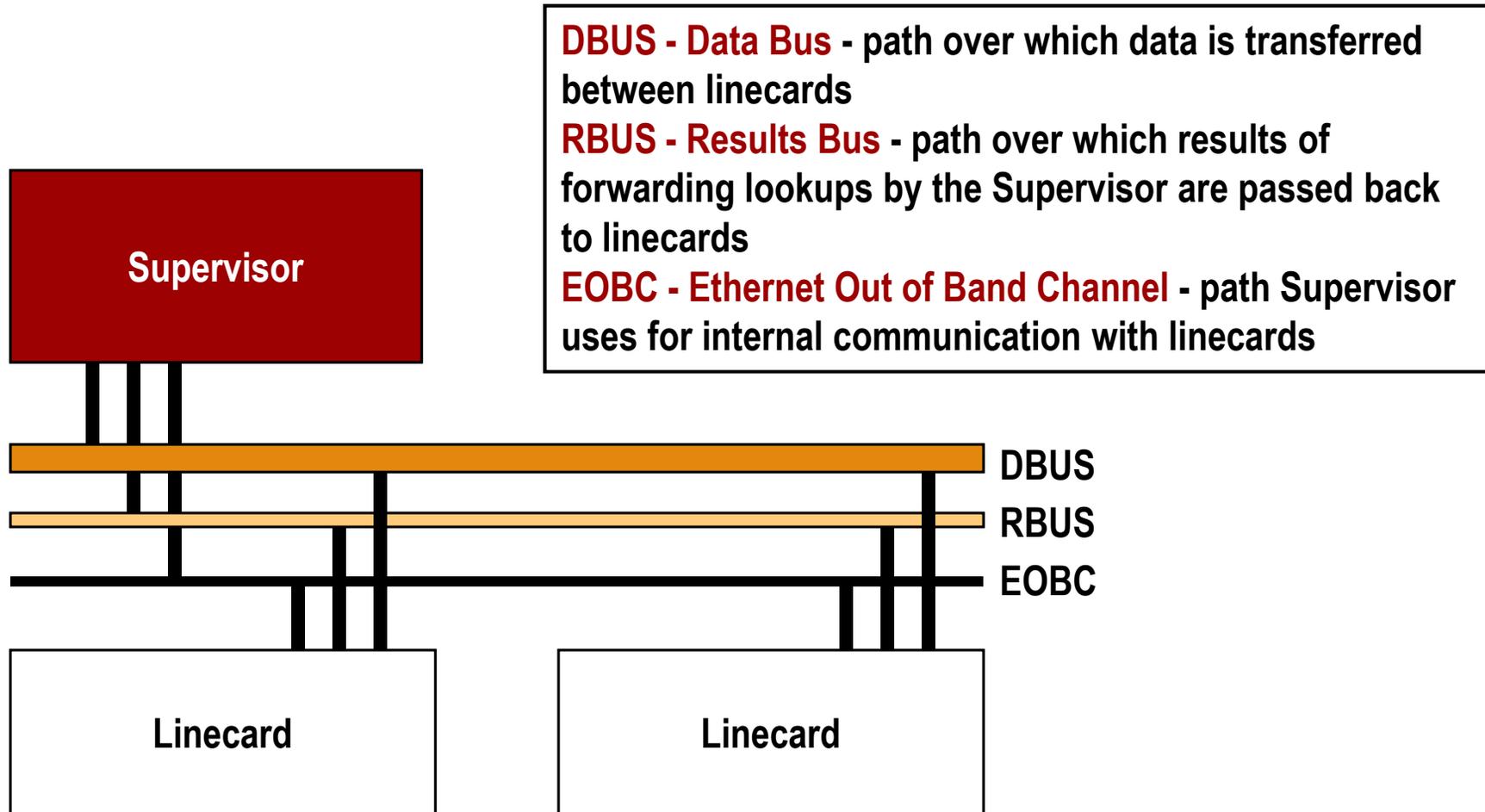
Two backplanes exist in the Catalyst 6500, the “Classic BUS” and the “Switch Fabric”...

	Classic BUS	Switch Fabric
Backplane Type	BUS	Crossbar
Supported by Sup720	Yes	Yes
Supported by Sup32	Yes	No
Speed	16Gb	8Gb or 20Gb
Full Duplex	Yes	Yes
Linecard Connection	Single Connection	Single or Dual Channel
Backplane is Shared Medium?	Yes - All modules connect to same BUS	No - Each module has discrete connection(s)
Supports Classic Linecard	Yes	No
Supports CEF256 Linecard	Yes	Yes
Supports CEF720 Linecard	Yes	Yes
Supports Linecard w/DFC	No	Yes

Catalyst 6500 Supervisors

The 32Gb Bus

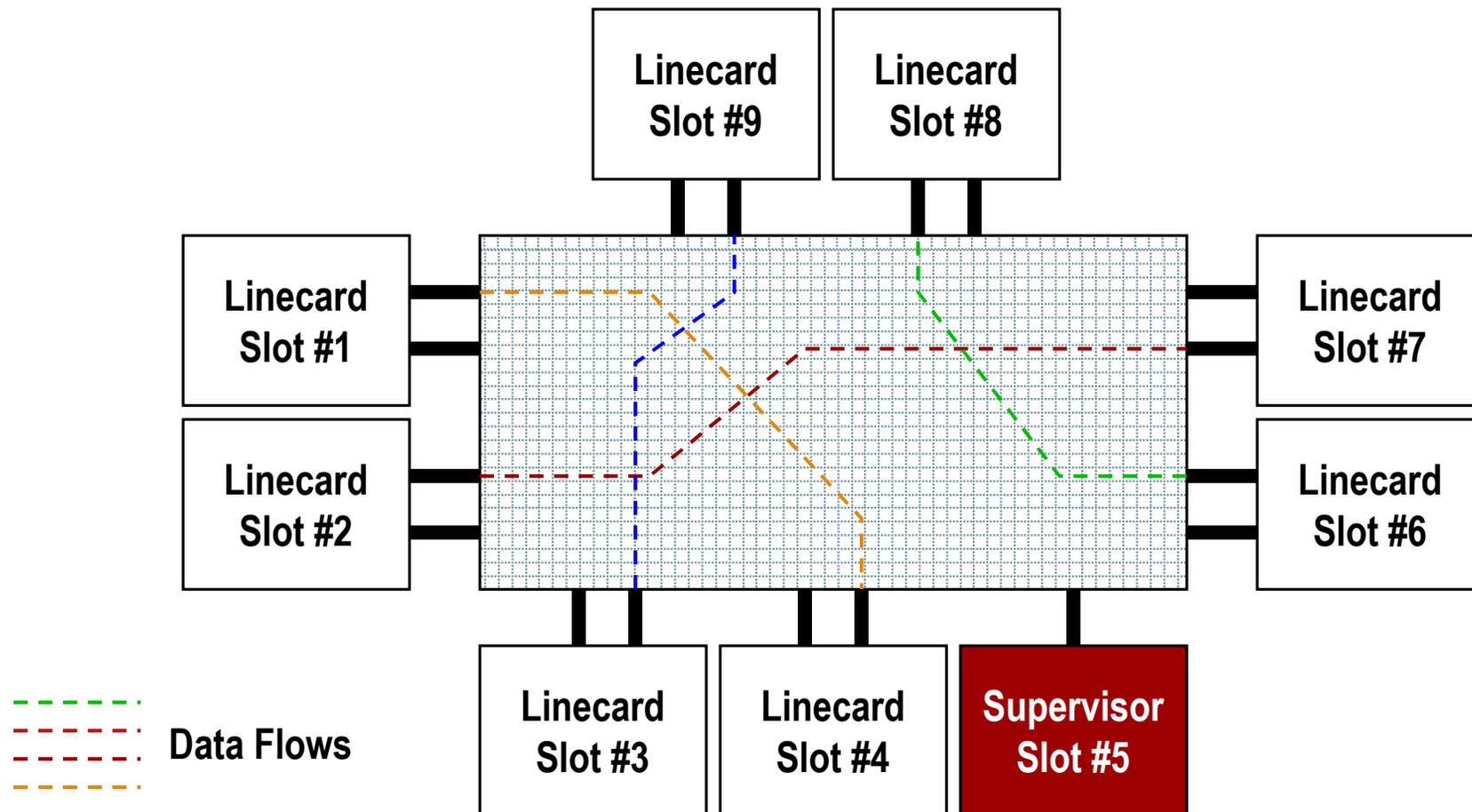
The 32Gb Classic Bus is a legacy backplane that originated with the first release of the Catalyst 6500 back in 1999.



Catalyst 6500 Supervisors

The 720Gb Switch Fabric

The Supervisor 720 supports a 720Gb Switch Fabric which offers each connected linecard a set of discrete communication paths into the switch backplane...





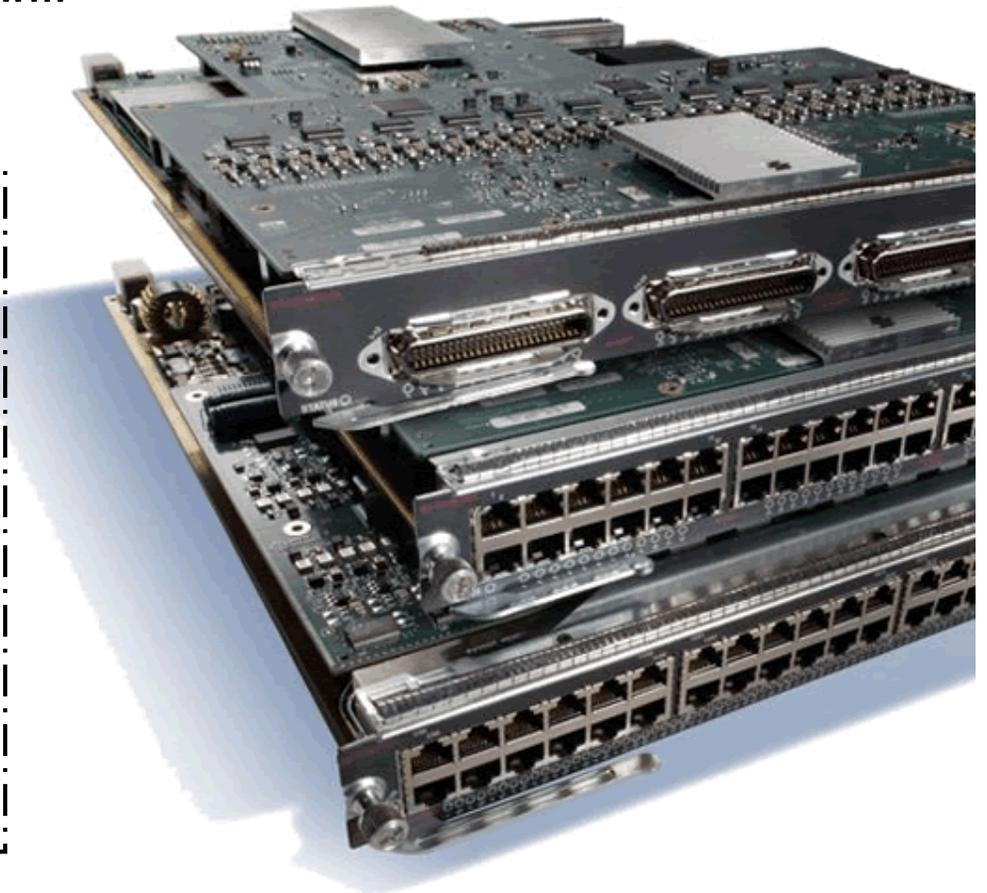
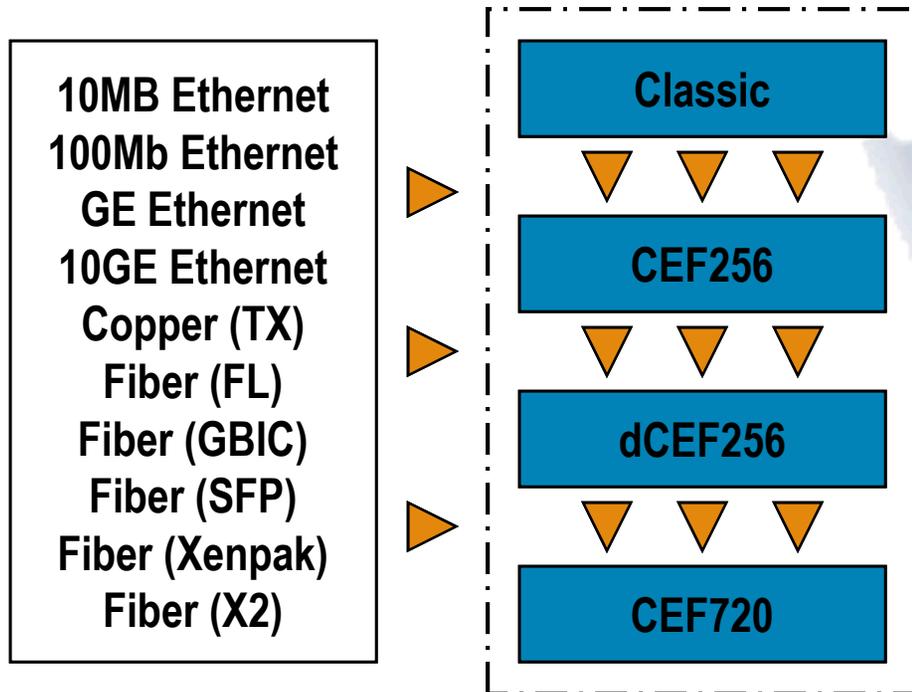
Catalyst 6500 Linecards



Catalyst 6500 Linecards

Introduction

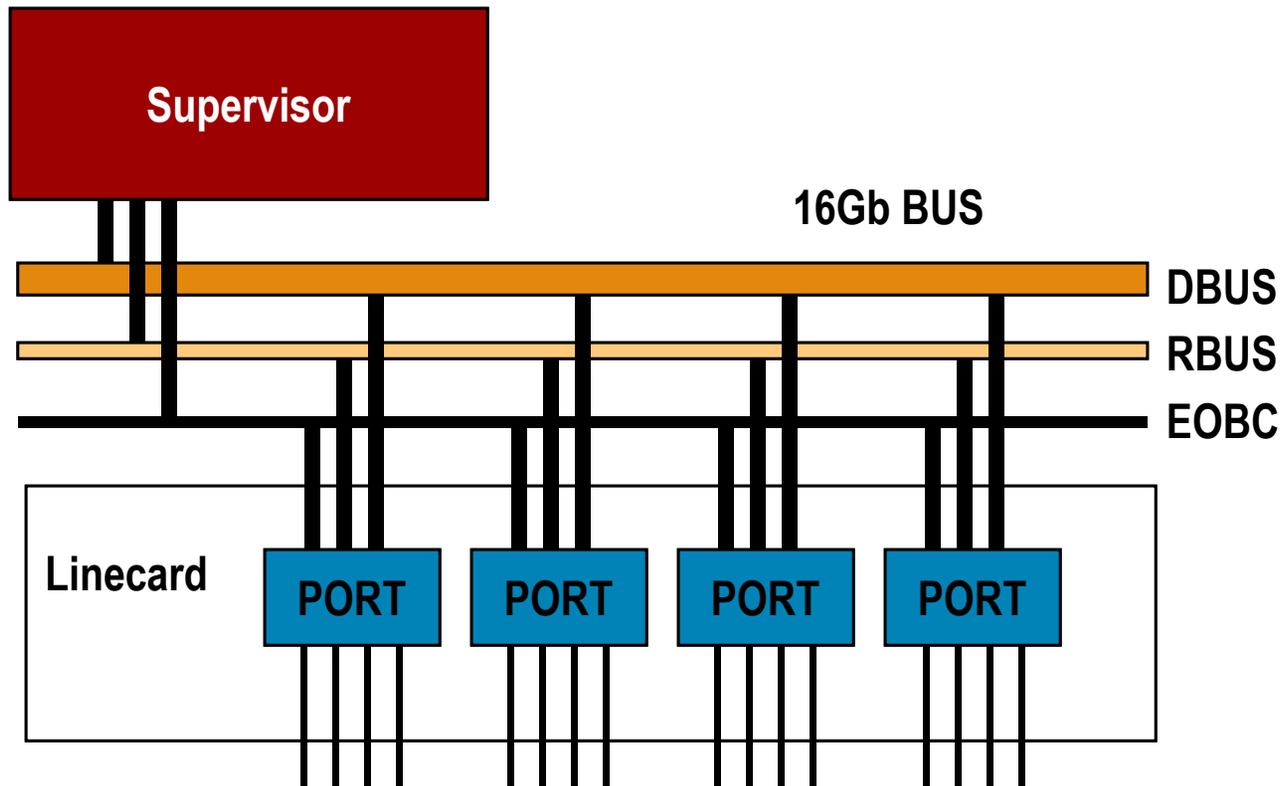
There are a multitude of linecards available for the Catalyst 6500 platform - they essentially fall into one of a number of categories defined below...



Catalyst 6500 Linecards

Classic Linecards

The Classic linecard connects to the 16Gb BUS - typically it has a number of Port ASICs on board that provide this connection as well as providing the front facing ports that hosts connect into...

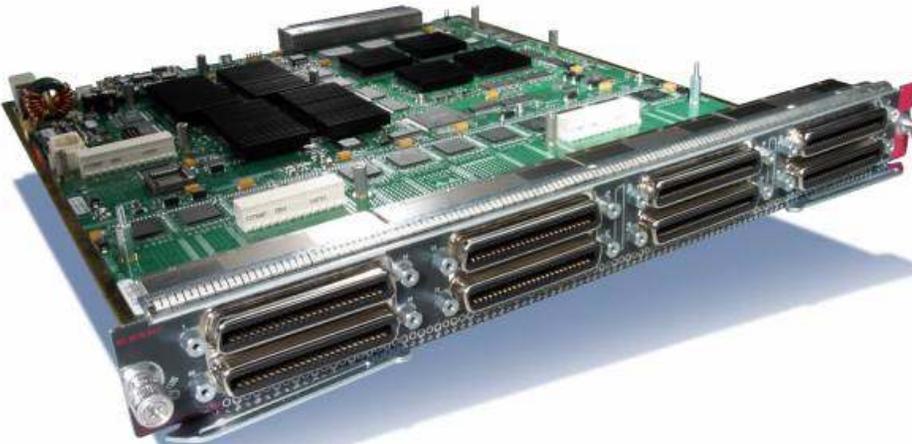
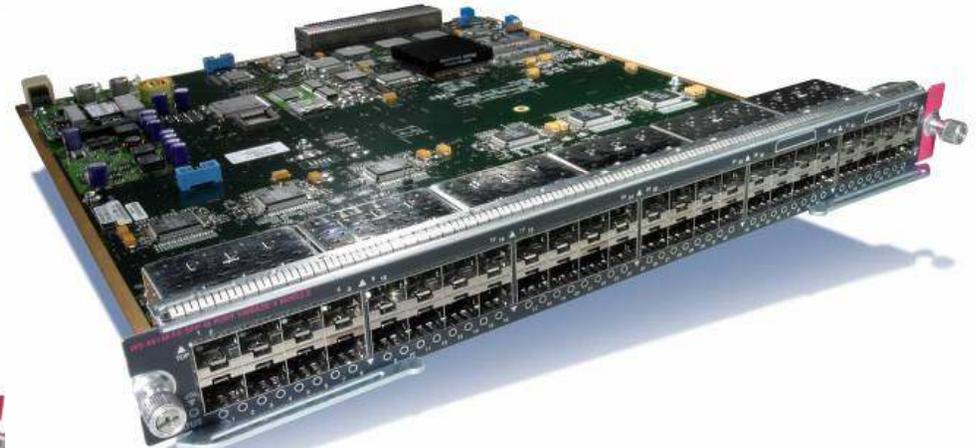
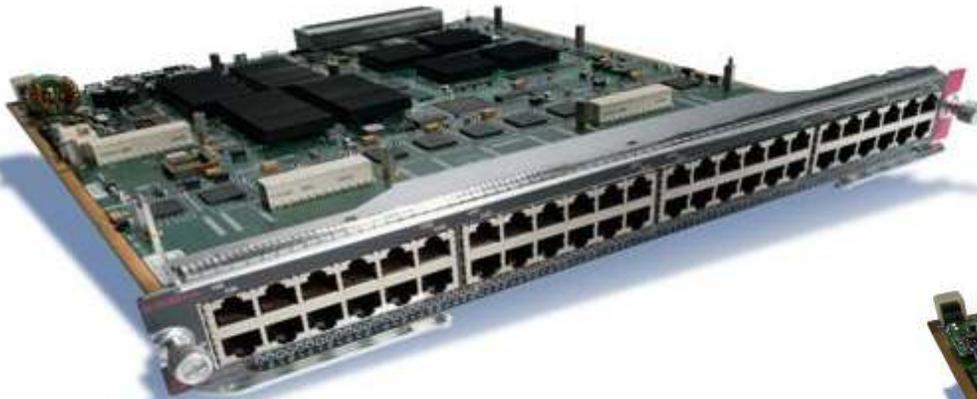


The BUS is often referred to as a 32Gb BUS

It is in fact a 16Gb BUS however, as it supports Full Duplex communication is was marketed as 32Gb (i.e. 16Gb Read + 16Gb Write)

Catalyst 6500 Linecards

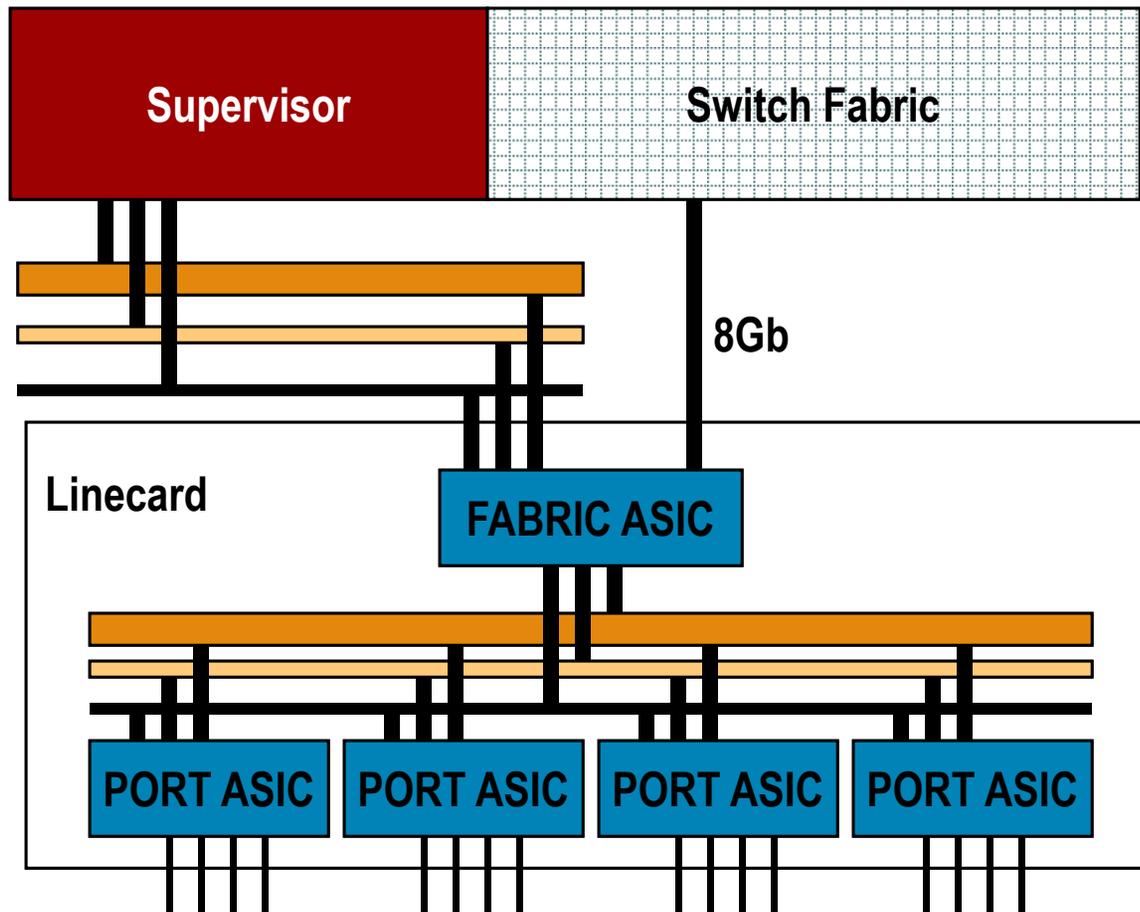
Classic Linecards



Catalyst 6500 Linecards

CEF256 Linecards

CEF256 represents the second generation of linecards - supporting a connection to the Classic Bus in addition to a connection to the Switch Fabric...



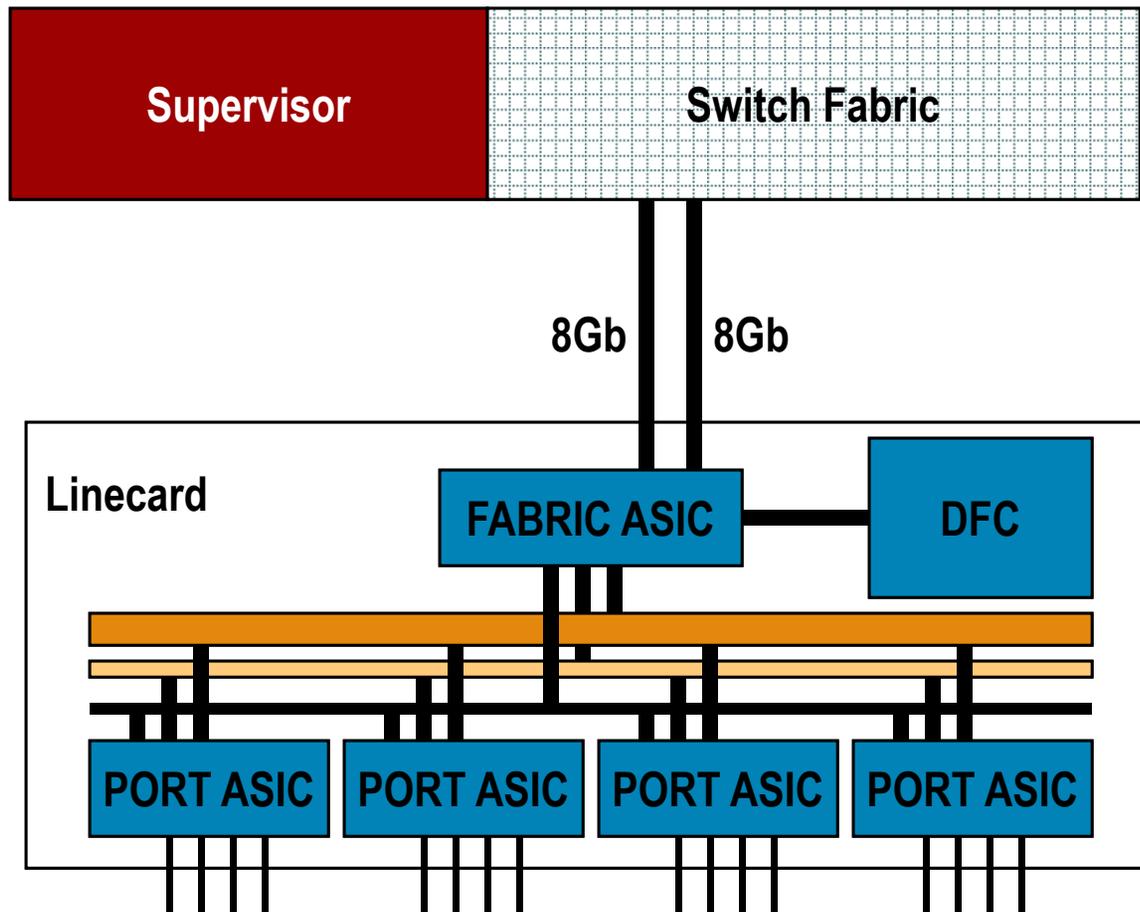
A CEF256 linecard supports a single 8Gb Fabric channel connection into the Switch Fabric plus a connection into the 16Gb Classic BUS

Note the CEF256 Linecards also use a local BUS on the linecard...

Catalyst 6500 Linecards

dCEF256 Linecards

dCEF256 was introduced as a higher performance linecard supporting 2 fabric channel connections...

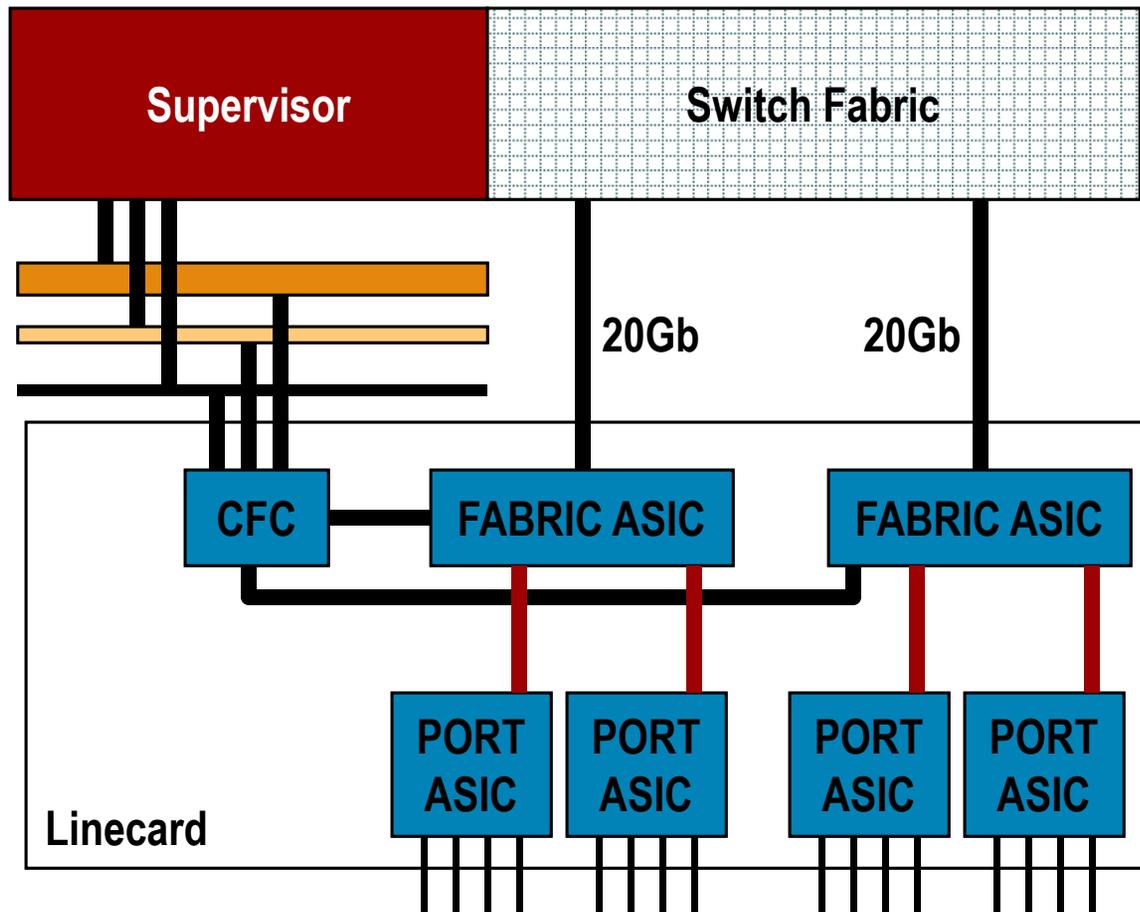


A dCEF256 linecard does NOT support a connection into the Classic BUS

Catalyst 6500 Linecards

CEF720 Linecards

The CEF720 is the latest generation of high performance linecards to be introduced into the Catalyst 6500 linecard family...



CEF720 Linecards connect into the BUS using a Centralized Forwarding Card (CFC)

They connect into the Switch fabric via dual 20Gb Fabric channels

Catalyst 6500 Linecards

WAN - SIP200

The **7600-SIP-200** supports the following...

Cisco 7500 Feature Parity

Up to 1.1Mpps without QoS

Up to 622Mbps performance

Dual Core CPU's

4 bays for SPA's

Up to 128MB of packet buffer per CPU

Distributed HQoS features
cRTP

MLPPP and LFI in hardware
Classification

Policing

Marking

CBWFQ/LLQ and WRED

Per Class Traffic Shaping



Catalyst 6500 Linecards

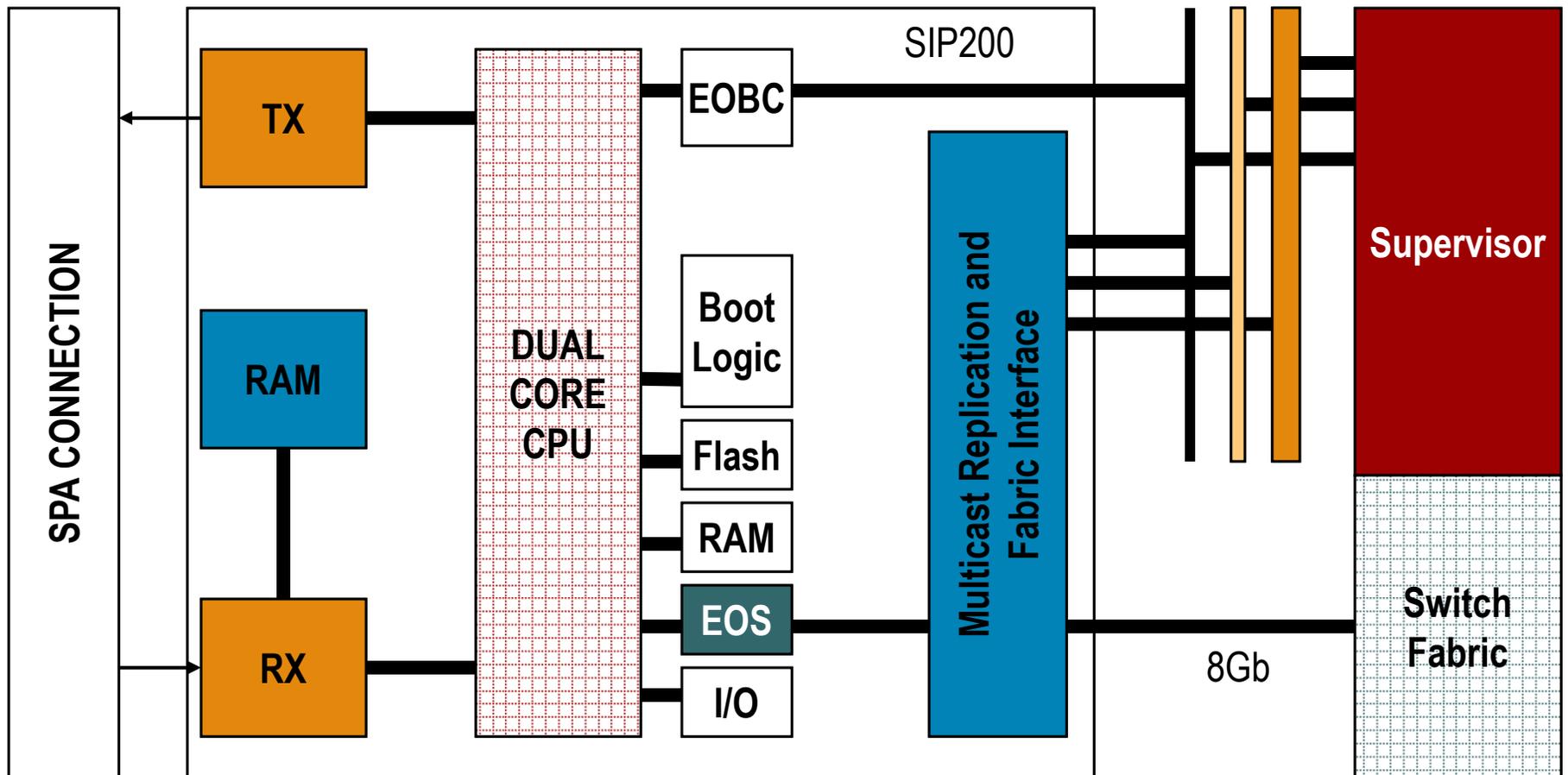
WAN - SIP200

SPA Name	Description	Height	Internal Code Name
SPA-CH8TE1	8- port Channelized T1/E1 SPA	Single height	Maverick
SPA-4XT3/E3	4-port T3/E3 SPA	Single height	Javelin
SPA-2XT3/E3	2-port T3/E3 SPA	Single height	Javelin
SPA-4XCT3/DS0	4- port Channelized T3 SPA	Single height	Patriot
SPA-2XCT3/DS0	2- port Channelized T3 SPA	Single height	Patriot
SPA-4XOC3-POS	4- port POS OC3 SPA	Single height	Sphinx
SPA-2XOC3-POS	2- port POS OC3 SPA	Single height	Sphinx
SPA-4XOC3-ATM	4- port ATM OC3 SPA	Double height	Warlord
SPA-2XOC3-ATM	2- port ATM OC3 SPA	Double height	Warlord

Catalyst 6500 Linecards

WAN - SIP200 Architecture

A block diagram of the SIP200 linecard is shown below...



Catalyst 6500 Linecards

WAN - SIP400

The **7600-SIP-400** supports the following...

Network Processor based carrier card

Up to 6.2Mpps @ 40 byte packets

Up to 4Gbps performance @ 64 byte packets

Dual Network Processors

4 bays for SPA's

Replacement for OSM

32,000 Queues

3 level Hierarchical QoS

Dual Rate, 3 Color Policer

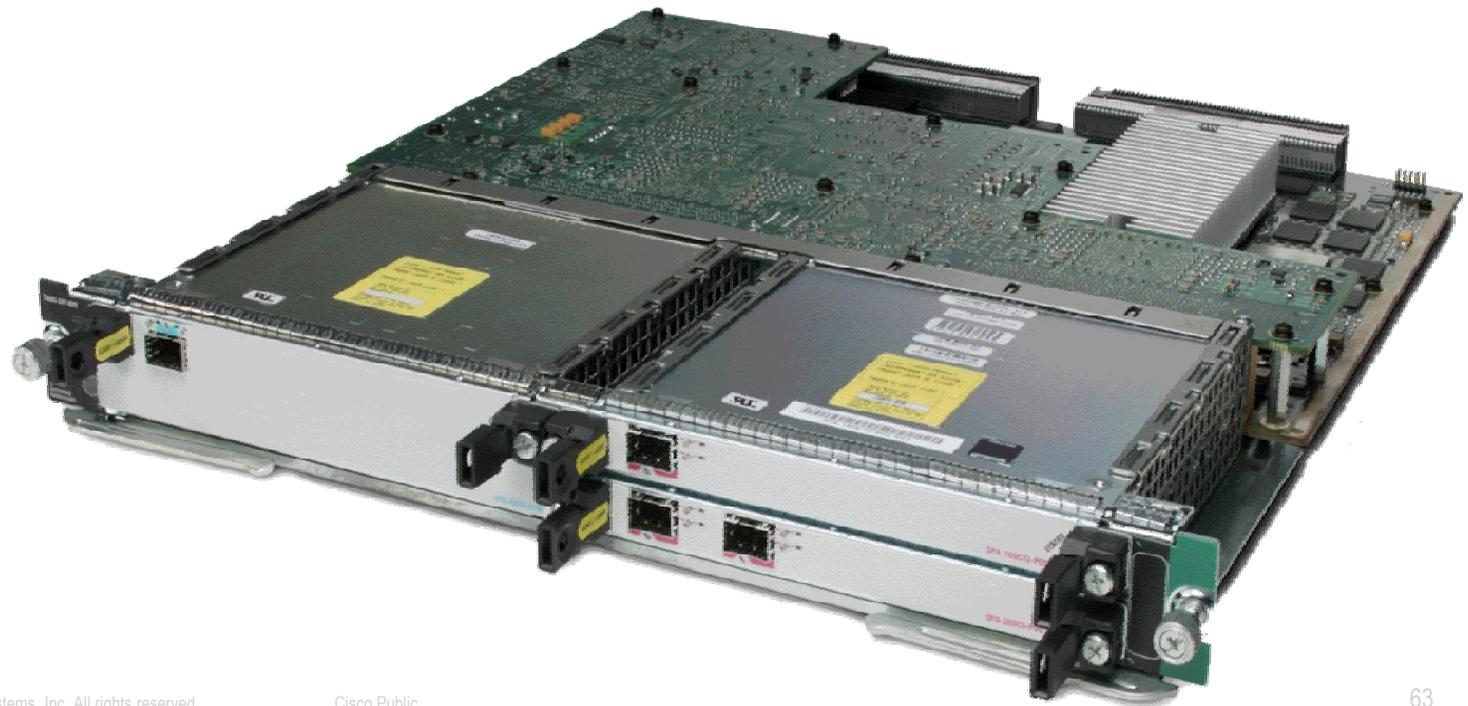
CBWFQ + LLQ + WRED

EoMPLS

FRoMPLS

ATM AAL5 over MPLS

ATM Cell Relay over MPLS



Catalyst 6500 Linecards

WAN - SIP400

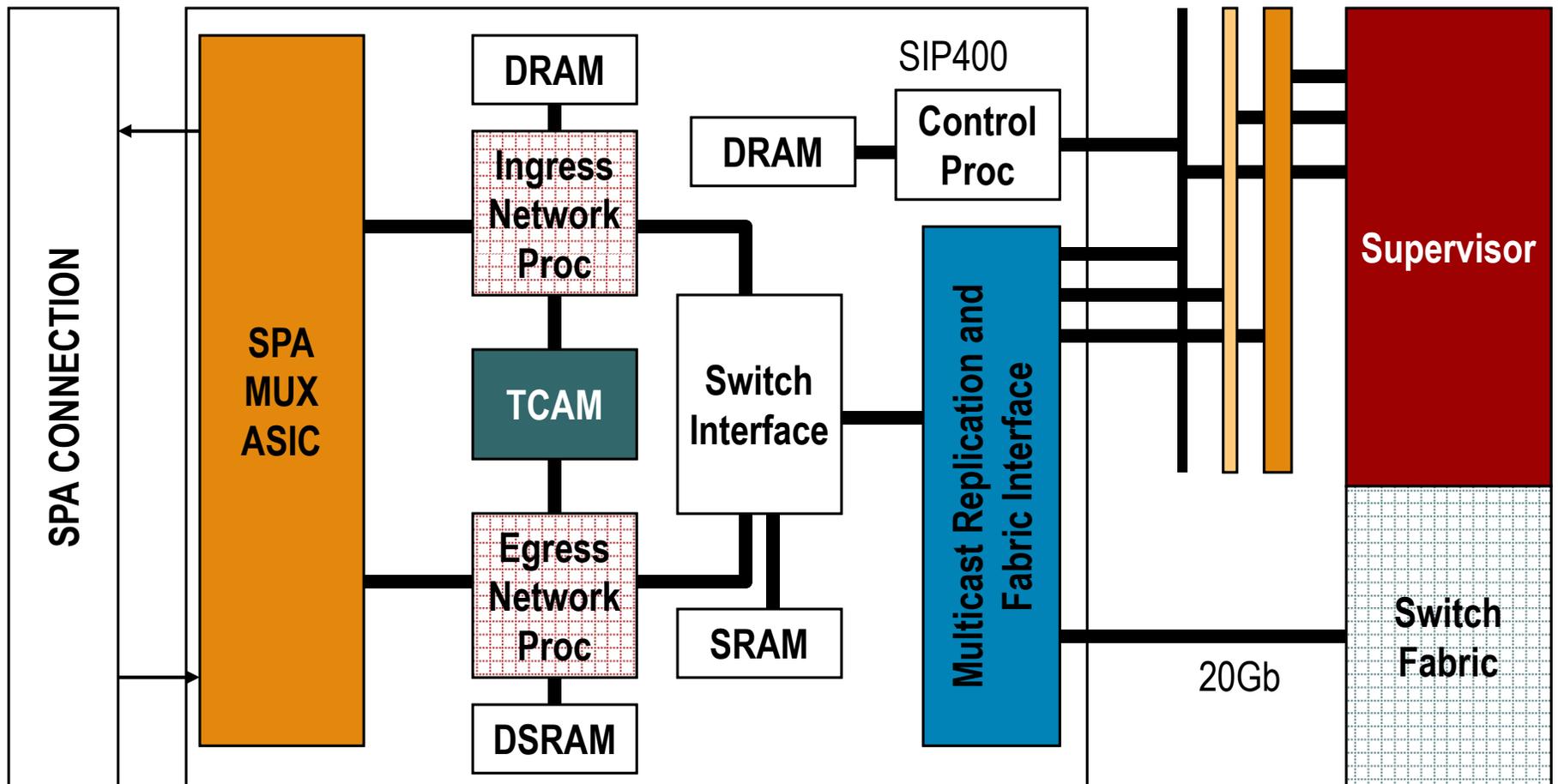
SPA's supported by the SIP400 include the following...

SPA	Ports	Interface	Form Factor
OC-3/STM-1 POS	2, 4	SFP	Single Height
OC-12/STM-4 POS	1, 2, 8	SFP	Single Height
OC-3/STM-1 ATM	2, 4	SFP	Double Height
OC12/STM-4 ATM	1	SFP	Double Height
OC48/STM-16 POS/RPR	2, 4	SFP	Single Height
OC48/STM-16 ATM	1	SFP	Double Height
T3/E3 ATM	2, 4	Copper	Single Height
Channelized T1/E1	8	Copper	Single Height
Clear Channel T3/E3	2, 4	Copper	Single Height
Channelized T3	2, 4	Copper	Single Height
Channelized OC-3/STM-1	1	SFP	Single Height
FE	4, 8	TX, FX	Single Height
GE	1, 2	SFP	Single Height

Catalyst 6500 Linecards

WAN - SIP400 Architecture

A block diagram of the SIP400 linecard is shown below...



Catalyst 6500 Linecards

WAN - SIP600

The **7600-SIP-600** supports the following...

Integrated DFC3

8000 full duplex queues

Up to 10Gbps performance @ 64 byte packets

Dual Network Processors

1Gb local Memory

20Gb Switch Fabric Connection

No connection to the Classic BUS

Sup720-3B and Sup720-3BXL only

VPLS/H-VPLS

Security ACL's

Policing

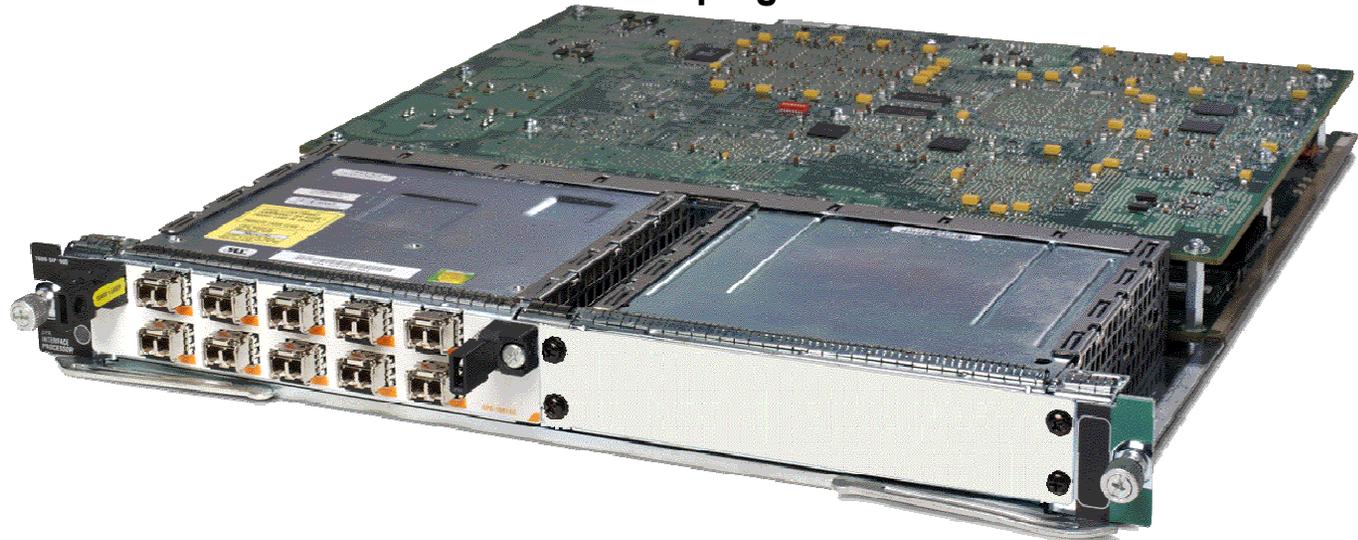
Classification

Marking

CBWFQ/LLQ

Hierarchical Traffic Shaping

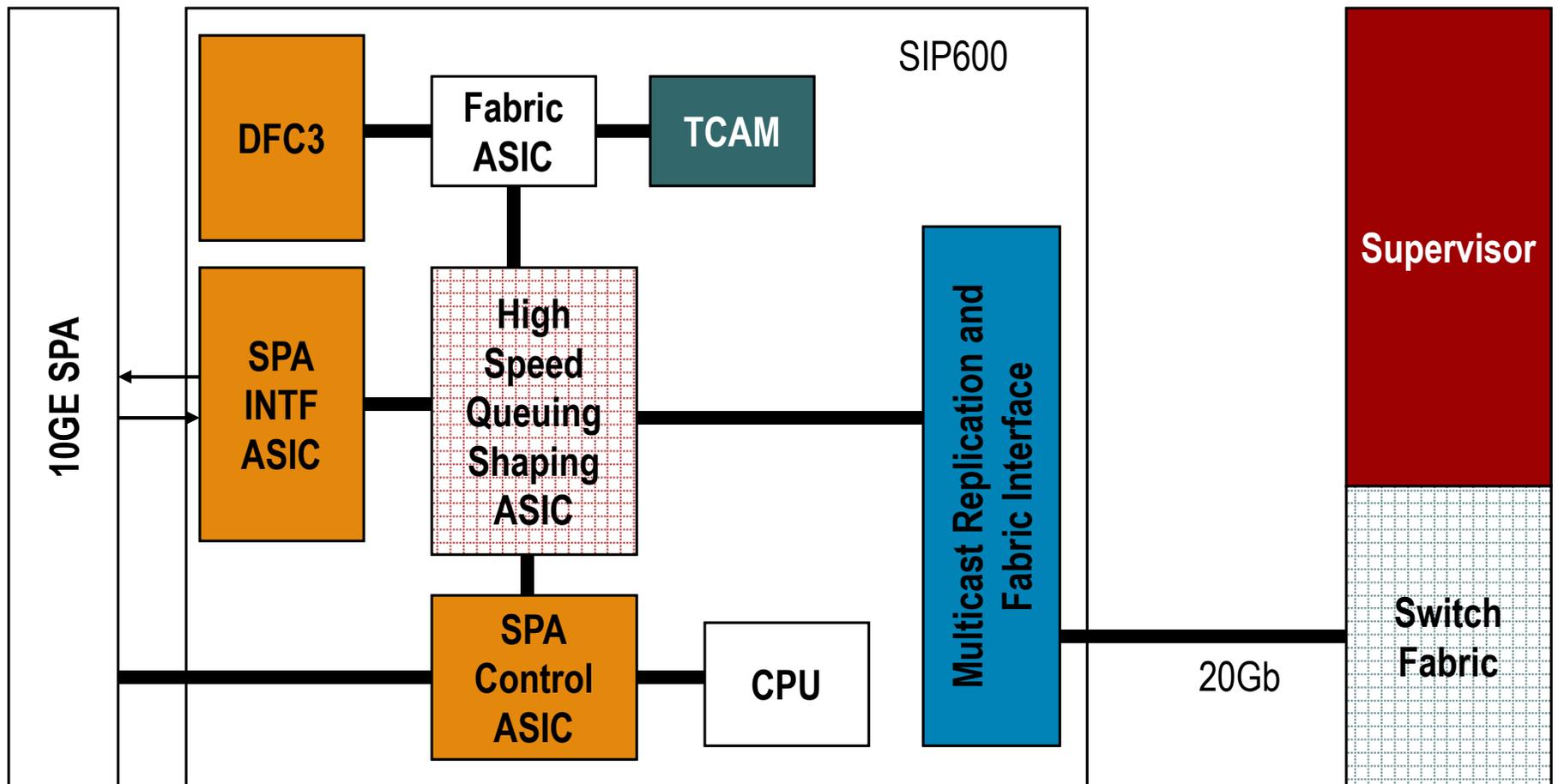
Shaping/WRED



Catalyst 6500 Linecards

WAN - SIP600 Architecture

A block diagram of the SIP600 linecard is shown below...



Catalyst 6500 Linecards

Optics - XENPAK for 10GE



Xenpak Modular Optics

IEEE 802.3ae 10 GbE MSA

Hot Pluggable 10GbE 'GBIC'

SC duplex fiber optic connector

Compliant for all IEEE 802.3ae and 802.3ak mediums

Xenpak optics are used in the new 10GE modules. They allow flexibility in choice of optics per port on each 10GE module. Xenpak optic options include the following...

Xenpak Modular Optic Options include

- **WS-XENPAK-LR**—10km Single Mode Fiber
- **WS-XENPAK-ER**—40km Single Mode Fiber
- **WS-XENPAK-SR**—66m to 300m Multi-mode Fiber
- **WS-XENPAK-LX4**—300m Multi-mode Fiber
- **WS-XENPAK-CX4**—10GbE Copper Short Reach up to 15m using Infini-band cabling
- Infini-band Cable available in 1m, 5m, 10m and 15m options.

Catalyst 6500 Linecards

Optics - DWDM and Receive Only Xenpak



DWDM Xenpak Modular Optics

IEEE 802.3ae 10 GbE MSA

Hot Pluggable 10GbE 'GBIC'

SC duplex fiber optic connector

Compliant for all IEEE 802.3ae and 802.3ak mediums

Xenpak optics also now include DWDM and Receive Only Optics

Xenpak DWDM Modular Optic Options specifications

- Support 10GBase Ethernet
- 32 different Xenpak options each supporting a non-tuneable ITU 100GHz wavelength with the Cisco ONS DWDM channel plan
- Supports digital optical monitoring
- Dual SC/PC connection

Xenpak Receive Only Modular Optic Options specifications

- WDM-XENPAK-REC
- Used when creating a Unidirectional Ethernet (UDE) Link

Catalyst 6500 Linecards

Optics - X2 for 10GE



X2 Modular Optics

IEEE 802.3ae 10 GbE MSA

Hot Pluggable 10GbE 'Optic'

SC/PC duplex fiber optic connector

Compliant for all IEEE 802.3ae and 802.3ak mediums

X2 optics are used in the new 6708 10GE module. They provide full interoperability with the equivalent Xenpak optic. X2 optics include the following...

X2 Modular Optic Options include

- **X2-10GB-LR**—10km Single Mode Fiber
- **X2-10GB-SR**—26m to 300m Multi-mode Fiber
- **X2-10GB-LX4**—300m Multi-mode Fiber
- **X2-10GB-CX4**—10GbE Copper Short Reach up to 15m using Infiniband cabling

Catalyst 6500 Linecards

Mixing Different Linecards Architectures

When transferring data between linecards, the backplane will operate in one of three modes – these modes are determined by the combination of linecards installed in the chassis and which module the traffic sourced from and destined to...

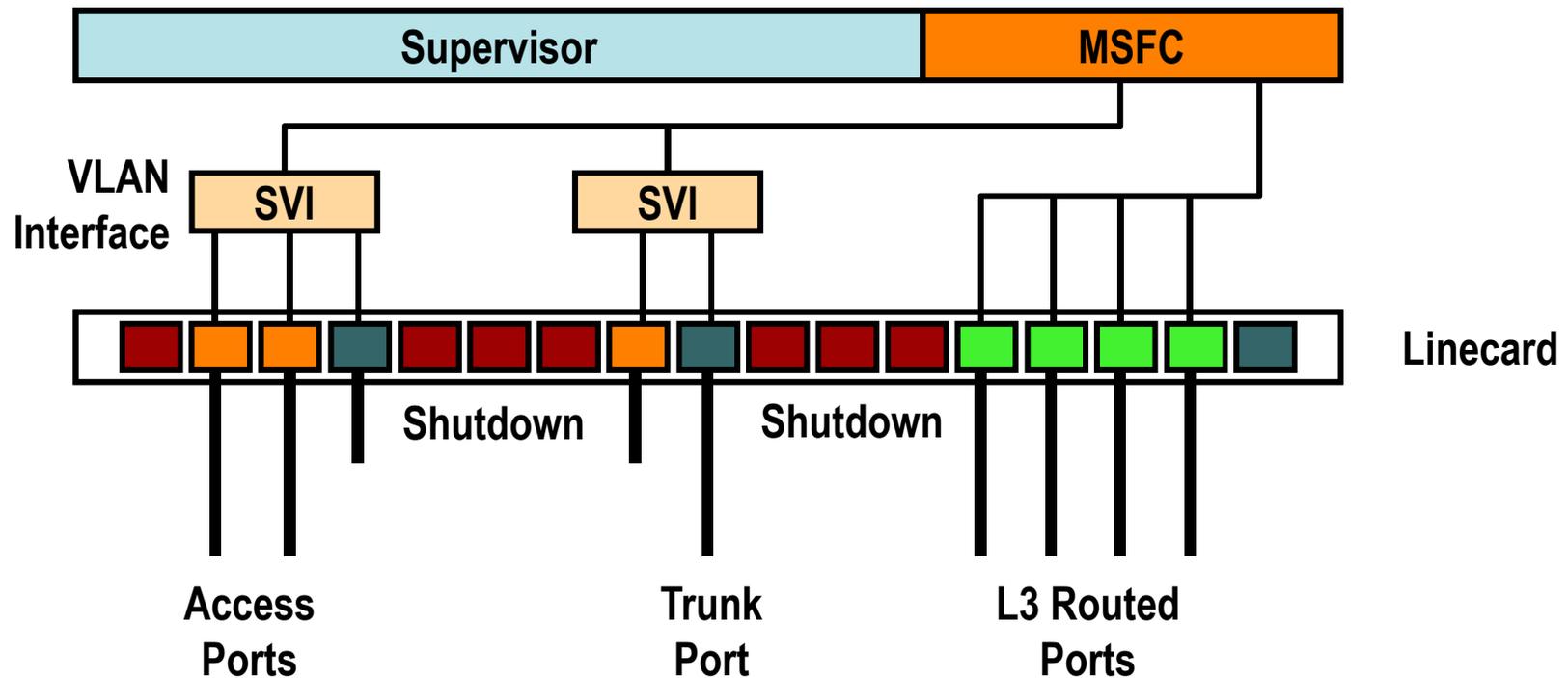
Mode	Description
BUS	Used for traffic between non fabric (classic) enabled modules and for traffic between a non fabric and a fabric enabled linecard...centralized performance to 15Mpps
COMPACT	Used when only ALL fabric enabled linecards used in a chassis – this mode uses a compact form of DBus header which optimizes centralized performance to 30Mpps
TRUNCATED	Used for traffic between fabric enabled linecards when a non fabric enabled linecard is installed in the chassis. In this mode, centralized forwarding reverts back to 15Mpps.

Catalyst 6500 Linecards

Linecard Port Configuration

When running IOS, Ethernet ports can be configured with one of three interface types: Access, Trunk or Router. Interfaces in IOS assume a different default behavior than those same ports under CatOS in that they are shutdown on initial startup.

Supervisor Engine



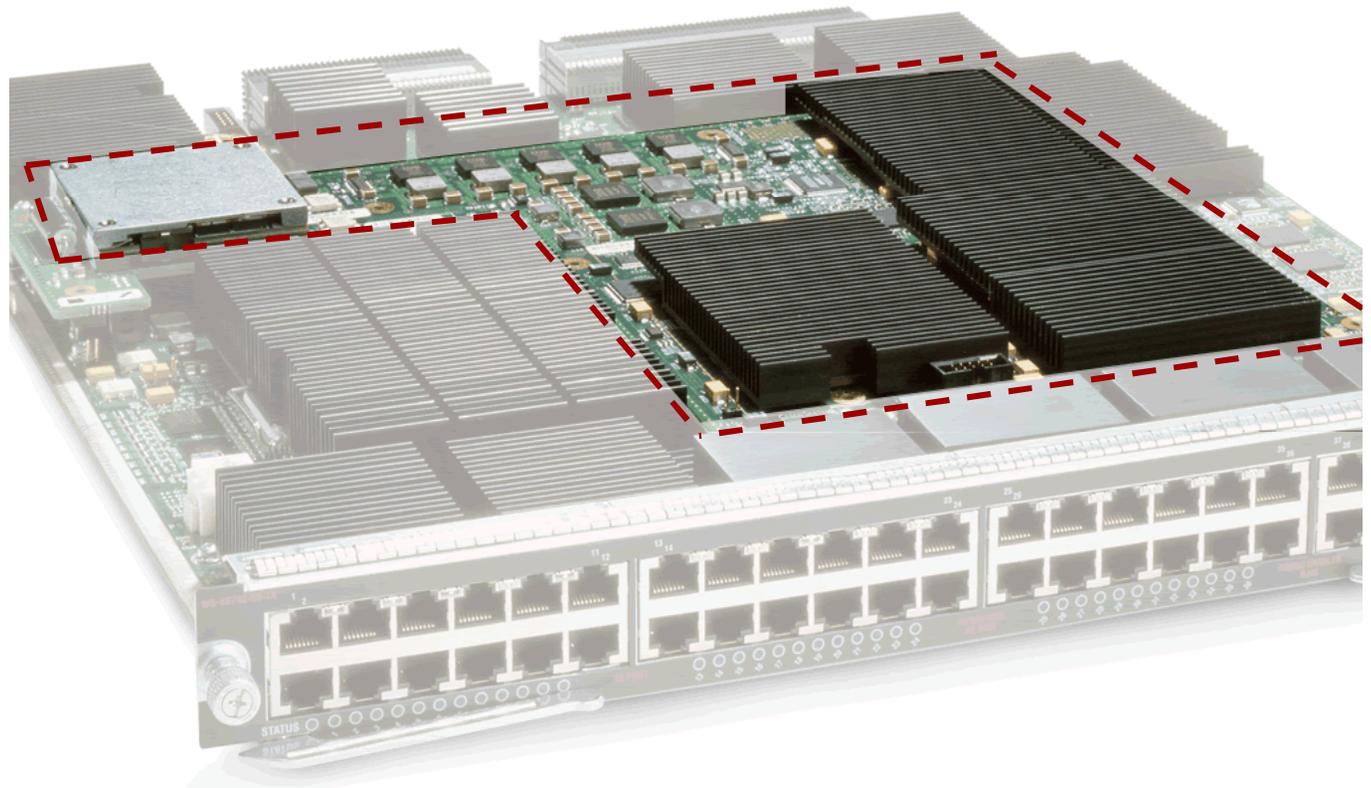
Catalyst 6500 Linecards

Centralized Forwarding Cards (CFC)

The Centralized Forwarding Card (CFC) provides BUS connectivity for the CEF720 linecards...

The CFC sits on all CEF720 linecards and provides the connection to the Classic BUS

CFC is used to communicate with the Supervisor when centralized forwarding is used



Catalyst 6500 Linecards

Distributed Forwarding Card 3 (DFC3)

The DFC3 is an optional extra - it is used to provide local switching for the linecard to incrementally boost overall switch performance - if installed on a CEF720 linecard, it takes the place of the CFC...



The DFC3 supports forwarding rates up to **48Mpps**

The DFC3 also stores a local copy of the forwarding tables, as well as Security and QoS ACL's that are centrally defined

Five different versions of the DFC are supported...

DFC3a
DFC3B/DFC3BXL
DFC3C/DFC3CXL

Catalyst 6500 Linecards

DFC3 Interoperability with PFC3

The use of a DFC3 requires it to operate with the equivalent PFC3 version - a mix of PFC3 and DFC3 versions will result in the system operating at the lowest common denominator...

	PFC3A	PFC3B	PFC3BXL
DFC3	Yes	Operate as PFC3A	Operate as PFC3A
DFC3B	Operate as DFC3A	Yes	Operate as PFC3B
DFC3BXL	Operate as DFC3A	Operate as DFC3B	Yes
DFC3C	Operate as DFC3A	Operate as DFC3B	Operate as PFC3B and DFC3B
DFC3CXL	Operate as DFC3A	Operate as DFC3B	Operate as DFC3BXL

Catalyst 6500 Linecards

Inline Power



WS-F6K-FE48-AF for WS-X6148-RJ45
WS-F6K-GE48-AF for WS-X6148-GETX
WS-F6K-GE48-AF also for WS-X6548-GETX
WS-F6K-FE48X2-AF for WS-X6148X2-RJ45

Maximum number of Inline Devices supported in AC power mode and DC power mode				
Chassis	AC - Class 2	AC - Class 3	DC - Class 2	DC - Class 3
Catalyst 6503-E	70	48	70	48
Catalyst 6504-E	227	110	227	110
Catalyst 6506-E	480	284	381	173
Catalyst 6509-E	587	288	374	184
Catalyst 6513	574	281	357	176

**** Numbers derived from running the CCO power calculator against the largest available single power supply for a given chassis**

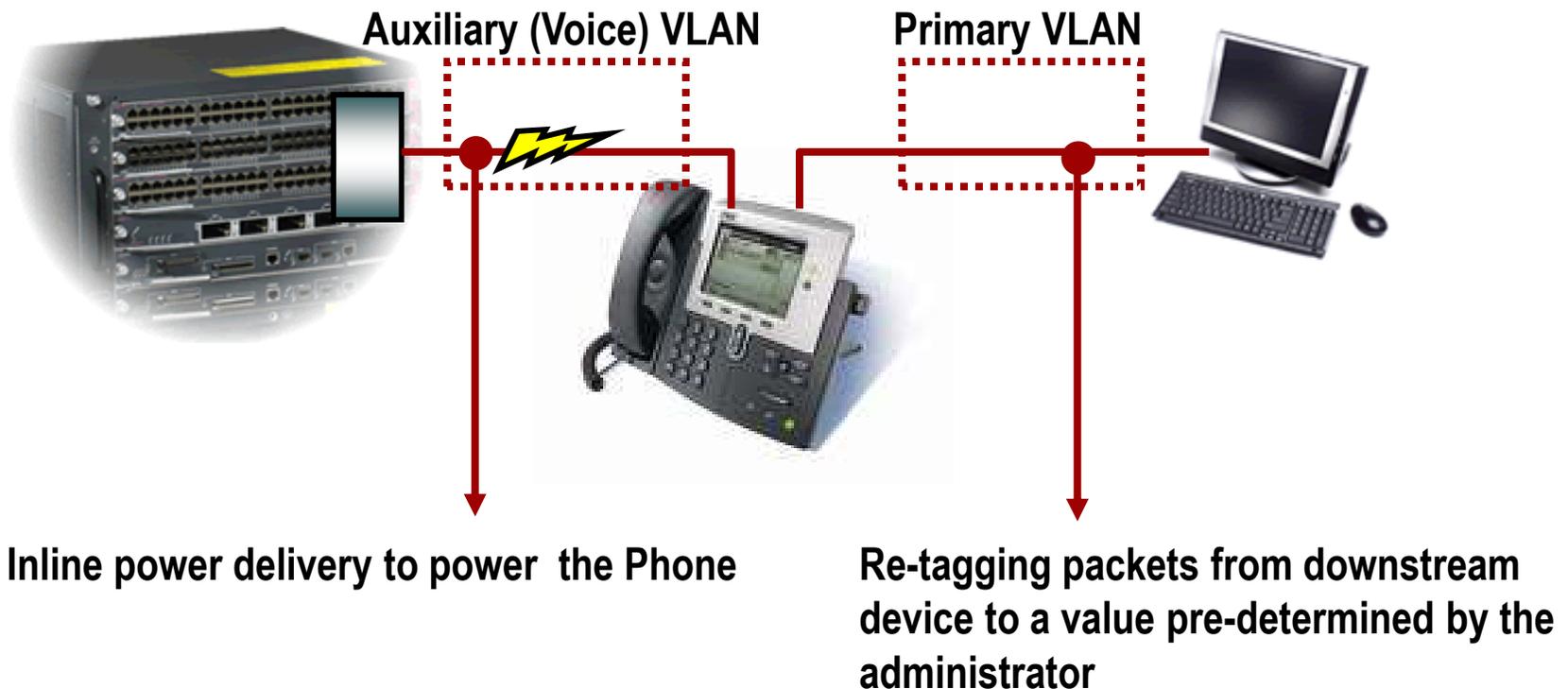
Class 2 – 7W (4ma-5ma, and 19V to 21V)
Class 3 – 15.4W (6ma-7ma, and 19V to 21V)

Catalyst 6500 Linecards

Understanding IP Phone Support

There are three main areas where the switch interacts with the Cisco IP Phone – they are in the areas of delivery of inline power ,VLAN tagging, and extended trust settings.

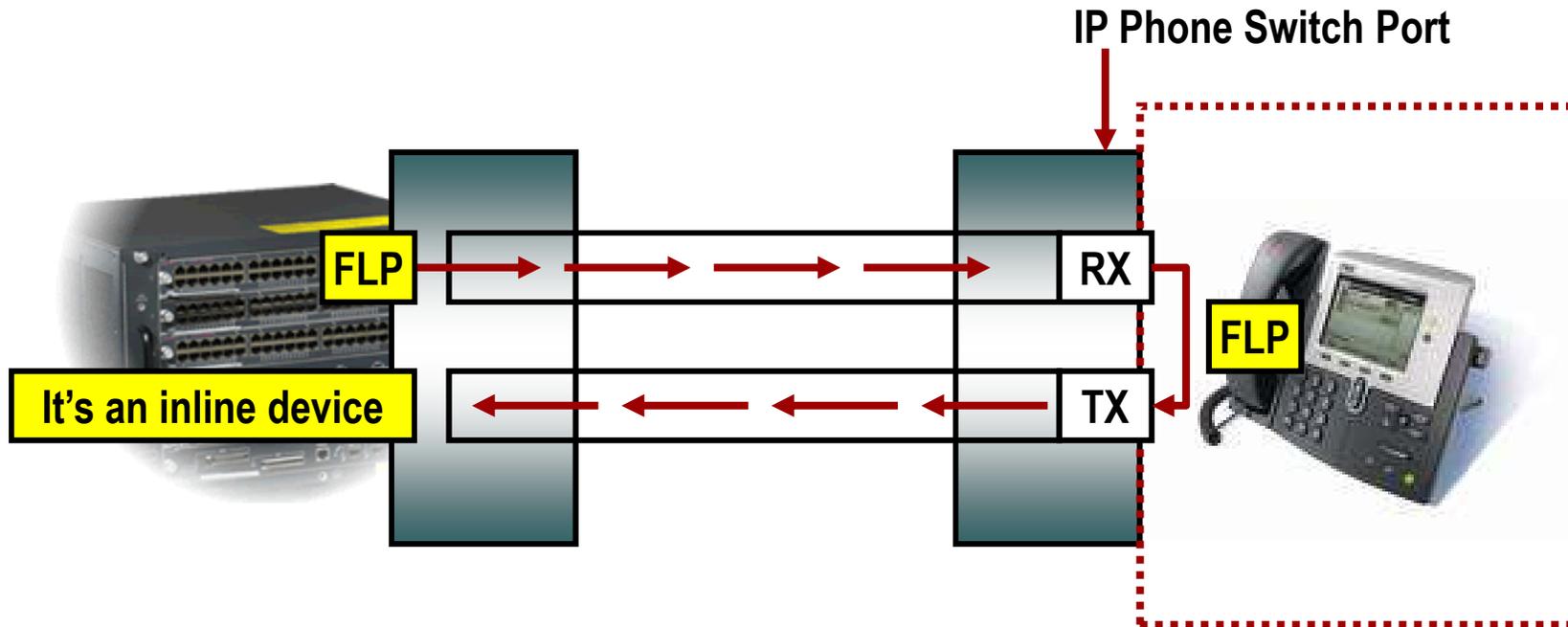
Segregated VLAN's for Voice and Data traffic



Catalyst 6500 Linecards

Inline Device Discovery

When a switchport configured for inline power comes online, the switch will send a Fast Link Pulse (FLP) to the attached device – in the Cisco IP phone, it will loop the FLP back to the switch, indicating its inline power capable - at this point the switch is ready to deliver inline power...



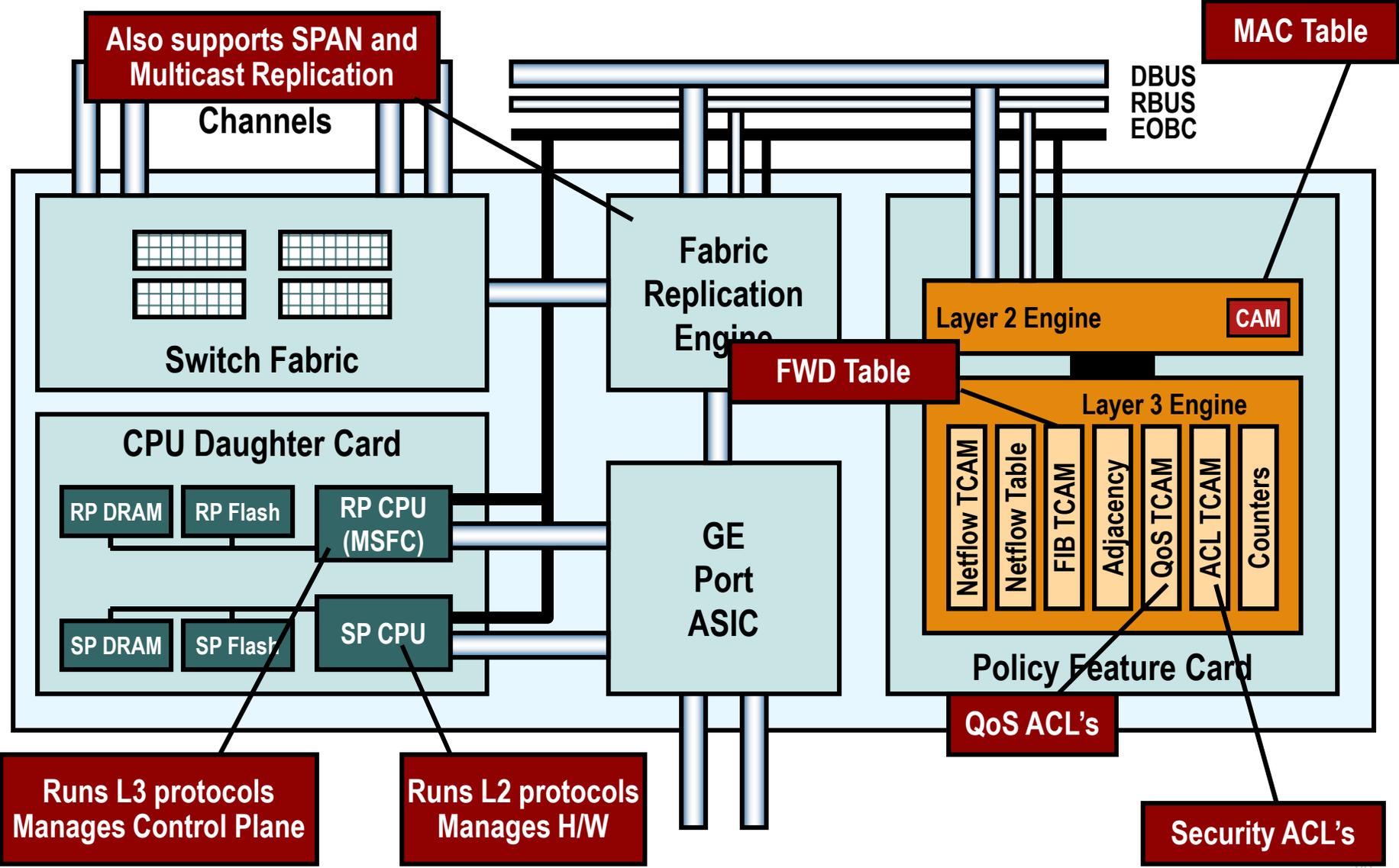


Catalyst 6500 Internals



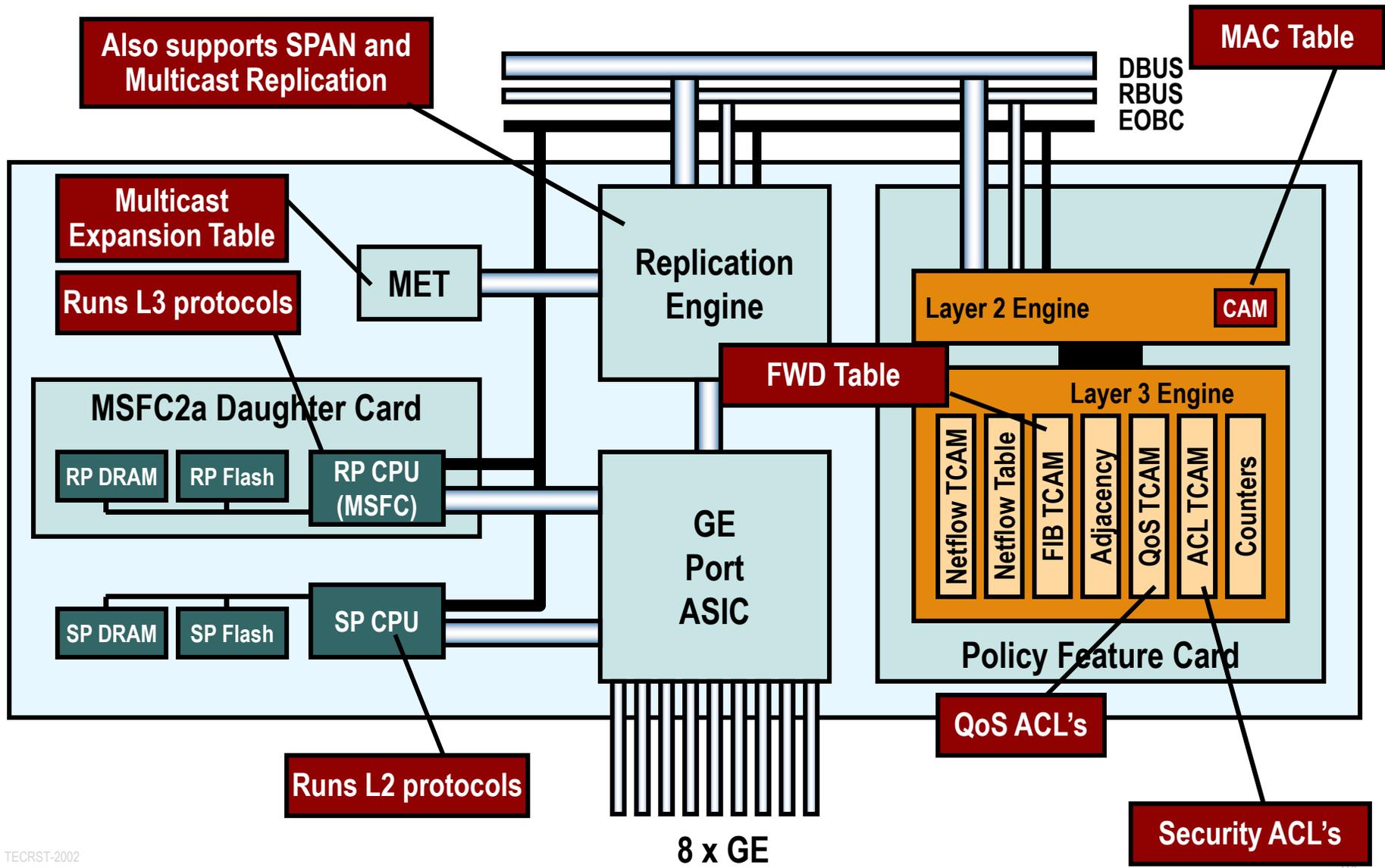
Catalyst 6500 Internals

Supervisor 720 - Board Layout



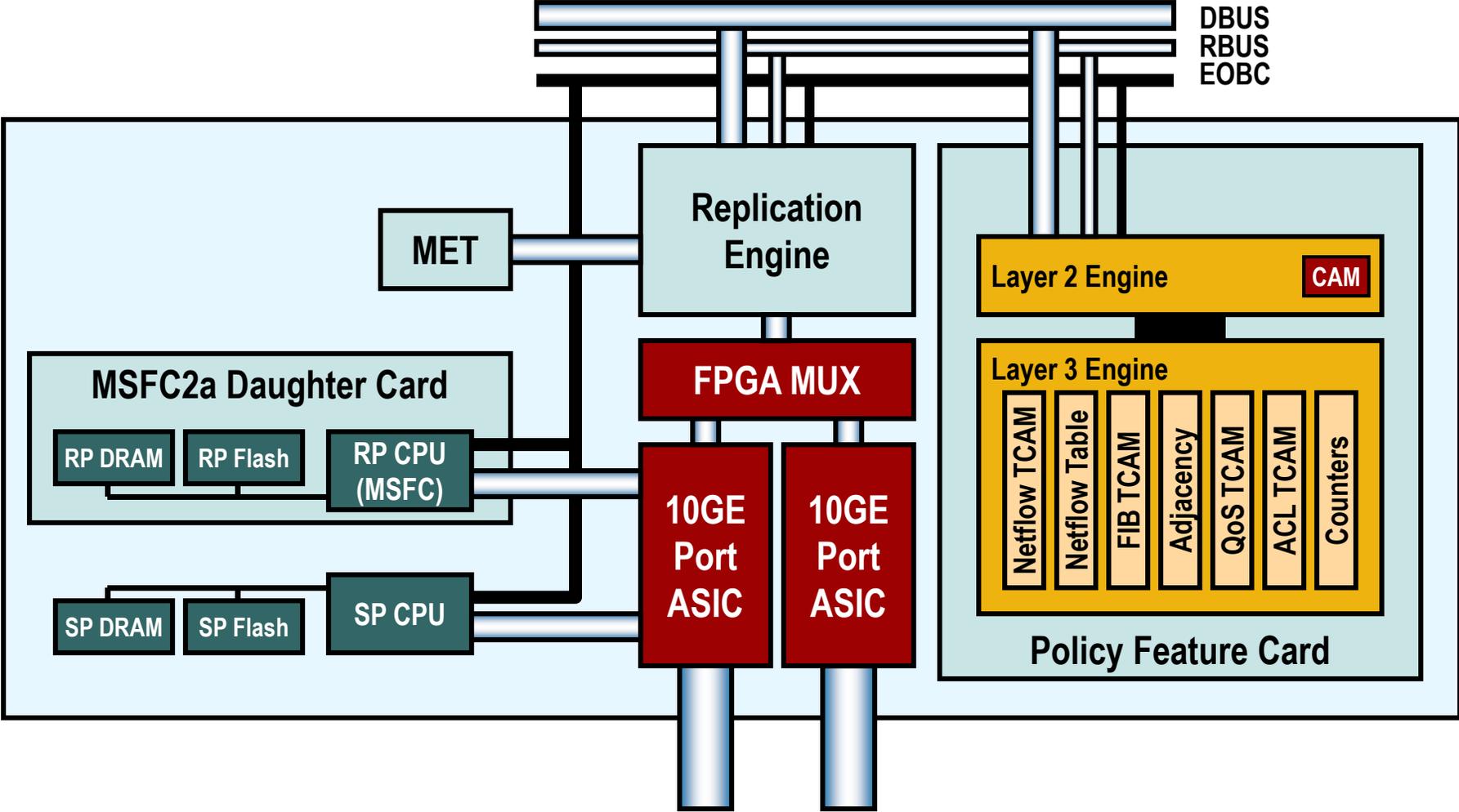
Catalyst 6500 Internals

Supervisor 32 8GE - Board Layout



Catalyst 6500 Internals

Supervisor 32 10GE - Board Layout



Catalyst 6500 Internals

The Packet

Everything a Switch does is centered on the data it forwards...



A Layer 2 Switch will use the Destination MAC Address to make forwarding decisions

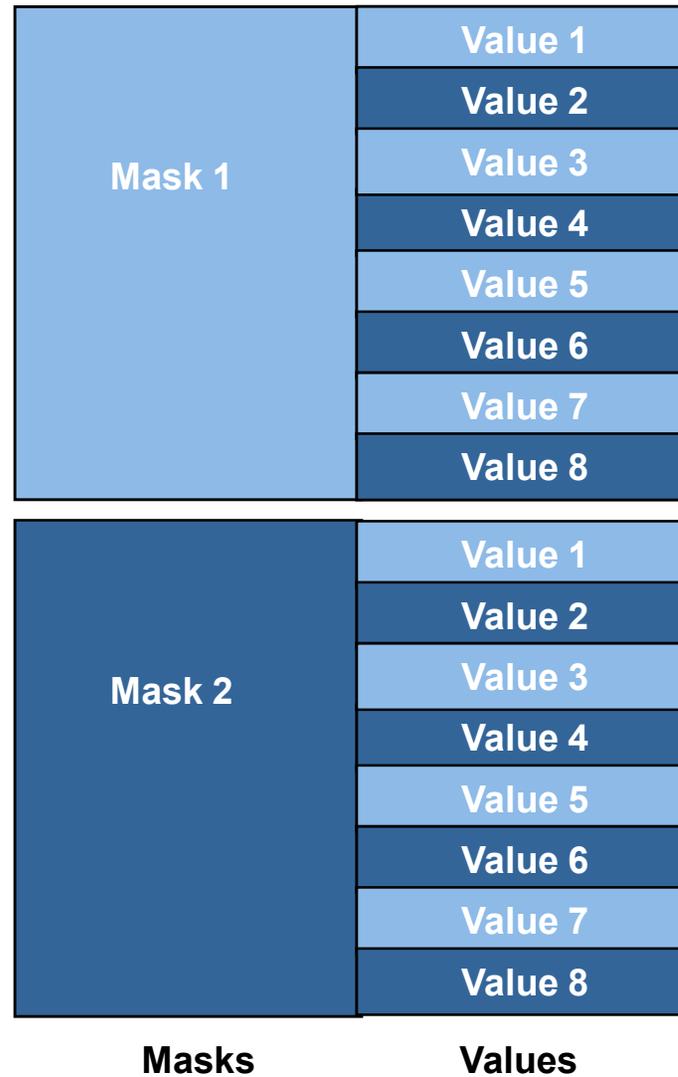
A Layer 3 Switch will use the Destination IP Address to make forwarding decisions



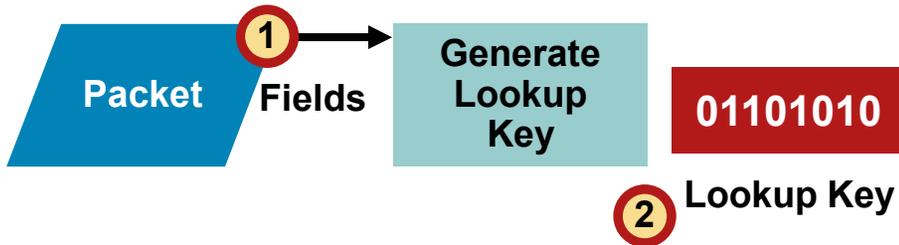
Version	IHL	Type of Service	Length	
Identification			Flags	Fragment Offset
Time to Live (TTL)		Protocol	Header Checksum	
Source IPv4 Address				
Destination IPv4 Address				
Options				
Data				

PFC TCAM Technology

- TCAM—Ternary Content Addressable Memory
- Leveraged heavily in Catalyst 6500
 - FIB, ACL, QoS, NetFlow all utilize TCAM memory
- All entries accessed in parallel—fixed performance independent of number of entries
- Memory consists of groups of values and associated masks
 - 8:1 ratio of values to masks
- Masks are used to “wildcard” some portion of values



Generic TCAM Lookup Logic



1. Relevant fields read from contents of packet
2. Lookup key created

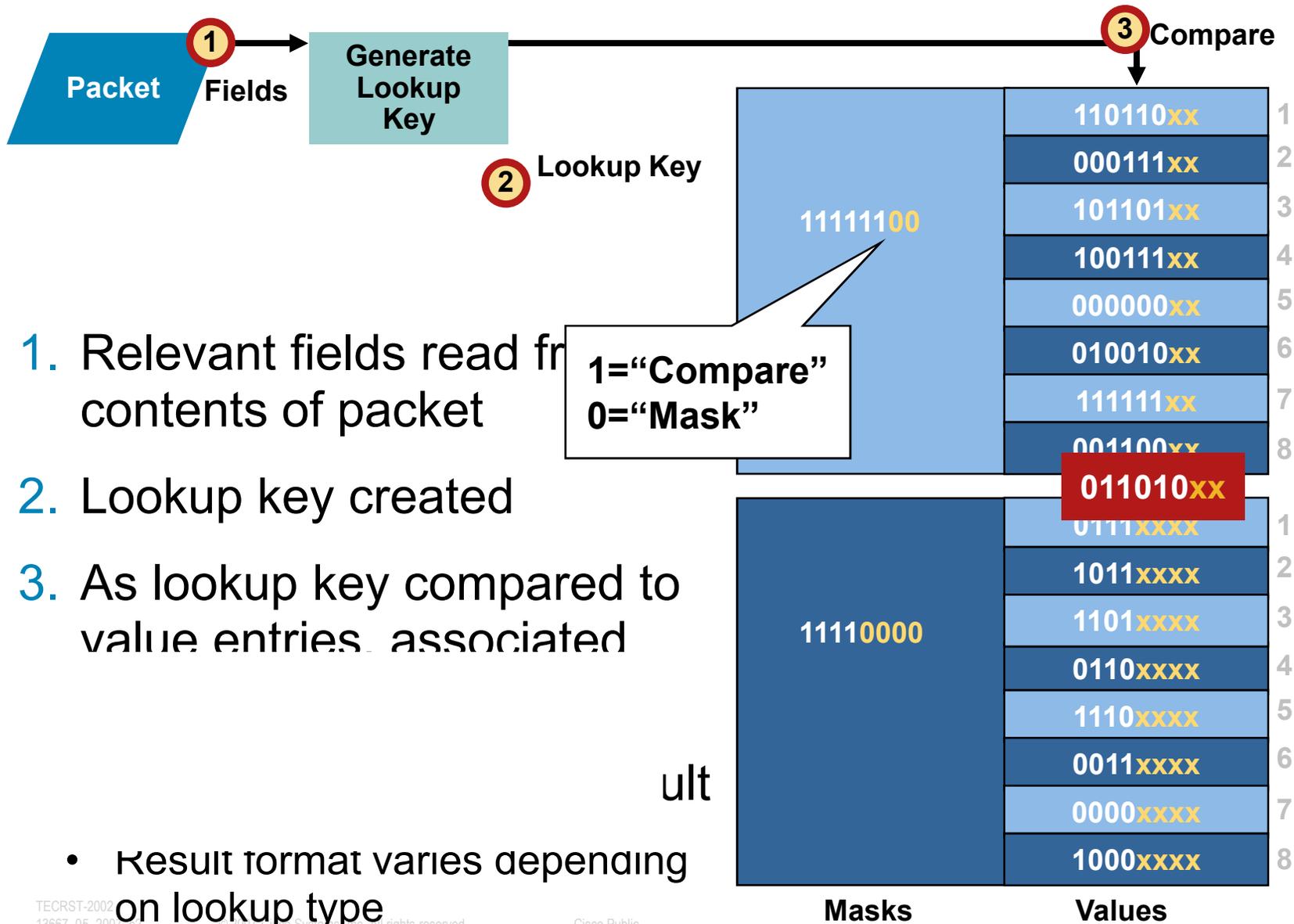
11111100	110110xx	1
	000111xx	2
	101101xx	3
	100111xx	4
	000000xx	5
	010010xx	6
	111111xx	7
	001100xx	8

11110000	0111xxxx	1
	1011xxxx	2
	1101xxxx	3
	0110xxxx	4
	1110xxxx	5
	0011xxxx	6
	0000xxxx	7
	1000xxxx	8

Masks

Values

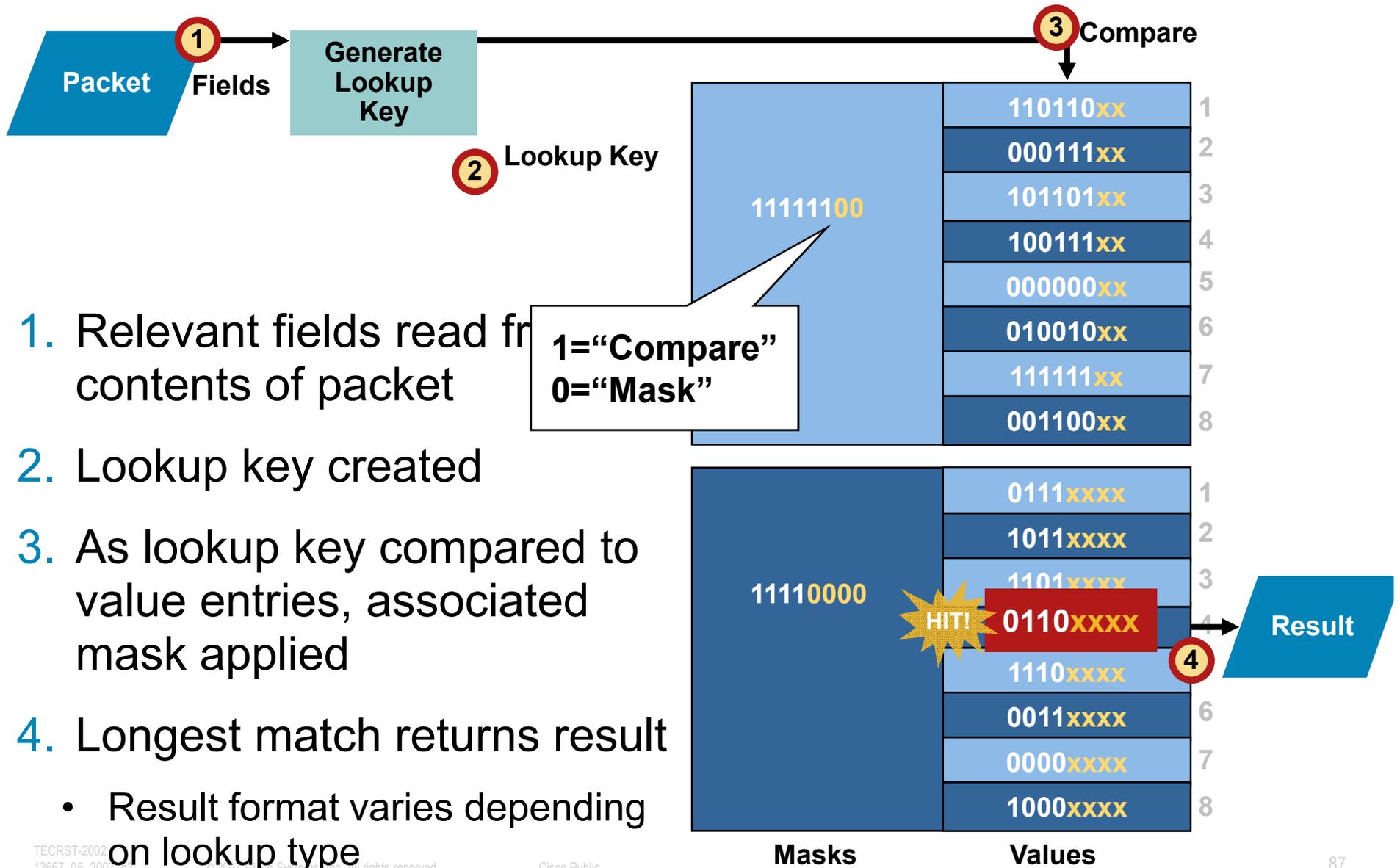
Generic TCAM Lookup Logic



1. Relevant fields read from contents of packet
2. Lookup key created
3. As lookup key compared to value entries associated

- Result format varies depending on lookup type

Generic TCAM Lookup Logic

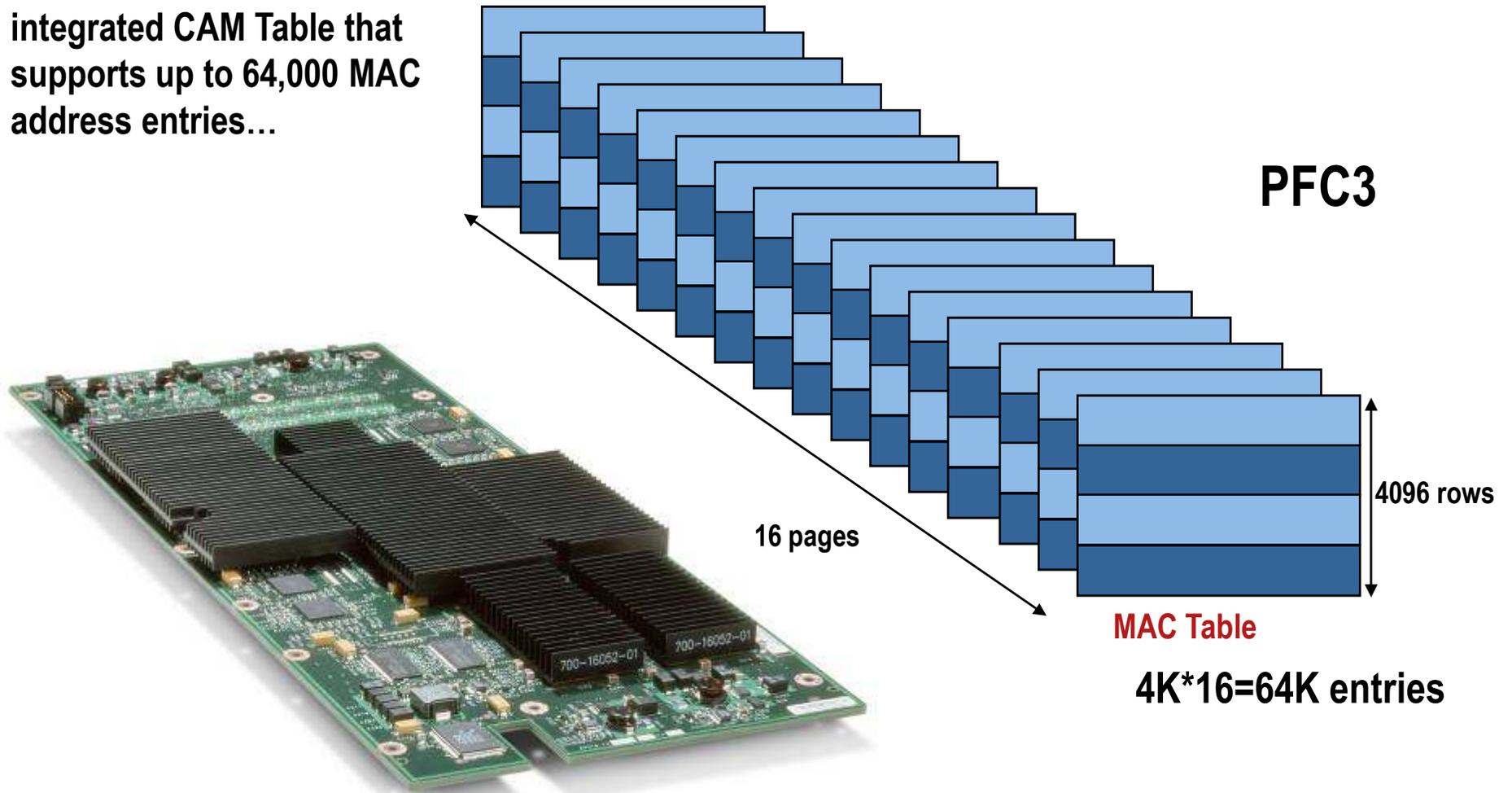


1. Relevant fields read from contents of packet
2. Lookup key created
3. As lookup key compared to value entries, associated mask applied
4. Longest match returns result
 - Result format varies depending on lookup type

Catalyst 6500 Internals

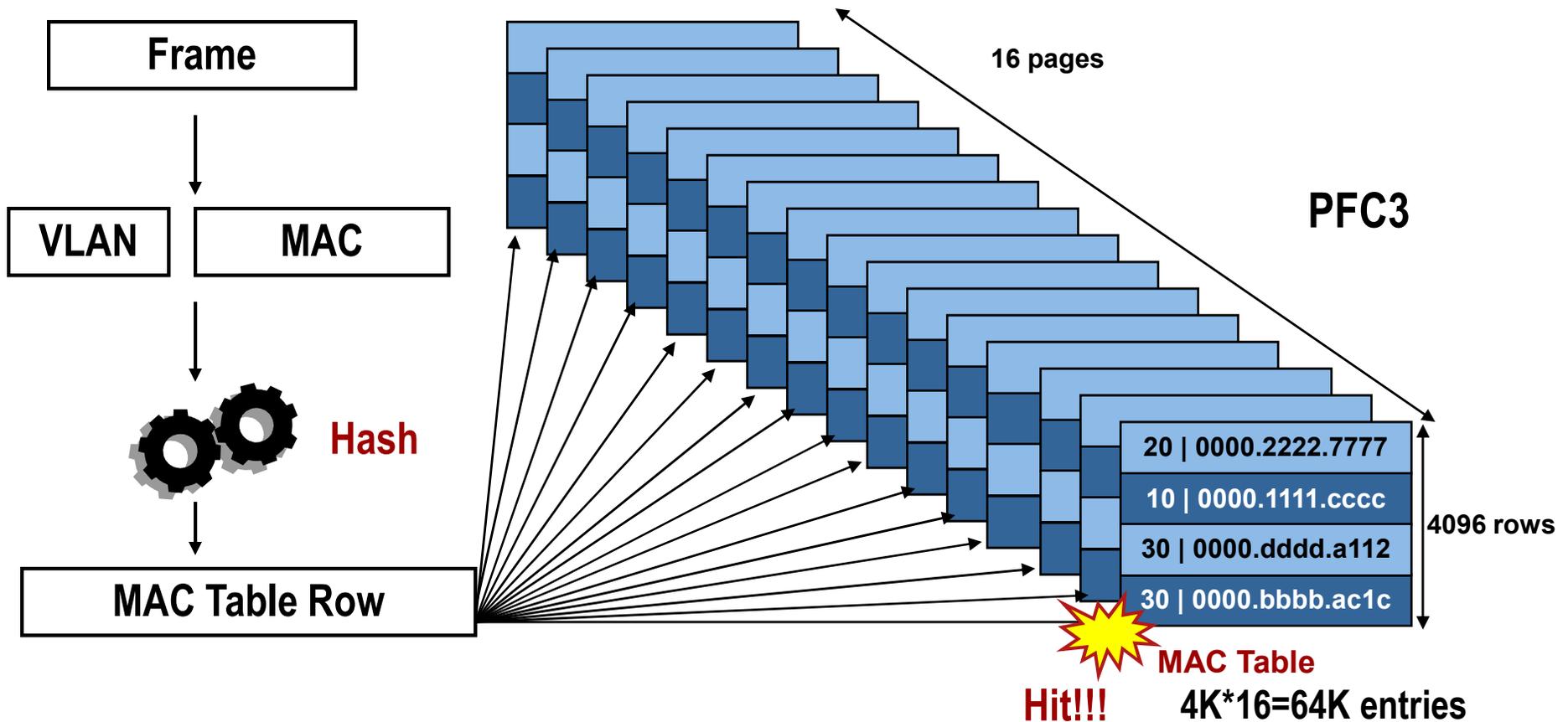
Layer 2 Forwarding on the PFC3

On the PFC3 is an integrated CAM Table that supports up to 64,000 MAC address entries...



Catalyst 6500 Internals

Layer 2 Forwarding on the PFC3

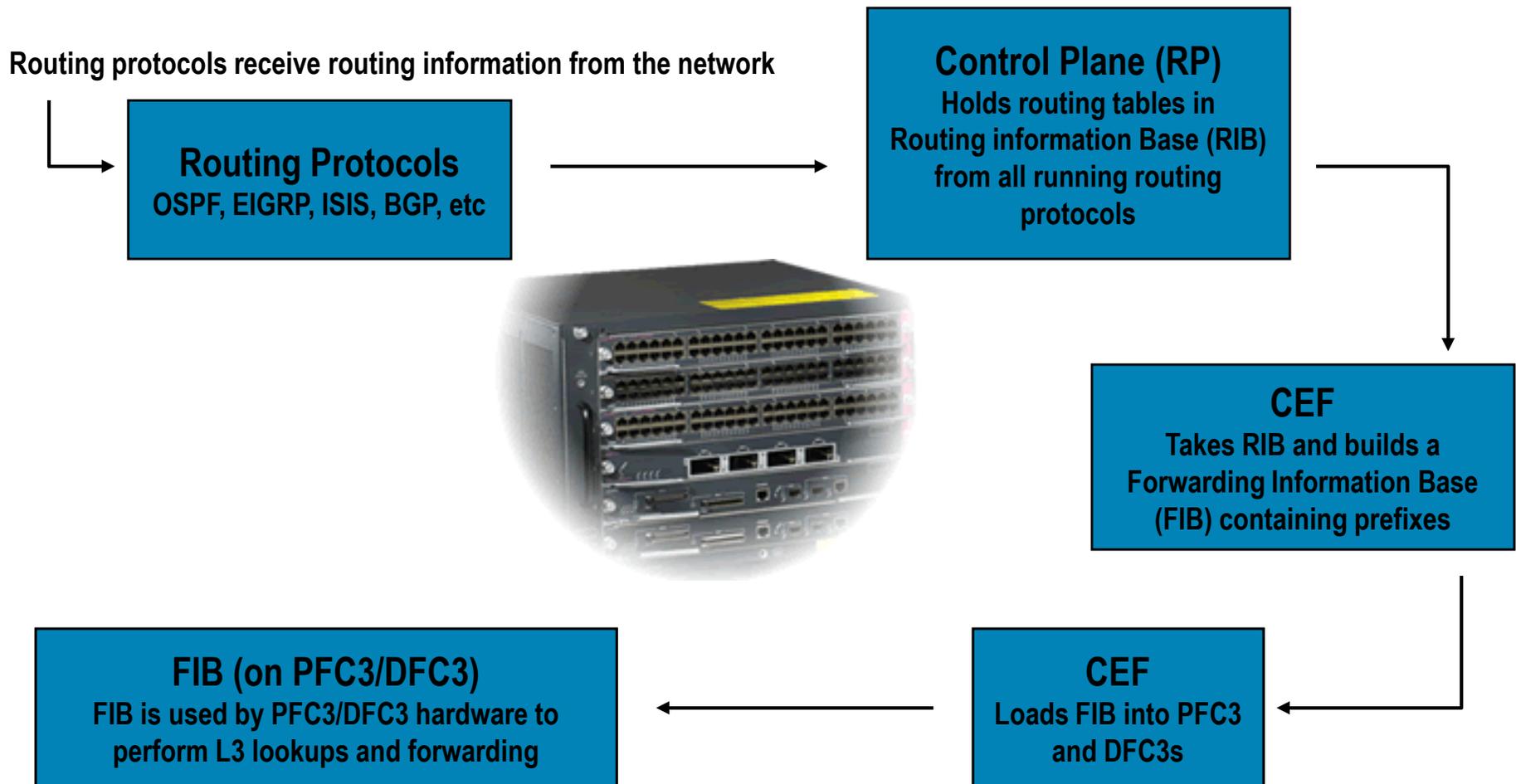


1. Hash result identifies starting page and row in MAC table
2. Lookup key (VLAN and MAC) compared to contents of indexed line on each page, sequentially
3. Destination lookup: Match returns destination interface(s), miss results in flood Source lookup: Match updates age of matching entry, miss installs new entry in table

Catalyst 6500 Internals

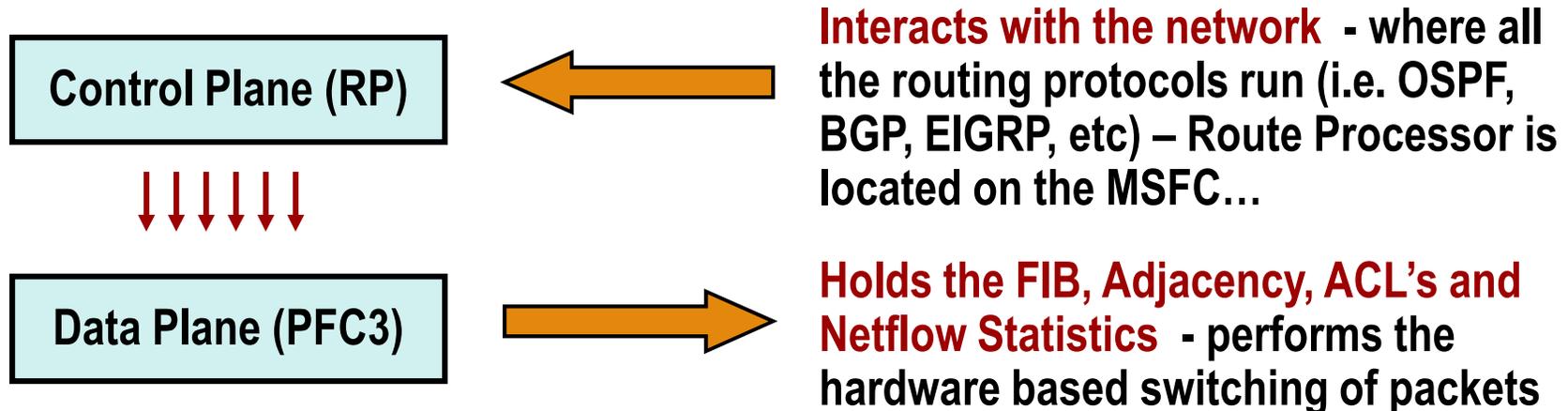
Layer 3 Forwarding on the PFC3

Layer 3 Forwarding is controlled by the CEF (Cisco Express Forwarding) process - the elements include...



Catalyst 6500 Internals

Layer 3 Forwarding on the PFC3



Hardware Based CEF Process

FIB lookup based on destination prefix (longest-match)

FIB “hit” returns adjacency, adjacency contains rewrite information (next-hop)

ACL, QoS, and NetFlow lookups occur in parallel and effect final result

Catalyst 6500 Internals

Layer 3 Forwarding on the PFC3

Located on the PFC3 is the FIB and Adjacency Table...

The FIB contains the following

- IPv4 entries logically arranged from most to least specific
- Overall FIB hardware shared by
 - IPv4 Unicast
 - IPv4 Multicast
 - IPv6 Unicast
 - IPv6 Multicast
 - MPLS

Adjacency table:

- Hardware adjacency table also shared among protocols
- Actual adjacency table entries are NOT shared



FIB TCAM

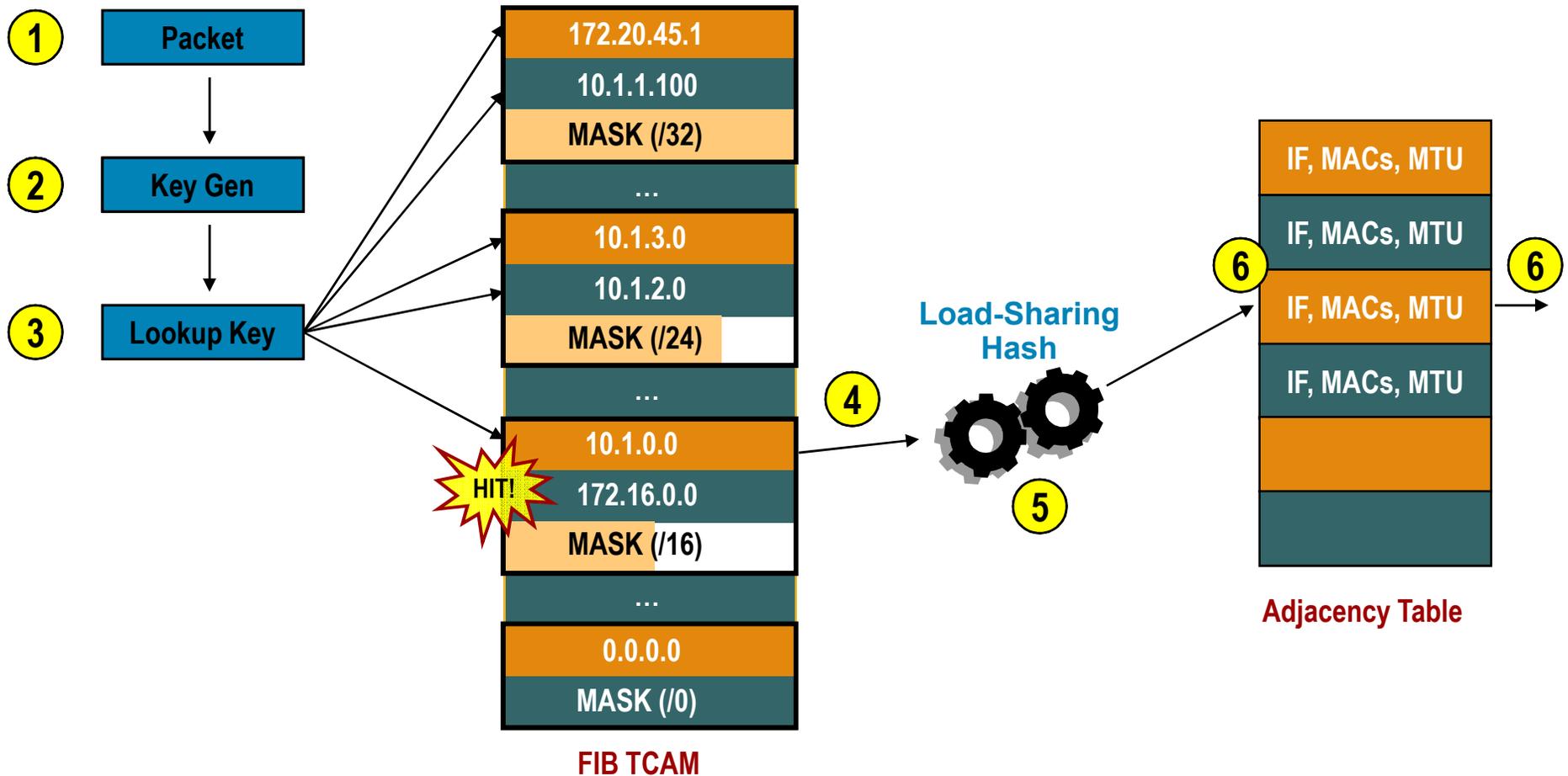


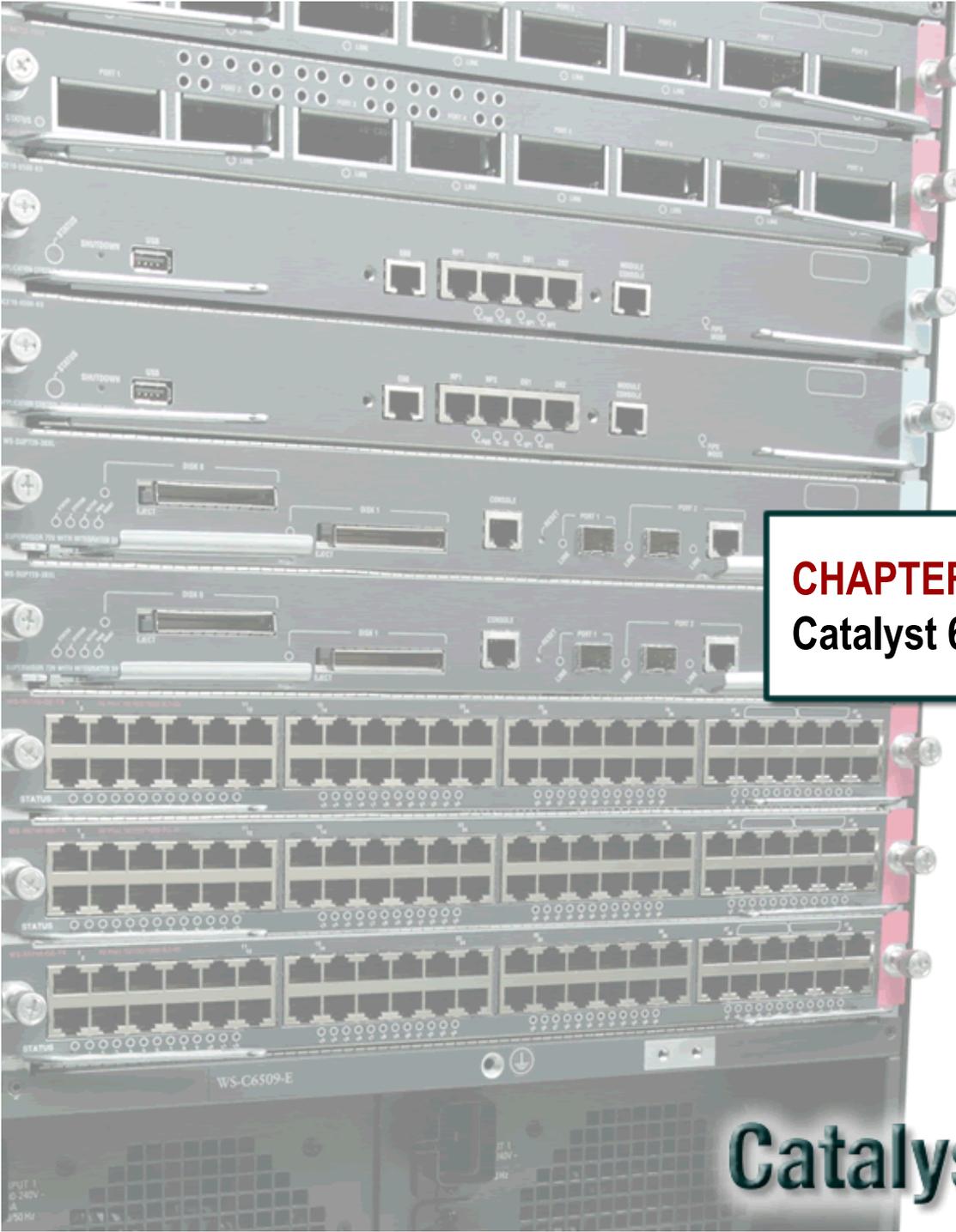
Adjacency Table

Catalyst 6500 Internals

IPv4 Layer 3 Forwarding on the PFC3

Assuming a lookup was performed for a packet with a destination of 10.1.5.2, then the following would occur...





CHAPTER 7
Catalyst 6500 Packet Walks

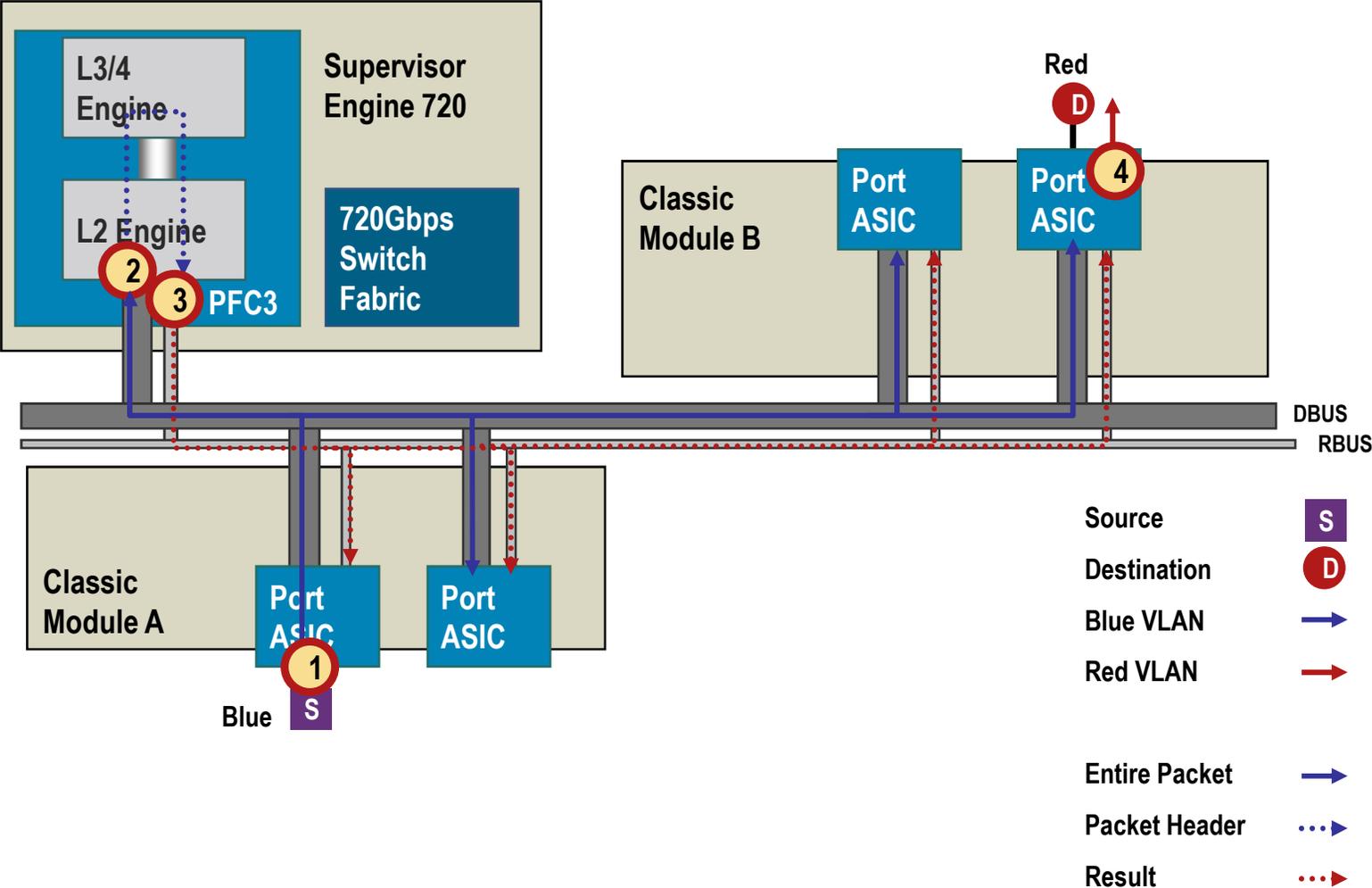
Catalyst 6500 Bootcamp



Catalyst 6500 Packet Walks



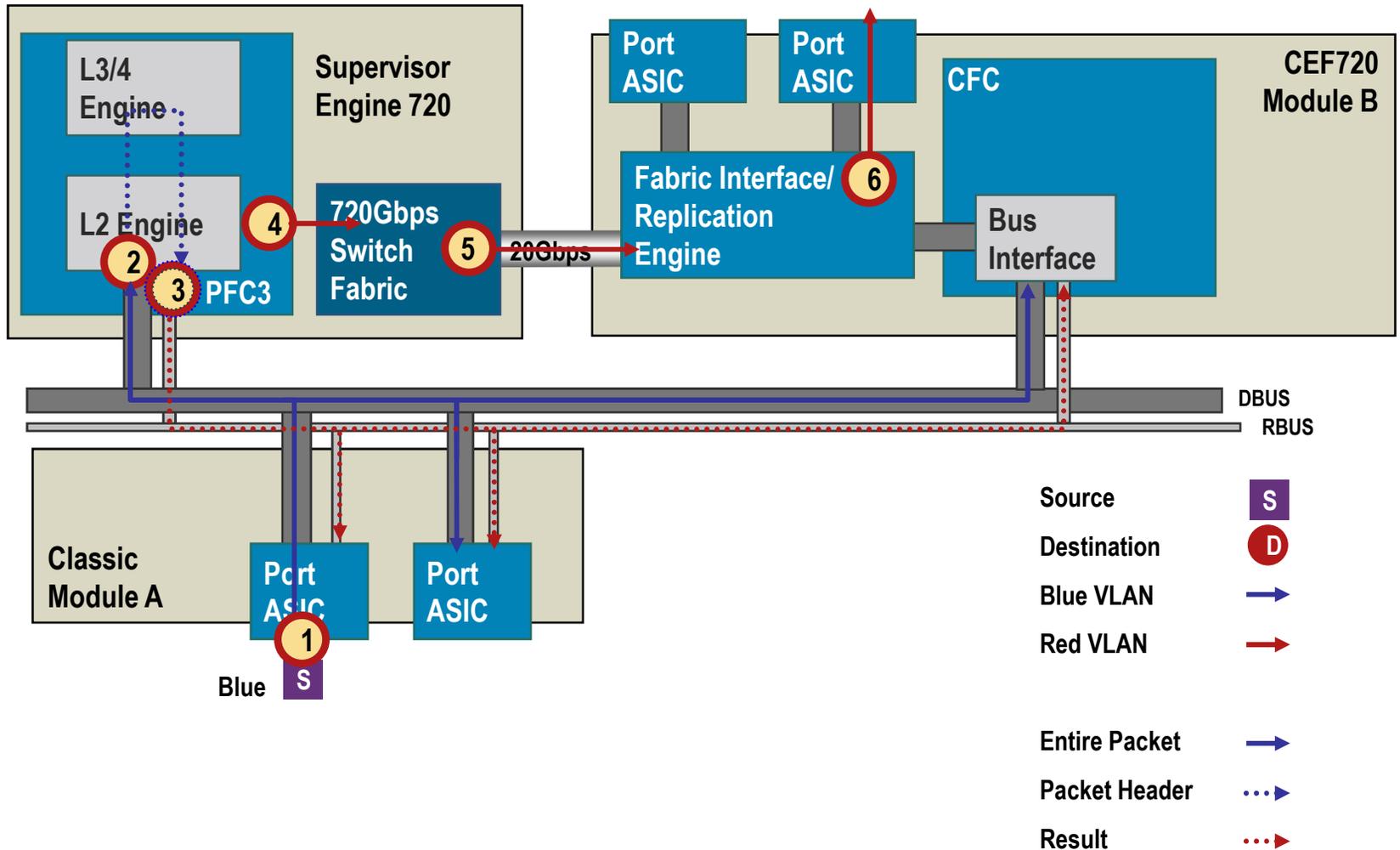
Centralized Forwarding: Classic to Classic



Reference: Classic to Classic

1. Unicast IPv4 packet received on Classic Module A; entire packet is flooded on DBUS and all devices, including the PFC on the supervisor engine, receive it
2. PFC makes a forwarding decision for the packet
3. PFC floods forwarding decision result on RBUS
4. Egress port ASIC on Classic Module B is selected to transmit the packet—all other devices on the bus discard the packet

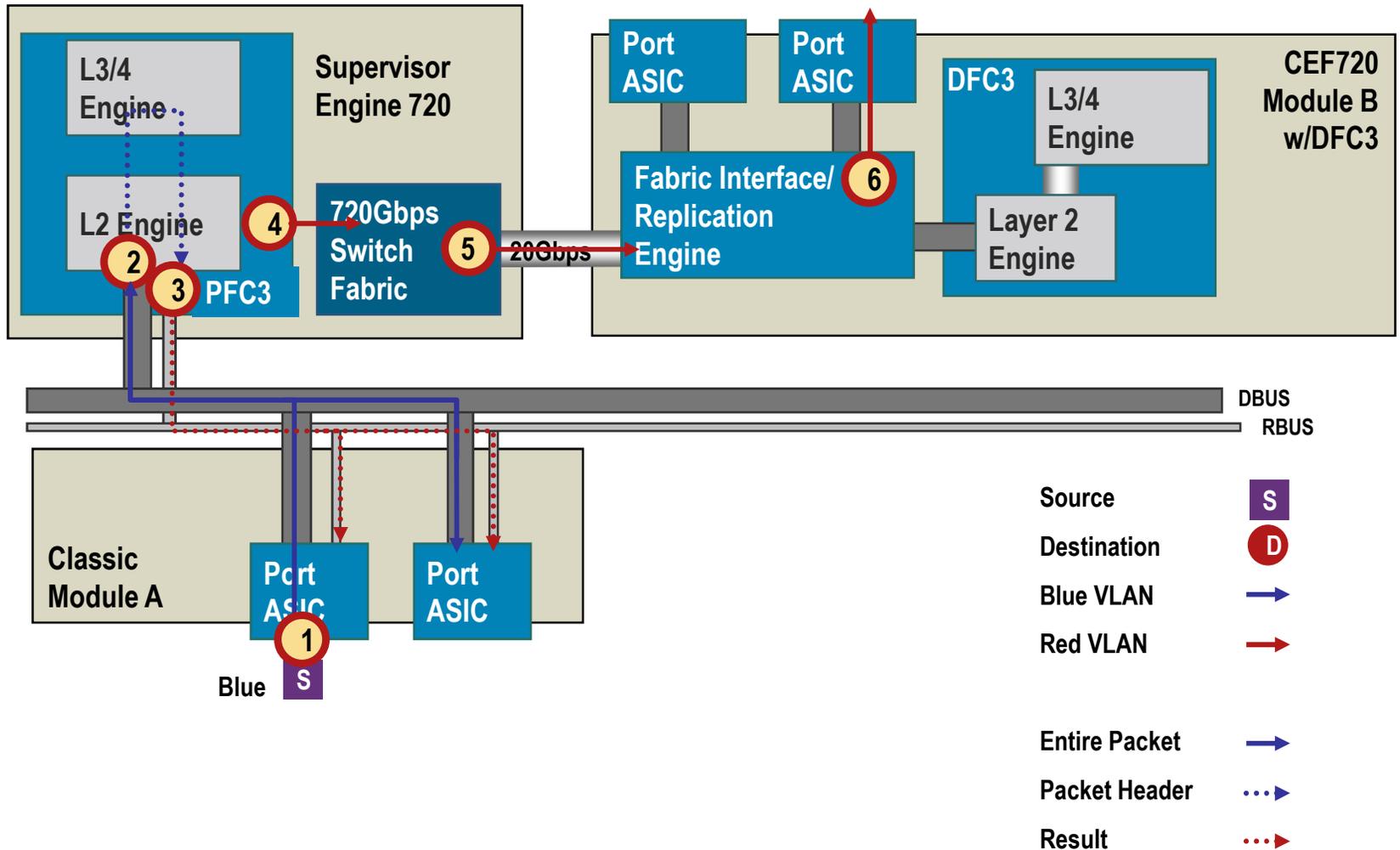
Centralized Forwarding: Classic to CEF720



Reference: Classic to CEF720

1. Unicast IPv4 packet received on Classic Module A; entire packet is flooded on DBUS and all devices, including the PFC on the supervisor engine, receive it; CFC on CEF720 Module B ignores the packet
2. PFC makes a forwarding decision for the packet
3. PFC floods forwarding decision result on RBUS; all devices on the bus discard the packet since the Egress port is on linecard CEF720 Module B; CFC on CEF720 Module B ignores the result
4. The packet is forwarded to the Switch Fabric ASIC
5. Fabric interface transmits packet across the fabric
6. CEF720 Module B receives the packet and transmits the packet to the egress port ASIC

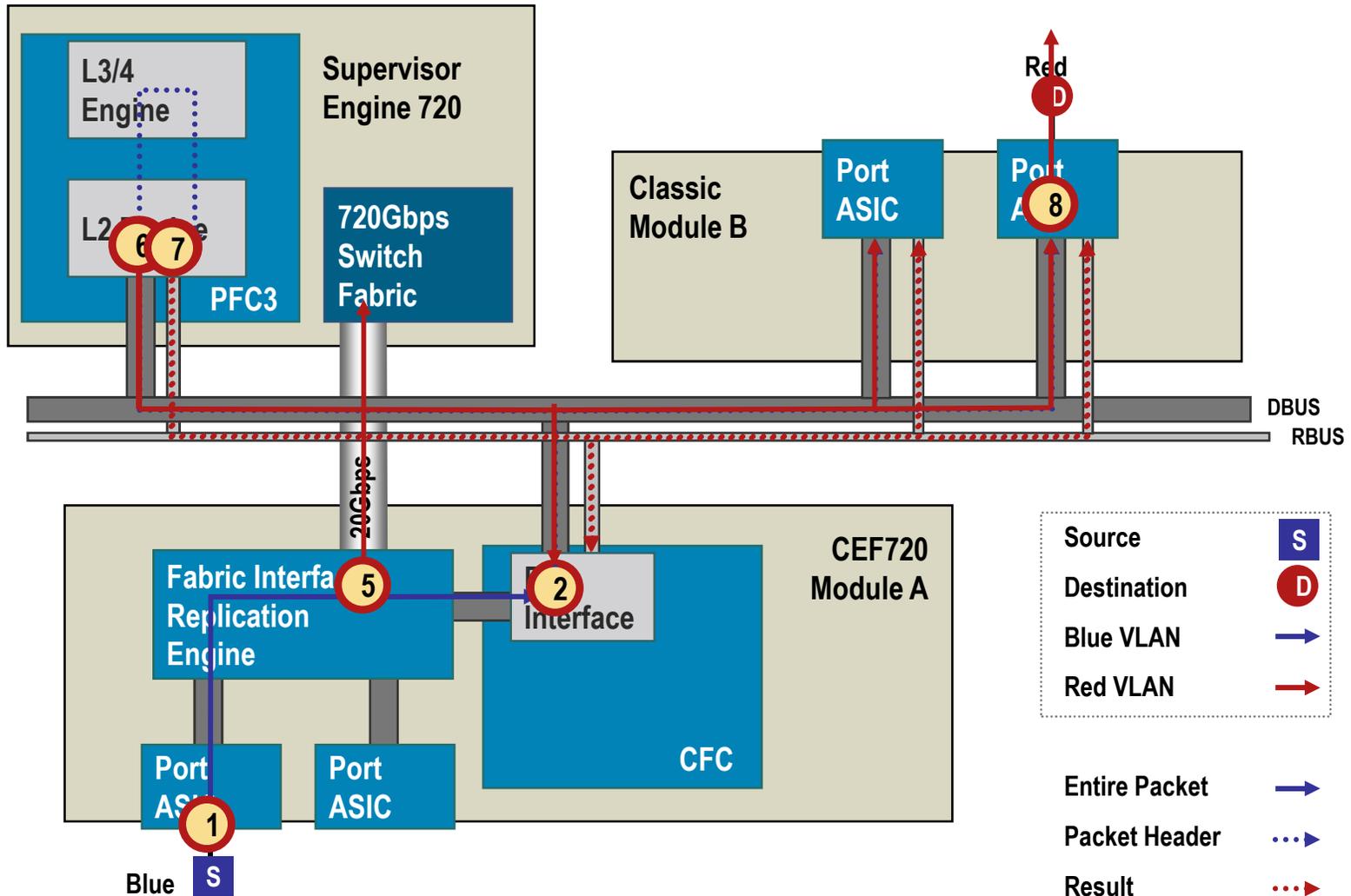
Centralized Forwarding: Classic to CEF720 w/DFC3



Reference: Classic to CEF720 w/DFC3

1. Unicast IPv4 packet received on Classic Module A; entire packet is flooded on DBUS and all devices, including the PFC on the supervisor engine, receive it
2. PFC makes a forwarding decision for the packet
3. PFC floods forwarding decision result on RBUS, and all devices on the bus discard the packet since the Egress port is on linecard CEF720 w/DFC3 Module B
4. The packet is forwarded to the Switch Fabric ASIC
5. Fabric interface transmits packet across the fabric
6. CEF720 Module B receives the packet and transmits the packet to the egress port ASIC

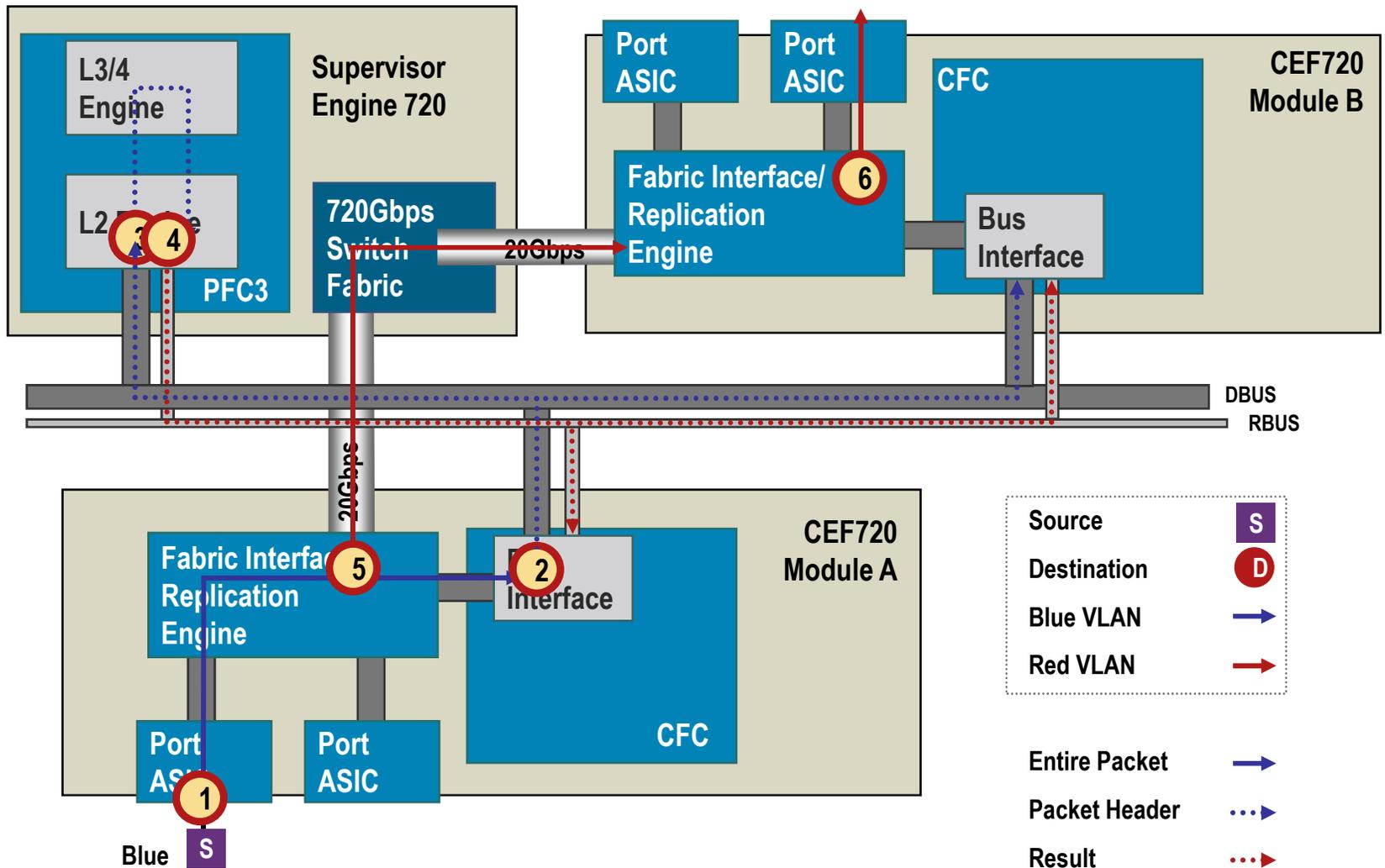
Centralized Forwarding with Fabric: CEF720 to Classic



Reference: CEF720 to Classic

1. A Unicast IPv4 packet received on CEF720 Module A; entire packet is forwarded to the Bus Interface on the CFC
2. The Bus Interface ASIC on CFC forwards the header (compact or truncated) to the Data Bus (DBUS); the header is received by the PFC3 and is ignored by any other device attached to the DBUS
3. The PFC makes a forwarding decision for the packet
4. The PFC floods forwarding decision result on RBUS; only the source Bus Interface processes the result; other devices on the RBUS ignore the result
5. The result + packet is sent from the CFC to the Fabric interface which transmits the packet and result across the fabric to the Sup720, based on the PFC forwarding decision
6. The Sup720 floods the packet onto the DBUS and all devices receive it; CFC on CEF720 Module A ignores the frame
7. The Sup720 generates a new result, identical to the original, and floods it onto the RBUS; CFC on CEF720 Module A ignores the result
8. Egress port ASIC on Classic Module B is selected to transmit the packet—all other devices on the bus discard the packet

Centralized Forwarding with Fabric: CEF720 to CEF720

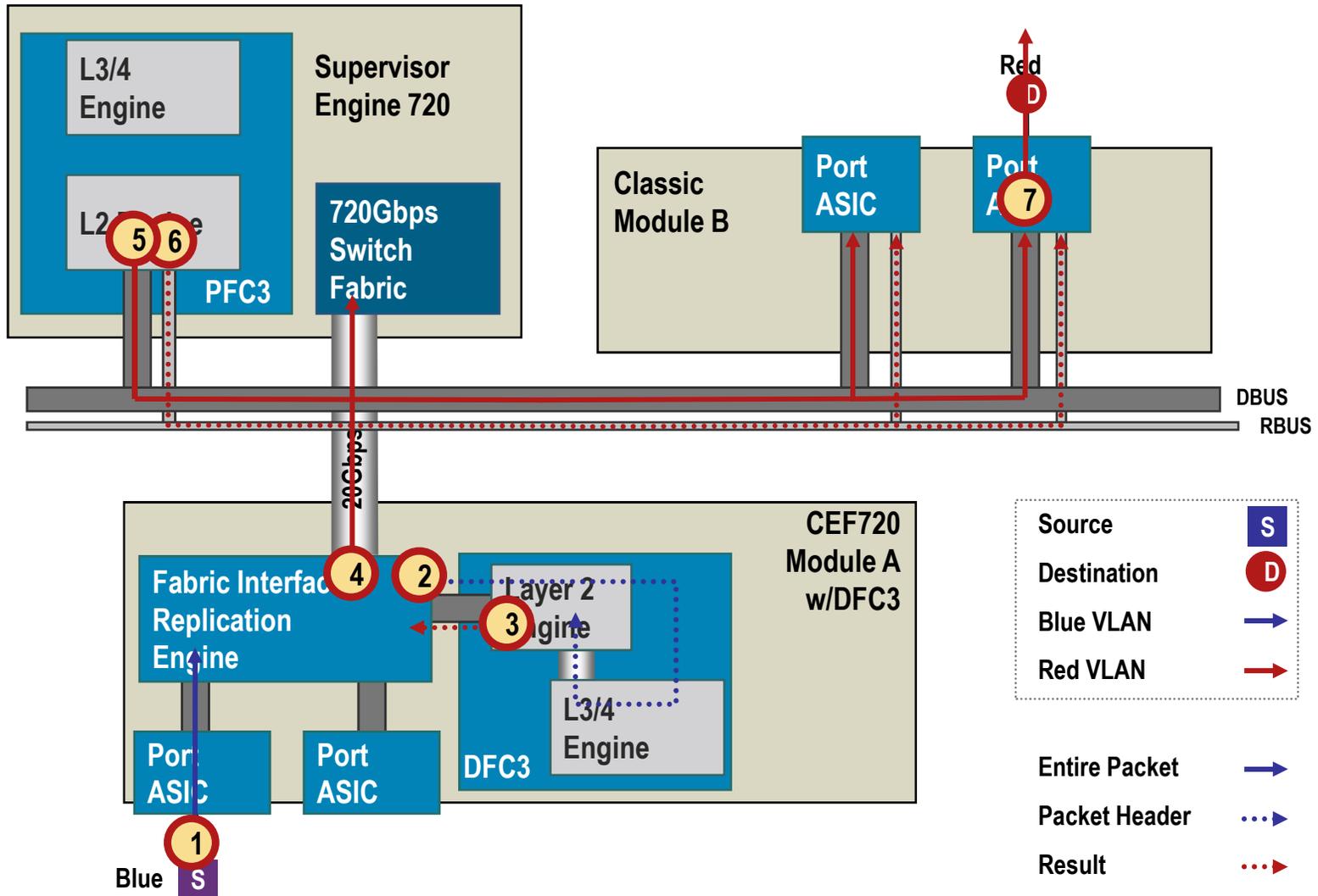


NOTE: Forwarding from CEF720 to CEF720 w/DFC3 is the same process except CEF720 w/DFC3 does not have any Bus connections

Reference: CEF720 to CEF720

1. A Unicast IPv4 packet received on CEF720 Module A; entire packet is forwarded to the Bus Interface on the CFC
2. The Bus Interface ASIC on CFC of CEF720 Module A forwards the header (compact or truncated) to the Data Bus (DBUS); the header is received by the PFC3 and is ignored by any other device attached to the DBUS
3. The PFC makes a forwarding decision for the packet
4. The PFC floods forwarding decision result on RBUS; only the source Bus Interface processes the result; other devices on the RBUS ignore the result
5. The result + packet is sent from the CFC to the Fabric interface on CEF720 Module A which transmits the packet and result across the fabric to CEF720 Module B, based on the PFC forwarding decision
6. CEF720 Module B receives the packet and transmits the packet to the egress port ASIC

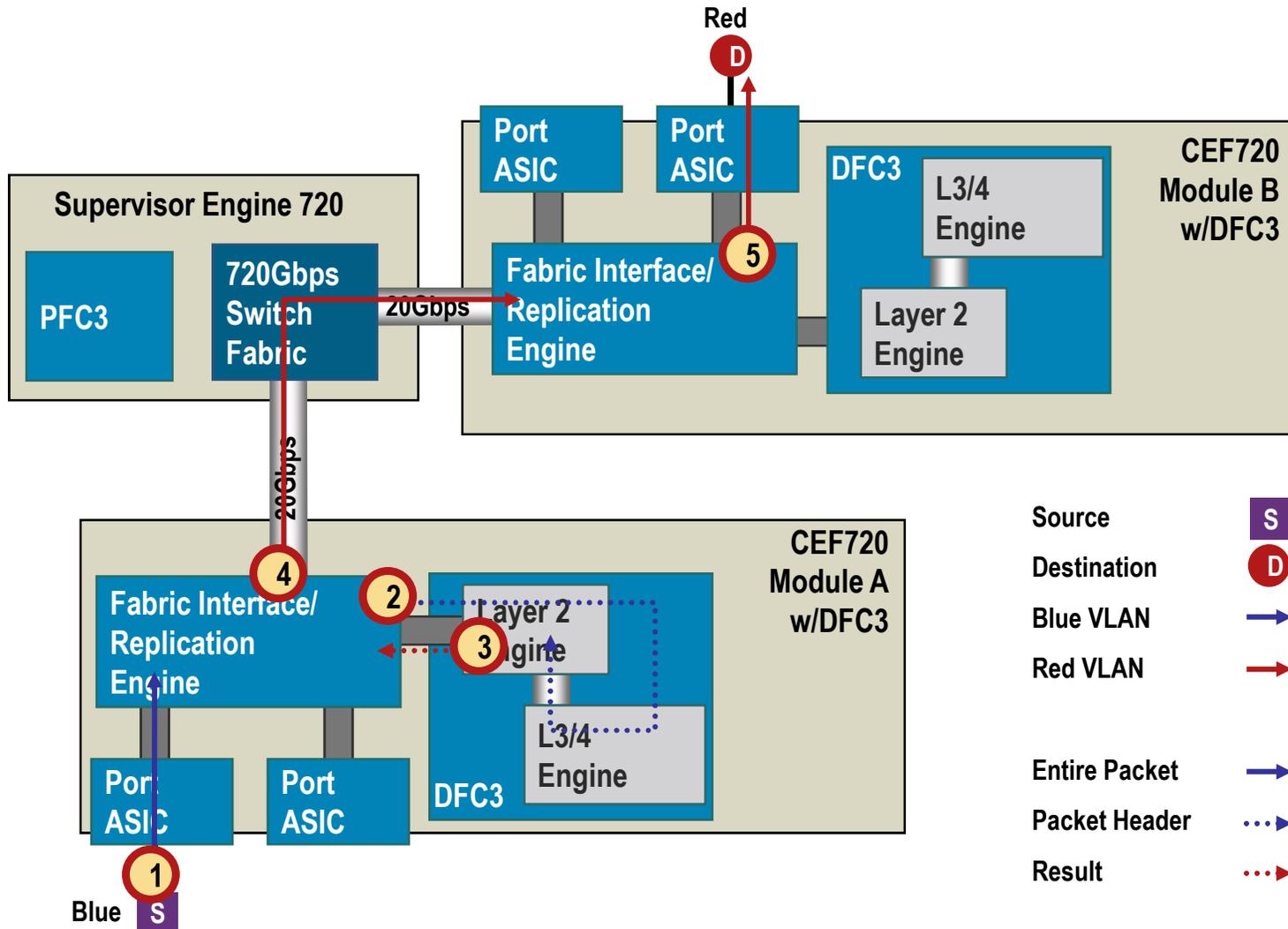
Distributed Forwarding: CEF720 w/ DFC3 to Classic



Reference: CEF720 w/DFC3 to Classic

1. Unicast IPv4 packet received on CEF720 w/DFC3 Module A; entire packet is forwarded to the fabric interface
2. Fabric interface sends just the packet header to the DFC3; DFC3 makes a forwarding decision for the packet
3. DFC3 returns the forwarding decision result to the fabric interface
4. The frame is sent across the fabric to the Sup720, based on the DFC3 forwarding decision
5. The Sup720 floods the packet onto the DBUS and all devices receive it
6. The Sup720 generates a new result, identical to the original, and floods it onto the RBUS
7. Egress port ASIC on Classic Module B is selected to transmit the packet—all other devices on the bus discard the packet

Distributed Forwarding: CEF720 w/DFC3 to CEF720 w/DFC3

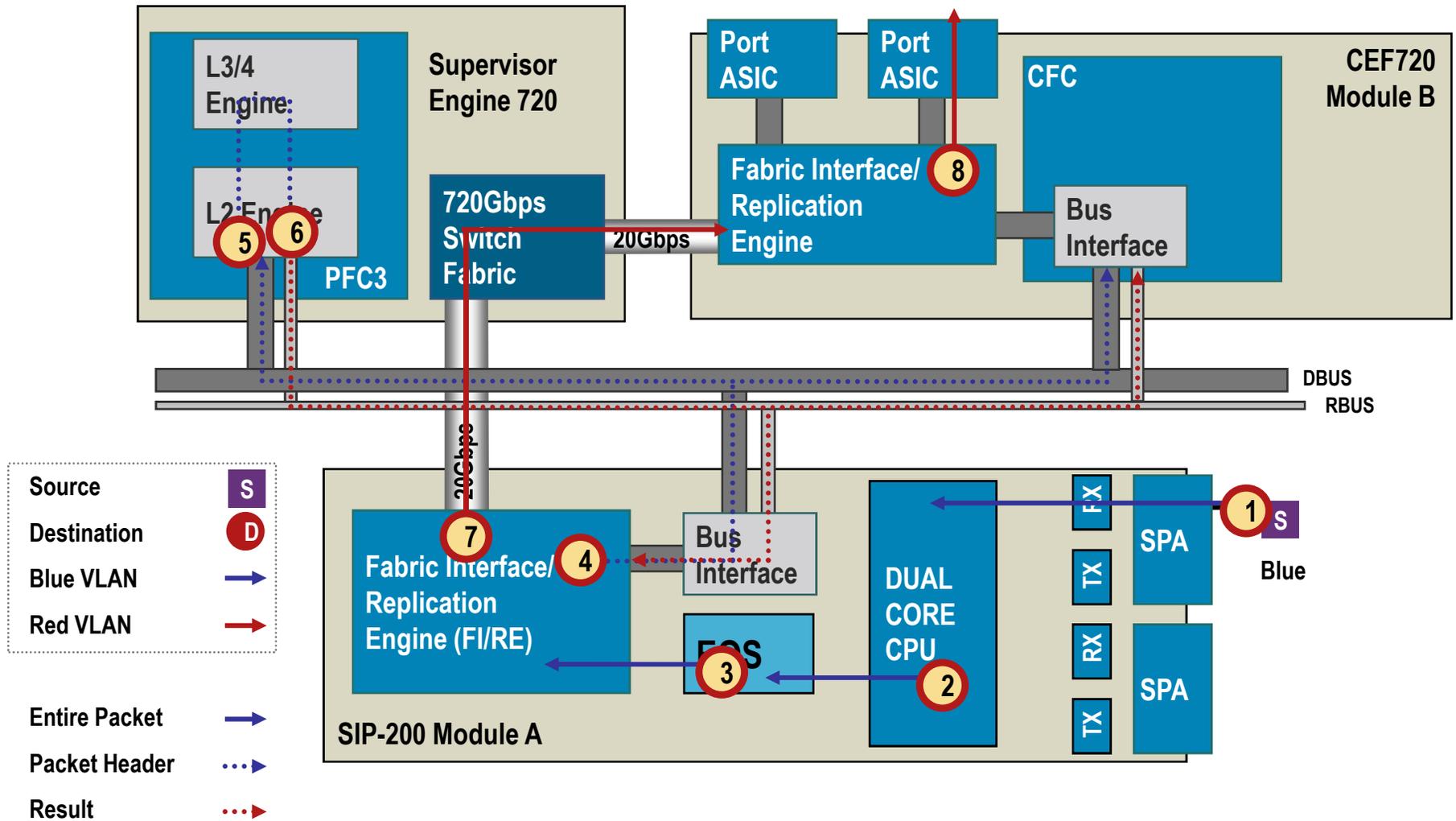


NOTE: Forwarding from CEF720 w/DFC3 to CEF720 is the same process except CEF720 has a Bus connections

Reference: CEF720 w/DFC3 to CEF720 w/DFC3

1. Unicast IPv4 packet received on CEF720 w/DFC3 Module A; entire packet is forwarded to the fabric interface
2. Fabric interface sends just the packet header to the DFC3; DFC3 makes a forwarding decision for the packet
3. DFC3 returns the forwarding decision result to the fabric interface
4. Fabric interface transmits packet across the fabric
5. CEF720 w/DFC3 Module B receives the packet and transmits the packet to the egress port ASIC

WAN Forwarding: SIP-200 to CEF720

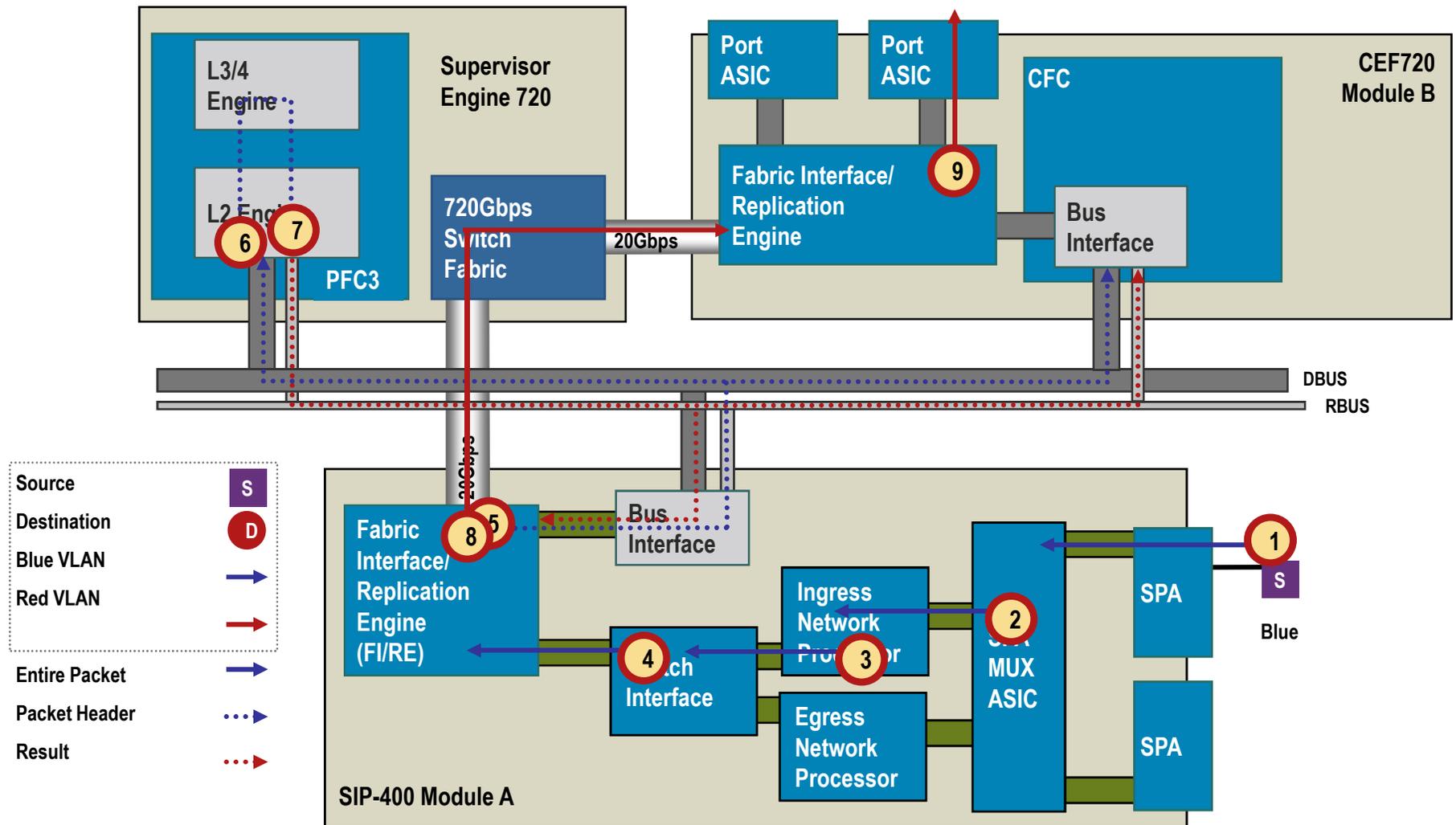


Reference: SIP-200 to CEF720

1. A Unicast IPv4 packet received on SIP-200 Module A SPA interface; entire packet is forwarded through the RX FPGA to the Dual Core CPU
2. Dual Core CPU removes the WAN header and classifies the packet: non-IP packets are sent to the Supervisor 720 RP, IP packets have a DBUS header appended and are sent to EOS
3. EOS generates CRC for DBUS header and payload and forwards the packet to FI/RE.
4. FI/RE saves the packet in memory and floods DBUS header onto DBUS; header is received by PFC3 and ignored by CFC on CEF720 Module B
5. PFC3B makes a forwarding decision for the packet
6. The PFC floods forwarding decision result on RBUS; only the source Bus Interface processes the result; other devices on the RBUS ignore the result
7. The result is sent to FI/RE which transmits the packet and result across the fabric to CEF720 Module B, based on the PFC forwarding decision
8. CEF720 Module B receives the packet and transmits the packet to the egress port ASIC

NOTE: Forwarding from SIP-200 to CEF720 w/DFC3 is the same process except CEF720 w/DFC3 does not have any Bus connections

WAN Forwarding: SIP-400 to CEF720

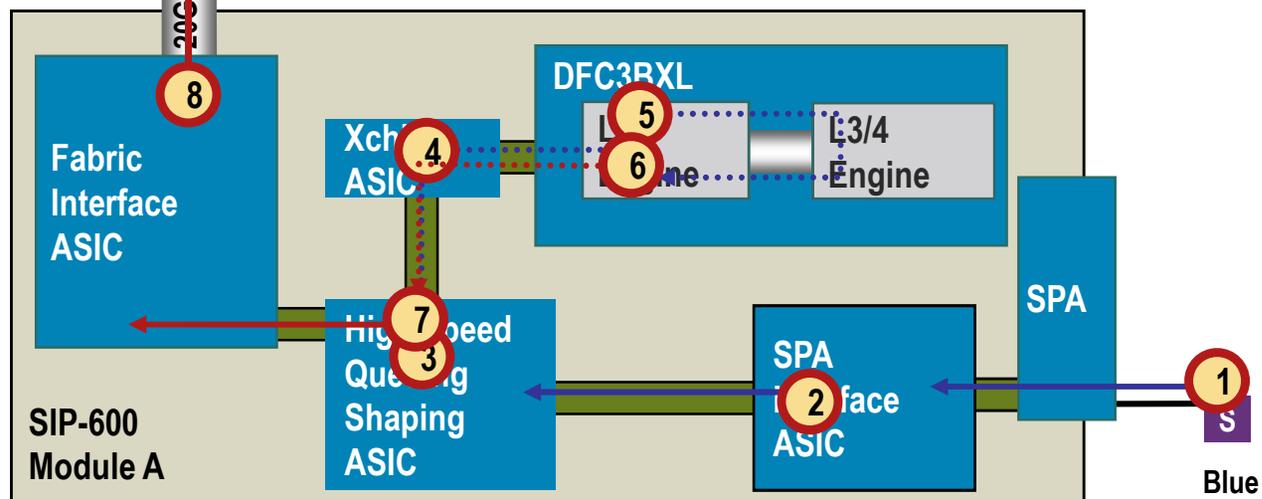
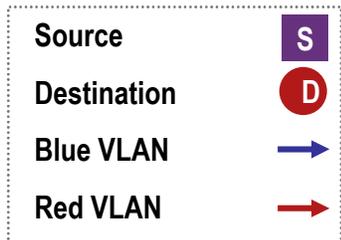
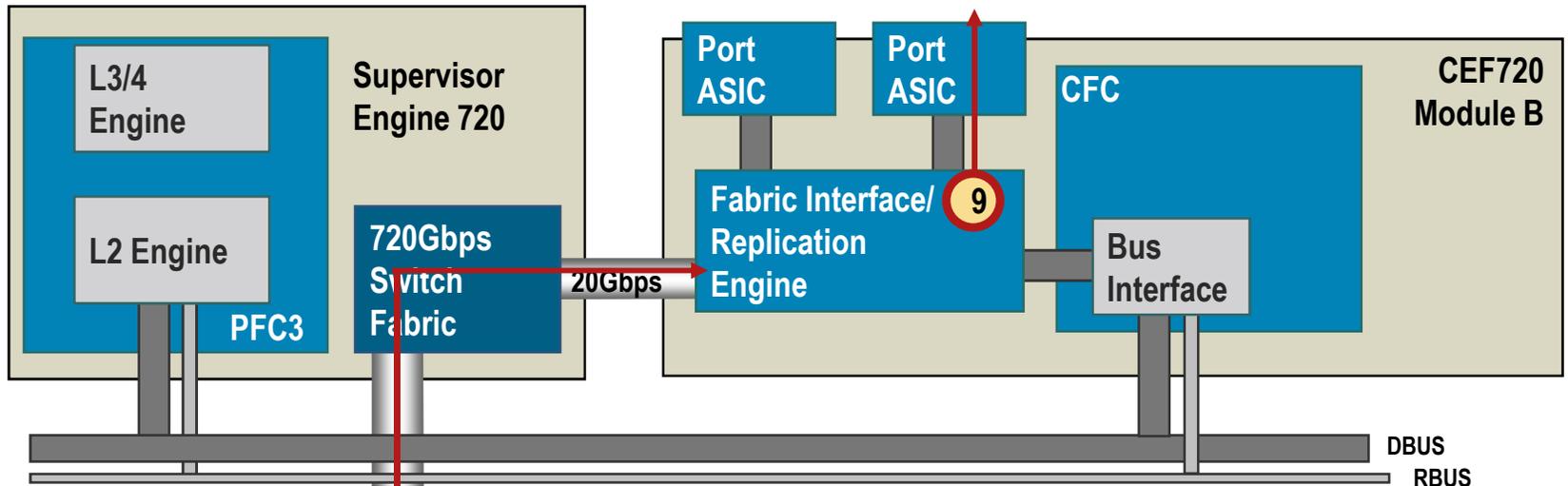


Reference: SIP-400 to CEF720

1. A Unicast IPv4 packet received on SIP-400 Module A SPA interface; entire packet is forwarded to SPA MUX ASIC
2. SPA MUX ASIC sends the packet on to the Ingress Network Processor (INP)
3. INP classifies the packet: non-IP packets are sent to the Supervisor 720 RP; IP packets have outer header (WAN or .1q) stripped, have a DBUS header appended and are sent to Switch Interface
4. Switch Interface updates the DBUS header CRC and forwards to FI/RE
5. FI/RE saves the packet in memory and floods DBUS header onto DBUS; header is received by PFC3 and ignored by CFC on CEF720 Module B
6. PFC3B makes a forwarding decision for the packet
7. The PFC floods forwarding decision result on RBUS; only the source Bus Interface processes the result; other devices on the RBUS ignore the result
8. The result is sent to FI/RE which transmits the packet and result across the fabric to CEF720 Module B, based on the PFC forwarding decision
9. CEF720 Module B receives the packet and transmits the packet to the egress port ASIC

NOTE: Forwarding from SIP-400 to CEF720 w/DFC3 is the same process except CEF720 w/DFC3 does not have any Bus connections

WAN Forwarding: SIP-600 to CEF720



Reference: SIP-600 to CEF720

1. A Unicast IPv4 packet received on SIP-600 Module A SPA interface; entire packet is forwarded to SPA Interface ASIC
2. SPA Interface ASIC sends the packet on to the High Speed Queuing and Shaping ASIC
3. High Speed Queuing and Shaping ASIC saves the packet in memory and sends the header to the Xchip ASIC
4. The Xchip will determine if the packet is to be sent directly to the Supervisor 720 Route Processor for processing (mostly for control plane traffic) or if it is to be sent to the DFC3BXL for processing; in this case it is sent to the DFC3BXL since it is data traffic
5. DFC3BXL makes a forwarding decision for the packet
6. DFC3BXL forwards the result to Xchip (which does the L2/L3 rewrites and any replication)) and back to the High Speed Queuing and Shaping ASIC
7. The High Speed Queuing and Shaping ASIC assembles the newly rewritten header with the previously stored packet and forwards it to the Fabric Interface ASIC.
8. The Fabric Interface ASIC transmits the packet across the fabric to CEF720 Module B, based on the PFC forwarding decision
9. CEF720 Module B receives the packet and transmits the packet to the egress port ASIC

NOTE: Forwarding from SIP-600 to CEF720 w/DFC3 is the same process except CEF720 w/DFC3 does not have any Bus connections

