

Cisco Catalyst 4500 Series Supervisor Engine 6-E CenterFlex Technology

Abstract

Cisco® CenterFlex technology, innovations enabled by the centralized application-specific integrated circuit (ASIC) complex at the heart of the Cisco Catalyst® 4500 Series Supervisor Engine 6-E, addresses the need for improved network performance, investment protection, and innovative new features. Cisco CenterFlex technology provides for system bandwidth of up to 320 Gbps with throughput of up to 250 Mpps. It works with classic line cards from the Cisco Catalyst 4000 and 4500 families and enhances the quality-of-service (QoS) capabilities of line cards introduced as early as 1999. The Cisco Catalyst 4500 Series Supervisor Engine 6-E CenterFlex technology benefits customers by adding new features to existing hardware as well as increasing capacity of networked systems.

Introduction

Enterprise IT departments increasingly view their networks as platforms for delivering critical applications as part of a service-oriented network architecture (SONA). This trend dictates that the capabilities of the network must increase over time to match the requirements of new applications. To that end, CenterFlex technology allows upgrading hardware capabilities of the entire switch through a simple supervisor engine upgrade.

The Supervisor Engine 6-E CenterFlex technology addresses this need by providing a simple upgrade paradigm. With all the intelligence located on a centralized component of a network element, it is possible to greatly enhance the capabilities of the system through upgrades to this single component: in this case, the supervisor card of the Cisco Catalyst 4500 switch. In other words, the investment in the switch and line cards is protected over time as new capabilities are added to the supervisor engine.

The Cisco Catalyst 4500 family has a multiple-year history of increasing performance and features while protecting existing investment in line cards. For instance, classic Cisco Catalyst 4000 line cards introduced in 1999 can be used with today's Supervisor Engine 6-E and take on the new features that this next generation supervisor engine has to offer.

Primary Customer Benefits of Supervisor Engine 6-E with CenterFlex

- High performance: Predictable high performance (IPv4/IPv6) with concurrently enabled services (QoS, security, multicast, and more)
- Increased control and flexibility: Optimize performance of voice, video, and data application over a unified network
- High availability and security: Minimize planned and unplanned downtime delivering business-critical applications securely and uninterrupted
- Scalable services capacity: Ample resources to enable new services today and in the future

- IPv4 to IPv6 migration: Optimized to enable IPv4 and IPv6 simultaneously, providing for a smooth migration
- Superior investment protection: Maximum backward and forward compatibility; mix and match new and classic line cards without performance degradation

What Innovations Does CenterFlex Technology Deliver?

- High centralized performance
- Backward and forward compatibility with Classic and E-Series Line Cards
- Mix and match classic and E-Series line cards, with each line card operating at its maximum speed
- Dynamic QoS and security resource allocation*
- Configurable queuing resources at port level (buffering)*
- Dynamic IPv6 resource allocation
- Low latency
- High Availability

CenterFlex Technology Overview

The CenterFlex ASIC complex comprises three devices. The Intelligent Packet Processor (IPP) receives incoming packets, stores them and retransmits them. The Very Fast Forwarding Engine (VFE) works with packet descriptors to apply services and switching. The ternary content addressable memory (TCAM4) provides 1 billion lookup results per second in support of the VFE.

Using industry-leading ASIC technology in the Supervisor Engine 6-E, CenterFlex technology delivers four times the slot capacity of the previous generation Cisco Catalyst 4500 supervisor engines. This architecture uses a feature size of 90nm, yielding higher circuit density and more features on the central supervisor engine. Capabilities such as IPv6 in hardware, flexible QoS mechanisms, and dynamic TCAM region sizing become available to applications running over all line cards introduced since 1999.

The Supervisor Engine 6-E CenterFlex-enabled TCAM4 allows each block of memory to be automatically configured for mask width. This allows customers to mix IPv4 and IPv6 flow masks efficiently, preventing the TCAM running out of masks during normal operation. TCAM4 processes four results per search, permitting, for instance, simultaneous access control list (ACL), QoS, and Layer 3 lookups. TCAM4 is also slated for inclusion in future versions of the Cisco Carrier Routing System (CRS-1).

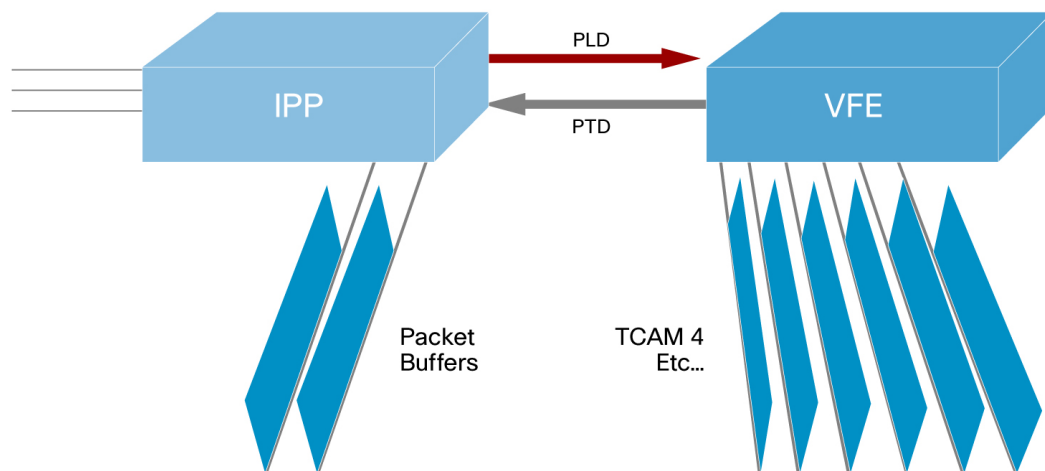
Each line card sends packets to the supervisor engine without processing. E-Series line cards are managed through a dedicated serial connection rather than in-band. CenterFlex works with classic line cards having a "Stub" ASIC or E-Series line cards with the "XgStub" ASIC.

XgStub uses a 90nm process just like the CenterFlex ASICs. It supports 2:1 oversubscription on 48-port cards and line rate on 24-port cards.*

* Q1 CY '08 Release

The IPP receives packets from the line cards and stores them in Packet Buffers. The IPP also does VLAN tag and header parsing. The IPP passes a Packet Lookup Descriptor (PLD) to the VFE, where a number of lookups happen in parallel. The VFE manages the Layer 2 lookup and Spanning Tree Protocol. It further does input classification and QoS lookups. It also accomplishes Layer 3 lookup and output classification. Finally, a Transmit Queue Descriptor is placed in Queue Memory, and a Packet Transmit Descriptor is sent back to the IPP, where the packet is sent to the correct egress line card. The architecture is illustrated in Figure 1.

Figure 1. CenterFlex technology



The Supervisor Engine 6-E has 24 PCB layers, compared to 18 for the Cisco Catalyst 4500 Supervisor Engine IV and 16 for the Cisco Catalyst 4000 Supervisor Engine II. The board uses 20 different voltage levels compared to 8 for the Supervisor Engine IV and 4 with the Supervisor Engine II. A comparison of the intricacy of various generations of the Cisco Catalyst 4500 is provided in Table 1.

Table 1. Supervisor Engine Comparisons

Supervisor Engine	PCB Layers	Voltage Levels	Component Count	Pin Count
Supervisor Engine 6-E	24	20	5913	29,458
Supervisor Engine IV	18	8	2039	16,474
Supervisor Engine II	16	4	1878	15,750

Benefits of CenterFlex

CenterFlex delivers high availability in a number of ways. First, through reduced component count on line cards and supervisor engines, the mean time between failures (MTBF) is drastically improved. The Supervisor Engine 6-E with CenterFlex technology boasts an MTBF figure in excess of 2 million operating hours.

The system also prevents unplanned outages through Non-Stop Forwarding and Stateful Swichover (NSF/SSO)* technologies. The combination of CenterFlex and NSF/SSO helps ensure that Layer 2 and Layer 3 adjacencies are maintained should the system need to switch over to the redundant supervisor engine in the face of a hardware failure.

* Q1 CY '08 Release

Further, CenterFlex enables In-Service Software Upgrades (ISSU)* in order to reduce planned maintenance windows for software enhancements to the platform. With ISSU, software upgrades result in less than 200 milliseconds of traffic interruption.

Since all traffic on the Cisco Catalyst 4500 platform follows the same path from source to destination interface, the system exhibits a deterministic latency profile. With latency as low as 3 microseconds, the CenterFlex technology is at home in collapsed core/distribution and access roles.

CenterFlex collects the switch intelligence in the supervisor engine card. This allows the system to cost-effectively scale from 116 ports in the 3-slot model to 388 ports in the 10-slot model.

The CenterFlex technology supports dynamic allocation of TCAM blocks to match the configured application. For instance, the system uses wide TCAM blocks when IPv6 is in use. Unlike previous generations of TCAM, the memory is divided into 32 blocks, which are automatically sized for IPv4 or IPv6. This has the advantage of maximizing the number of routes that can be supported when IPv6 is configured.

Without question, investment protection is the single best reason to build a network around CenterFlex technology. With an unparalleled history of backward and forward compatibility, the Cisco Catalyst 4500 product line sets the standard for network investment protection. For instance, classic line cards first purchased in 1999 can still be used with the classic Cisco Catalyst 4500 Series chassis and CenterFlex-enabled Supervisor Engine 6-E. In a typical configuration, up to 85 percent of the customer's initial investment is preserved when upgrading to the latest CenterFlex supervisor engine. In such an upgrade, the classic line cards take advantage of the new software and hardware features of the supervisor engine.

Flexibility is a crucial feature of the CenterFlex technology. The entire system inherits new capabilities and features when the supervisor engine is upgraded. For instance, with the Supervisor Engine 6-E, the number of hardware queues increases from four to eight queues per port.* The flexibility of the architecture is demonstrated in that even classic line cards first deployed in 1999 take advantage of the eight queues per port feature when the supervisor engine upgrade is completed.

CenterFlex Enabled Features

Universal Serial Bus Support

The Cisco Catalyst 4500 adds flexibility in terms of moving code to and from the platform. In addition to the external compact flash memory port, the new Supervisor Engine 6-E sports a Universal Serial Bus (USB) port. The USB port will allow customers to copy software, configuration, and log files.*

FAT File System

Flexibility is further enhanced by modifications to the file storage system in use on internal and external storage media. The Supervisor Engine 6-E uses the same FAT file system as Microsoft Windows computers, allowing easy transfer of software, configuration, and log files to and from the CenterFlex platform.

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Increased System Performance

When coupled with the Cisco Catalyst 4500 E-Series chassis and line cards, CenterFlex technology dramatically increases the performance of the entire system. Bandwidth per slot increases to 24 Gbps, while total system bandwidth increases to 320 Gbps. Forwarding performance in this configuration increases to as much as 250 Mpps.

Increased Component Performance

The Supervisor Engine 6-E scales with up to 1 GB memory on board. When coupled with a faster CPU (1.2GHz compared to 800MHz on the Cisco Catalyst 4500 Series Supervisor Engine V-10GE), the extra memory permits faster control plane processing. To speed data to and from the CPU, the Supervisor Engine 6-E uses a 10 Gigabit connection between the CPU and its supporting field programmable gate arrays (FPGAs).

Increased Capacity

The CenterFlex technology increases the route table size to 256K IPv4 routes over the previous 128K routes. The system also has the ability to route ICMP packets and packets with IP options in hardware. This decreases CPU load and alleviates a potential denial-of-service (DoS) attack.

Hardware-Enabled Features

The CenterFlex VFE ASIC incorporates a number of other value-added features in hardware so as to increase performance for E-Series and classic line cards. For instance, IPv6 unicast and multicast, unicast Reverse Path Forwarding (uRPF), and IP Source Guard are all handled in hardware. With an upgrade to the CenterFlex Supervisor Engine 6-E, all classic line cards can take advantage of these new hardware features.

Enhanced QoS

The new Supervisor Engine 6-E includes a number of QoS enhancements. With the CenterFlex technology, these new features are available on all line cards in the Cisco Catalyst 4500 family. The first QoS enhancement to note is that the configuration of QoS features now follows the Modular QoS Command Line Interface (MQC) standard. This aligns configuration of the Cisco Catalyst 4500 with other Cisco platforms, reducing training and support requirements. One feature available through MQC is QoS groups. This feature gives the administrator the ability to match traffic based on Layer 2 and Layer 3 characteristics and mark it with a group ID. Then the administrator can apply a common egress policy to the grouped traffic.

Another QoS enhancement doubles the number of queues per port available through the Supervisor Engine 6-E.* The limit increases queuing capacity to eight queues per port from the previous four queues per port available with the Supervisor Engines IV, V, and V-10GE. With CenterFlex technology, the increased eight queues per port are available to all ports on the system, including all classic and E-Series line cards. Further, the queues are configurable rather than fixed. By default, each port is serviced from one queue. Additional queues are configured for different classes of service as defined by the administrator. The Supervisor Engine 6-E supports one priority queue, seven additional queues, and two thresholds.

Queue depth is also configurable on the Supervisor Engine 6-E.* This allows classes of service such as Cisco TelePresence or unified communications to buffer large bursts of traffic and conform to the needs of the application. Of the 512K queue entries available to the system, up to 8184 queue entries (that is, packets) may be allocated to an individual queue.

* Q1 CY '08 Release

Increasing the flexibility of the system, three different types of policers are now available. These are the single rate-two color policer, the single rate-three color policer, and the dual rate-three color policer. The Supervisor Engine 6-E allows the administrator to configure policers in 2K increments to either ingress or egress direction.

IPv6 Support

The CenterFlex technology allows all ports in the system to support hardware forwarding of IPv6 unicast and multicast traffic. In addition, IPv6 ACLs are hardware based for efficient processing. This support is enabled for all Cisco Catalyst 4000 and 4500 series classic line cards introduced since 1999 as well as E-Series line cards.

In conjunction with IPv6 multicast support in hardware, the Supervisor Engine 6-E employs IPv6 Multicast Listener Detection (MLD) Snooping. This capability, like its IPv4 analog, IGMP Snooping, limits the flooding of multicast data to only those ports interested in receiving it.

Hardware Multicast Support

The system increases multicast support to 128K multicast entries from the 64K previously enabled. In addition, CenterFlex technology enables Multicast Listener Discovery (MLD) Version 2 for IPv6 multicast support.

High Availability

The CenterFlex technology supports redundant Supervisor Engine 6-E configurations in the 7- and 10-slot chassis. To help ensure that control traffic between the two supervisor engines is never dropped, the system uses a dedicated gigabit control connection between the supervisor engines.

Two technologies have been implemented to protect against memory corruption-caused errors. The first is parity protection for CenterFlex memories. Parity protection allows detection and correction of bit errors in memory. The second technology detects and corrects soft errors in the CPU packet engine FPGA. These two innovations render the system more highly available for critical customer applications.

Conclusion

Enterprises need to increase network capacity while controlling costs. A centralized architecture like the CenterFlex technology, offered exclusively in the Supervisor Engine 6-E, allows customers to upgrade and gain a host of new capabilities and improved performance.

The Supervisor Engine 6-E with CenterFlex technology has an extremely advanced centralized architecture. Dozens of new flexible configuration features are added to the network along with increased centralized capacity while preserving the majority of the customer's investment in the original system.

For More Information

To learn more about CenterFlex and its unique ability to increase network capabilities while preserving investment in the network, see:

<http://cisco.com/en/US/products/hw/switches/ps4324/index.html>.

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