

Cisco Catalyst 4500 Series Supervisor Engine IV: Integrated Resiliency for Advanced Control of Converged Networks

The Cisco Catalyst 4500 Series integrates resiliency for advanced control of converged networks (Figure 1).

Figure 1. Cisco Catalyst 4500 Series Supervisor Engine IV



Overview

The Cisco® Catalyst® 4500 Series Supervisor Engine IV integrates nonblocking Layers 2–4 switching with integrated resiliency, further enhancing control of converged networks. Converged data, voice, and video networks with high availability enable business resiliency for enterprise and Metro Ethernet customers deploying Internet-based business applications. Network control extends from the backbone to the edge with intelligent services such as granular quality of service (QoS), Internet security, and network management. Scalability of these intelligent network services is made possible with dedicated specialized resources known as ternary content addressable memory (TCAM). Ample TCAM resources (192,000 entries) enable “high feature capacity,” which provides wire-speed routing and switching performance with concurrent provisioning of services such as QoS and security, helping ensure scalability for today’s network requirements with ample room for future growth.

The modular architecture, media flexibility, and expandability of the Cisco Catalyst 4500 Series help enable an extended window of deployment in converged networks, reducing the total cost of ownership (TCO) by minimizing recurring operational expenses, in turn improving return on investment (ROI).

The Cisco Catalyst 4500 Series Supervisor Engine IV delivers next-generation switching technology with proven Cisco IOS® Software to power scalable, intelligent multilayer switching solutions for converged data, voice, and video networks. Optimized for the enterprise wiring closet, branch office, or Layer 3 distribution points, the Cisco Catalyst 4500 Series Supervisor Engine IV provides the performance and scalability to handle the network applications of today and the future.

Chassis and Line-Card Support

You can deploy the supervisor engine IV in single-chassis nonredundant mode in the Cisco Catalyst 4503, 4503-E, 4506, and 4506-E chassis. You can also deploy it in single-chassis redundant mode as an option in the Cisco Catalyst 4507R chassis (slots 1 and 2 only) and Cisco Catalyst 4507R-E chassis (slots 3 and 4).

The supervisor engine IV is compatible with the classic Cisco Catalyst 4500 and the E-series Cisco Catalyst 4500 Line Cards. Table 1 gives performance information for the Cisco Catalyst 4500 Series Supervisor Engine IV.

Table 1. Cisco Catalyst 4500 Series Supervisor Engine IV Performance per Chassis

	Cisco Catalyst 4503 and Catalyst 4503-E Chassis	Cisco Catalyst 4506 and Catalyst 4506-E Chassis	Cisco Catalyst 4507R and Catalyst 4507R-E Chassis	Cisco Catalyst 4510R and Catalyst 4510R-E Chassis
Cisco Catalyst 4500 Series Supervisor Engine IV (part number WS-X4515)	28 Gbps and 21 Mpps supported	64 Gbps and 48 Mpps supported	64 Gbps and 48Mpps supported	Not supported

Predictable Performance and Scalability

The Cisco Catalyst 4500 Supervisor Engine IV delivers a 64-Gbps switching fabric with a 48-mpps forwarding rate in hardware for Layers 2–4 traffic. Switching performance is independent of the number of route entries or Layer 3 and 4 services enabled. Hardware-based Cisco Express Forwarding routing architecture allows for increased scalability and performance. . Table 2 provides a comparison of the performance and scalability features of all of the Cisco Catalyst 4500 Series Enhanced Layer 3 Supervisor Engines.

Table 2. Cisco Catalyst 4500 Enhanced Layer 3 Supervisor Engine Performance and Scalability Features

Feature and Description	Cisco Catalyst 4500 Supervisor Engine IV	Cisco Catalyst 4500 Supervisor Engine V	Cisco Catalyst 4500 Supervisor Engine V-10GE	Cisco Catalyst 4500 Supervisor Engine 6-E
Total centralized switching capacity	64 Gbps	96 Gbps	102 mpps and 136 Gbps	320 Gbps
Per-slot switching capacity	6 Gbps	6 Gbps	6 Gbps	24 Gbps
Throughput	48 mpps	72 mpps	102 mpps	250 mpps
Hardware forwarded IPv4 routing entries	128,000	128,000	128,000	256,000
Hardware forwarded IPv6 routing entries	—*	—*	—*	128,000
Multicast entries	28,000 (Layer 3) 16,000 (Layer 2)	28,000 (Layer 3) 16,000 (Layer 2)	28,000 (Layer 3) 16,000 (Layer 2)	56,000 for IPv4 28,000 for IPv6
CPU	333 MHz	400 MHz	800 MHz	1.3 GHz
CPU queues	32	32	32	64

Synchronous dynamic RAM (SDRAM)	512 MB	512 MB	512 MB	512 MB upgradable to 1 GB
NVRAM	Yes (512 KB)	Yes (512 KB)	No; Boot Flash (128 Mb)	No; Boot Flash (64 MB)
Security and QoS entries	64,000	64,000	64,000	128,000
Cisco Network Admission Control/Dynamic Host Configuration Protocol (NAC/DHCP) Snooping entries	3000/3000	3000/3000	6000/6000	6000
MAC addresses	32,000	32,000	55,000	55,000
Active VLANs	4,000	4,000	4,000	4,000
Spanning Tree Protocol instances	3,000	3,000	3,000	3,000
Switched virtual interfaces (SVIs)	4,000	4,000	4,000	4,000
Switched Port Analyzer (SPAN)	2 ingress and 4 egress	2 ingress and 4 egress	2 ingress and 4 egress	8 ingress and 8 egress: Future software release
Minimum software requirement	Cisco IOS Software Release 12.1(12c)EW or later	Cisco IOS Software Release 12.2(18)EW or later	Cisco IOS Software Release 12.2(25)EW or later	Cisco IOS Software Release 12.2(40)SG or later

* The amount of Software Based IPv6 entries supported is dependent on the DRAM space. The Cisco Catalyst 4500 Series is optimized for multimedia applications with its advanced multicast support. Protocol Independent Multicast (PIM), Source Specific Multicast (SSM), and Pragmatic General Multicast (PGM) are supported, giving you additional scalability to support multimedia applications. The supervisor engine IV also supports Internet Group Management Protocol (IGMP) Snooping in hardware, enhancing performance and reducing network traffic by allowing a switch to dynamically add and remove hosts from a multicast group.

Supervisor Engine IV Redundancy for Business Resiliency

The Cisco Catalyst 4507R chassis using the supervisor engine IV has been designed with an optional 1+1 redundant supervisor capability for integrated resiliency. One supervisor engine IV is designated as the primary (active) supervisor and is responsible for normal system operation; the other (secondary) can serve as a standby, monitoring the operation of the primary supervisor.

Nonstop Forwarding with Stateful Switchover (NSF/SSO) offers continuous packet forwarding during supervisor engine switchover. Information is fully synchronized between supervisors to allow the standby supervisor to immediately take over in subsecond time if the primary fails. In Service Software Upgrade (ISSU) allows you to upgrade or downgrade complete Cisco IOS Software images with minimal to no disruption to the network when using a redundant Cisco Catalyst 4500 system with dual supervisors. It allows for a rapid, nondisruptive software upgrade for new line cards, new power supplies, new features, or bug fixes. ISSU offers continuous packet forwarding during the supervisor engine switchover running different Cisco IOS Software versions.

NSF/SSO and ISSU dramatically improve the network reliability and availability in a Layer 2 or Layer 3 environment. NSF/SSO and ISSU are essential for business-critical applications such as voice over IP (VoIP). With these features, VoIP calls are not dropped.

The supervisor engine IV redundancy scheme is similar to that of the supervisor engine V and V-10GE models. Alerts are generated to the network monitoring software if either supervisor fails, and hot-swapping of supervisors is supported without disrupting system operation. Either the software or you can force switchover of supervisor engines with Simple Network Management Protocol (SNMP). The resiliency features of the Cisco Catalyst 4500 Series help prevent network

outages that could result in lost business and revenue. Table 3 gives high-availability and uplink options for the supervisor engines.

Table 3. Cisco Catalyst 4500 Enhanced Layer 3 Supervisor Engine High-Availability and Uplink Options

Feature and Description	Supervisor Engine IV	Supervisor Engine V	Supervisor Engine V-10GE	Supervisor Engine 6-E
Redundant capable	Yes Cisco Catalyst 4507R chassis and Cisco Catalyst 4507R-E	Yes Cisco Catalyst 4507R, Catalyst 4507R-E, Catalyst 4510R, and Catalyst 4510R-E	Yes Cisco Catalyst 4507R or 4507R-E and Cisco Catalyst 4510R or 4510R-E	Yes Cisco Catalyst 4507R or 4507R-E and Cisco Catalyst 4510R or 4510R-E
Active supervisor uplinks in redundant mode	2 Gigabit Ethernet	Up to 4 Gigabit Ethernet	Up to four Gigabit Ethernet and two 10 Gigabit Ethernet*	Two 10 Gigabit Ethernet (wire speed) Up to four 10 Gigabit (2:1 oversubscribed) Up to 8 Gigabit Ethernet (twin Gigabit Ethernet converters)
Active supervisor engine uplinks in nonredundant mode	2 Gigabit Ethernet	2 Gigabit Ethernet	4 Gigabit Ethernet and two 10 Gigabit Ethernet*	Two 10 Gigabit or one 10 Gigabit and 2 Gigabit Ethernet (twin Gigabit Ethernet converters) or 4 Gigabit Ethernet (twin Gigabit Ethernet converters)
Twin Gigabit Ethernet converter support	No	No	No	Yes
Uplink optic types	Gigabit interface converter (GBIC)	GBIC	Small Form-Factor Pluggable (SFP) (Gigabit Ethernet) or X2 optics (10-Gigabit Ethernet ports)	SFP (Gigabit Ethernet) with Twin Gigabit Ethernet converter or X2 optics (10-Gigabit Ethernet ports)
SSO/NSF and ISSU	Yes	Yes	Yes	Yes**

* Simultaneous use of Gigabit Ethernet and 10 Gigabit Ethernet is supported in Cisco IOS Software Release 12.2(25) SG and later.

** NSF/SSO/ISSU will be supported in First half of Calendar Year 2008 Cisco IOS Software Release.

Please refer to the section “Features at a Glance” for a complete listing of supported features.

Integrated Cisco IOS Software Switching Solution

The Cisco Catalyst 4500 Series Supervisor Engine IV supports Cisco IOS Software, providing operational ease of use by allowing you to deploy a single network operating system across your routed and switched infrastructures. Industry-leading Cisco IOS Software integrates features for scalability, bandwidth management, security services, network resiliency, and manageability into the Cisco Catalyst 4500 Series. Cisco IOS Software provides investment protection and tight coupling of Layers 2–4 services into a single, unified configuration file and system image. The Cisco Catalyst 4500 Series Supervisor Engine IV defaults to Layer 2 switching upon startup and can be configured to perform Layer 3 and 4 switching and routing services as desired.

IPv6 Support

PPIIPv6 is important for the future of IP networking and is critical for the expansion of IP address space in the future. IPv6 capability is required by many companies and is being mandated by governments worldwide. IPv6 has been supported on the Cisco Catalyst 4500 Supervisor Engine

V since Cisco IOS Software Release 12.2(20)EW with software-based forwarding. Please refer to the section “Features at a Glance” for a complete listing of supported features.

Intelligent Network Services with QoS and Sophisticated Traffic Management

The Cisco Catalyst 4500 Series Supervisor Engine IV offers superior per-port QoS features to help ensure that network traffic is classified, prioritized, and scheduled optimally to efficiently handle bandwidth-hungry multimedia, time-sensitive (voice), and mission-critical applications. Supervisor engine IV can classify, police, and mark incoming packets, allowing you to differentiate between traffic flows and enforce policies based on granular QoS fields. Sharing, shaping, and strict priority configurations determine scheduling of egress traffic beginning in Cisco IOS Software Release 12.1(13)EW. The supervisor engine IV supports Dynamic Buffer Limiting (DBL), a congestion-avoidance feature.

For details about the QoS features (including DBL), refer to “QoS on Cisco Catalyst 4500 Series Cisco IOS Software-Based Supervisor Engines” at:

http://www.cisco.com/en/US/products/hw/switches/ps4324/prod_white_papers_list.html.

Table 4 provides QoS feature highlights for all of the Cisco Catalyst 4500 enhanced Layer 3 supervisor engines.

Table 4. Cisco Catalyst 4500 Enhanced Layer 3 Supervisor Engine QoS Feature Summary

Feature and Description	Supervisor Engine IV	Supervisor Engine V	Supervisor Engine V-10GE	Supervisor Engine 6-E
QoS hardware entries	32,000	32,000	32,000	64,000
Policers	8,000 input 8,000 output	8,000 input 8,000 output	8,000 input 8,000 output	16,000 with flexible assignment for input/output
Hierarchical policers	No	No	Yes; Microflow policing with onboard NetFlow	Yes; 2 rate 3 color
Number of Tx queues	4	4	4	Flexible queues up to 8 1
Maximum Tx queue size	1920 packets per Tx queue	2336 packets per Tx queue	2336 packets per Tx queue	Dynamic 56–8192 packets per queue, depending on the number and type of line card and the number of queues configured on the port; Refer to documentation for more details*
Dynamic queue sizes	No	No	No	Yes
Configurable classification mapping tables	No	No	No	Yes
Match IP on MAC header	No	No	No	Yes
Modular QoS compliance	No	No	No	Yes
DBL: Congestion-Avoidance feature	Yes	Yes	Yes	Yes
QoS sharing	Support only on nonblocking Gigabit Ethernet ports	Supported on all ports	Supported on all ports	Supported on all ports
Shaping	Yes per Tx queue	Yes per Tx queue	Yes per Tx queue	Yes per Tx queue
Broadcast suppression	Software**	Hardware for all ports	Hardware for all ports	Hardware for all ports
Multicast suppression	No	Hardware for all ports	Hardware for all ports	Hardware for all ports

* Will be supported as part of the software upgrade in First Half of Calendar Year 2008
 ** Hardware performance for nonblocking Gigabit Ethernet ports and software performance for all other ports
 Please refer to the section “Features at a Glance” for a listing of supported features.

Comprehensive Management

The Cisco Catalyst 4500 Series Supervisor Engine IV features a single console port and a single IP address to manage all features of the system. Remote in-band management is available through SNMP, Telnet client, BOOTP, and Trivial File

Transfer Protocol (TFTP). Support for local or remote out-of-band management is delivered through a terminal or modem attached to the console interface.

The Cisco Catalyst 4500 Supervisor Engine IV delivers a comprehensive set of management tools to provide the required visibility and control in the network. Managed with CiscoWorks solutions, Cisco Catalyst switches can be configured and managed to deliver end-to-end device, VLAN, traffic, and policy management. The CiscoWorks LAN Management Solution (LMS) bundle offers tools such as CiscoWorks Resource Manager Essentials and CiscoView. These Web-based management tools offer several services, including automated inventory collection, software deployment, easy tracking of network changes, views into device availability, and quick isolation of error conditions. Table 5 gives management feature highlights of the supervisor engines.

Table 5. Cisco Catalyst 4500 Enhanced Layer 3 Supervisor Engines: Management Feature Highlights

Feature and Description	Supervisor Engine IV	Supervisor Engine V	Supervisor Engine V-10GE	Supervisor Engine 6-E
USB drive support	No	No	No	Yes: Future software release
Compact Flash support	Yes; 64- and 128-MB options	Yes; 64- and 128-MB options	Yes; 64- and 128-MB options	Yes; 64- and 128-MB options
FAT file system support	No	No	No	Yes
SPAN	2 ingress and 4 egress	2 ingress and 4 egress	2 ingress and 4 egress	8 ingress and 8 egress: Future software release

Please refer to the section “Features at a Glance” for a complete listing of supported features.

Advanced Security

The Cisco Catalyst 4500 Series offers a rich set of industry-leading, integrated security features to proactively lock down your critical network infrastructure. It reduces network security risks with a rich set of NAC capabilities and 802.1x-based user authentication, authorization, and accounting (AAA). The security policy enforcement is uncompromised with the wire-rate, dedicated access control lists (ACLs) to fend off ever-increasing virus and security attacks. The Cisco Catalyst 4500 Series offers powerful, easy-to-use tools to effectively prevent untraceable man-in-the-middle attacks, control plane resource exhaustion, IP spoofing, and flooding attacks, without any change to the end-user or host configurations. Secure remote access, file transfers, and network management are accomplished with the Secure Shell (SSH Version 1 and Version 2) Protocol, Secure Copy Protocol (SCP), and SNMPv3, respectively.

Cisco NAC is a foundational component of the Cisco Self-Defending Network strategy, improving the ability of the network to automatically identify, prevent, and respond to security threats. NAC

helps enable the Cisco Catalyst switches to collaborate with third-party solutions for security-policy compliance and enforcement before a host is permitted to access the network.

Cisco NAC performs posture validation at the Layer 2 network edge for hosts with or without 802.1x enabled. You can isolate vulnerable and noncompliant hosts, give them reduced network access, or direct them to remediation servers based on organizational policy. By helping ensure that every host complies with security policy, you can significantly reduce the damage caused by infected hosts. NAC is available through standard software upgrades or Cisco SMARTnet® contracts on Cisco Catalyst switches. Table 6 gives security features of the supervisor engines.

Table 6. Cisco Catalyst 4500 Enhanced Layer 3 Supervisor Engines: Security Feature Highlights

Feature and Description	Supervisor Engine IV	Supervisor Engine V	Supervisor Engine V-10GE	Supervisor Engine 6-E
Security entries	32,000	32,000	32,000	64,000
NAC/DHCP Snooping entries	3000/3000	3000/3000	6000/6000	6000
Unicast Reverse Path Forwarding (URPF)	No	No	No	Yes, in hardware
Control plane policing	Yes	Yes	Yes, in hardware	Yes, in hardware*
802.1x	Yes	Yes	Yes	Yes
802.1X extensions	Yes	Yes	Yes	Yes*
IP Source Guard, Dynamic ARP Inspection, and DHCP Snooping	Yes	Yes	Yes	Yes
NAC	Yes	Yes	Yes	Yes*

* This feature will be supported in future IOS Software Release.

Please refer to the section “Features at a Glance” for a complete listing of supported features.

Cisco Catalyst 4500 Series Netflow Services Card for Supervisor Engine IV

The Cisco Catalyst 4500 Series NetFlow Services Card (Figure 2) is an optional daughter card for the Cisco Catalyst 4500 Series Supervisor Engine IV or V, providing Layer 3 statistics and enhanced VLAN statistics without affecting the forwarding performance rates on the supervisor engine.

Figure 2. Cisco Catalyst 4500 Series NetFlow Services Card and Supervisor Engine IV



NetFlow Services Card Product Description

NetFlow is a versatile feature that allows you to monitor traffic flows for the purpose of billing, network planning, or security purposes. The NetFlow services card supports per-packet statistics capture in hardware for flow- and VLAN-based statistics monitoring. NetFlow services capture and cache detailed information about each data flow (a stream of packets traveling in one direction from one endpoint to another across the network). Data in the NetFlow cache includes information about specific flows, including details such as IP addresses, packet and byte counts, time stamps, and application ports. You can export, collect, and analyze this data for numerous purposes such as virus and denial-of-service (DoS) mitigation. More information about NetFlow technology is available at:

http://www.cisco.com/en/US/products/ps6601/products_ios_protocol_group_home.html.

NetFlow Services Card Applications

NetFlow technology efficiently provides the metering base for critical applications, including network traffic accounting, usage-based network billing, network planning, network monitoring, and data-mining capabilities for both service provider and enterprise customers.

An enterprise customer might use NetFlow information for departmental charge-backs, cost allocation, network budget justification, network monitoring and planning, application monitoring and planning, use monitoring and planning, enterprise accounting, usage-based billing, data warehousing, or management reports.

A service provider customer can use NetFlow information to charge customers according to bandwidth, application usage, QoS, or distance, rather than at a flat rate.

A more detailed list of general NetFlow applications is available at:

http://www.cisco.com/en/US/products/ps6601/products_ios_protocol_group_home.html.

NetFlow Services Card Features

With Cisco IOS Software Release 12.1(13)EW, the Cisco Catalyst 4500 Series with the supervisor engine IV supports NetFlow statistics. The NetFlow daughter card provides line-rate flow statistics as well as Layer 2 VLAN statistics without a performance penalty. NetFlow Data Export (NDE) Versions 1 and 5 are supported in Cisco IOS Software Release 12.1(13)EW. Cisco IOS Software Release 12.1(19)EW provides several enhancements to the NetFlow daughter card, including support for NetFlow Version 8. NetFlow Version 8 enables aggregation of the NetFlow Data Export stream. Cisco IOS Software Release 12.1(19)EW also provides additional fields for NetFlow Version 5.

The default is NetFlow Statistics Collection and NetFlow Data Export Versions 1 and 5. The supported fields within NDE Version 5 with Cisco IOS Software Release 12.1(19)EW are identified as follows:

- Source and destination IP address (hardware)
- IP Protocol (hardware)
- Layer 4 source and destination ports (for TCP/User Datagram Protocol [UDP] or 0 otherwise) (hardware)
- Start and end time stamps (hardware)
- Packet counts and byte counts (hardware)
- Input/output interface (software)

- Next-hop router (software)
- Source and destination autonomous system number (software)
- Source and destination prefix mask (software)
- VLAN statistics collection
- Command-line interface (CLI) support for NetFlow and VLAN statistics
- SNMP support for VLAN statistics
- NetFlow Aggregation Support (NFX) (NetFlow Version 8)

NetFlow Services Card Hardware and Software Requirements

The NetFlow services card is supported only on the supervisor engine IV and V models with Cisco IOS Software and is not supported in the Cisco Catalyst OS Software.

Software Requirements

The minimum software versions are as follows:

- Supervisor engine IV with NetFlow services card: Cisco IOS Software Release 12.1(13)EW or later
- Supervisor engine V with NetFlow services card: Cisco IOS Software Release 12.2(18)EW or later

NetFlow Collection (NFC) and Network Data Analyzer (NDA) requirements:

- Cisco CNS NetFlow Collection Engine (NFC) Version 3.5 or later
- Cisco Network Data Analyzer (NDA) Version 3.6 or later

Hardware Requirements

- Supervisor engine IV or V is required.
- Redundant supervisor engine IV daughter card configurations must match. If a NetFlow services card is deployed on a primary supervisor engine, then a second NetFlow services card must be deployed on a secondary supervisor engine IV in the same chassis.

The NetFlow services card can be shipped preinstalled with a supervisor engine IV from the factory or as a separate, field-replaceable unit. The supervisor engine IV must be removed from the chassis to install the NetFlow services module; it is not hot-swappable.

Features at a Glance

Layer 2 Features

- Layer 2 hardware forwarding at 48 Mpps
- Layer 2 switch ports and VLAN trunks
- IEEE 802.1Q VLAN encapsulation
- Inter-Switch Link (ISL) VLAN encapsulation
- Dynamic Trunking Protocol (DTP)
- VLAN Trunking Protocol (VTP) and VTP domains
- Support for 4096 VLANs per switch

- Per-VLAN Spanning Tree Protocol (PVST+) and Per-VLAN Rapid Spanning Tree Protocol (PVRST)
- Spanning Tree Protocol PortFast and PortFast Guard
- Spanning Tree Protocol UplinkFast and BackboneFast
- 802.1s
- 802.1w
- 802.3ad
- Spanning Tree Protocol Root Guard
- Cisco Discovery Protocol
- Internet Group Management Protocol (IGMP) Snooping v1, v2, and v3
- Cisco EtherChannel[®] technology, Cisco Fast EtherChannel technology, and Cisco Gigabit EtherChannel technology across line cards
- Port Aggregation Protocol (PAgP)
- Link Aggregation Control Protocol (LACP)
- Unidirectional Link Detection Protocol (UDLD) and aggressive UDLD
- Q-in-Q passthrough
- Jumbo Frames (up to 9216 bytes)
- Baby Giants (up to 1600 bytes)
- Unidirectional Ethernet
- SSO in subsecond failover time
- Storm control (formally known as broadcast suppression)
- Forced 10/100 autonegotiation
- Web Content Communication Protocol Version 2 Layer 2 Redirect
- Private VLAN Promiscuous Trunk
- Match class of service (CoS) for non-IPv4 traffic
- Layer 2 Tunneling Protocol (L2TP) over trunk port
- CoS mutation
- Per-VLAN Control Traffic Intercept

Layer 3 Features

- Hardware-based IP Cisco Express Forwarding routing at 48 Mpps
- IP routing protocols (Interior Gateway Routing Protocol [IGRP], Enhanced IGRP [EIGRP], Open Shortest Path First [OSPF], Routing Information Protocol [RIP], and RIPv2)
- Border Gateway Protocol Version 4 (BGPv4) and Multicast Border Gateway Protocol (MBGP)
- Software routing of Internetwork Packet Exchange (IPX) and AppleTalk
- Intermediate System-to-Intermediate System (IS-IS) routing protocol
- IGMP v1, v2, and v3
- IGMP filtering on access and trunk ports
- IP Multicast routing protocols (PIM, SSM, and Distance Vector Multicast Routing Protocol [DVMRP])

- Pragmatic General Multicast (PGM)
- Cisco Group Multicast Protocol (GMP) server
- Full Internet Control Message Protocol (ICMP) support
- ICMP Router Discovery Protocol
- Policy-Based Routing (PBR)
- Virtual Route Forwarding-lite (VRF-lite)
- IPv6 software switched
- EIGRP Stub
- IP unnumbered for SVI
- SVI Autostate Exclude
- Multicast Source Discovery Protocol (MSDP)
- Auto-Rendezvous Point Listener (IP Multicast)

Sophisticated QoS and Traffic Management

- Per-port QoS configuration
- Support for four queues per port in hardware
- Strict Priority Queuing
- IP differentiated services code point (DSCP) and IP Precedence
- Classification and marking based on IP type of service (ToS) or DSCP
- Classification and marking based on full Layer 3 and Layer 4 headers
- Input and output policing based on Layer 3 and Layer 4 headers
- Support for 1024 policers on ingress and 1024 policers on egress configured as aggregate or individual
- Shaping and sharing output queue management
- DBL: Congestion-avoidance feature
- No performance penalty for granular QoS functions
- Auto-QoS CLI for VoIP deployments
- Per-port, per-VLAN QoS
- Selective DBL

Predictable Performance

- 64-Gbps switching fabric
- Layer 2 hardware forwarding at 48 Mpps
- Layer 3 hardware-based IP Cisco Express Forwarding routing at 48 Mpps
- Layer 4 TCP/UDP hardware-based filtering at 48 Mpps
- No performance penalty with advanced Layer 3 and Layer 4 services enabled
- Software-based learning at a sustained rate of 1000 hosts per second
- Support for 32,768 MAC addresses
- Support for 131,072 entries in routing table (shared between unicast and multicast)
- Scalability to 4000 virtual ports (VLAN port instances)
- Bandwidth aggregation up to 16 Gbps through Cisco Gigabit EtherChannel technology

- Hardware-based multicast management
- Hardware-based ACLs, router ACLs (RACLs), and VLAN ACLs (VACLs)

Comprehensive Management

- Manageable through Cisco Network Assistant
- Single console port and single IP address to manage all system features
- Software configuration management, including local and remote storage
- Manageable through CiscoWorks Windows network-management software on a per-port and per-switch basis, providing a common management interface for Cisco routers, switches, and hubs
- SNMPv1, v2, and v3 instrumentation, delivering comprehensive in-band management
- CLI-based management console to provide detailed out-of-band management
- Remote Monitoring (RMON) software agent to support four RMON groups (history, statistics, alarms, and events) for enhanced traffic management, monitoring, and analysis
- Support for all nine RMON groups through the use of a Cisco SwitchProbe analyzer (SPAN) port, which permits traffic monitoring of a single port, a group of ports, or the entire switch from a single network analyzer or RMON probe
- Analysis support, including ingress port, egress port, and VLAN SPAN
- Layer 2 Traceroute
- Remote SPAN (RSPAN)
- Cisco SmartPort macros
- SPAN ACL filtering
- SPAN CPU port
- DHCP Client Autoconfiguration
- Enhanced SNMP MIB support
- HTTPS
- Time Domain Reflectometry (TDR)
- Optional Compact Flash memory card to store software images for backup and easy software upgrades
- NetFlow VLAN Statistics (NetFlow services card required)
- MAC Address Notification

Advanced Security

- TACACS+ and RADIUS, which help enable centralized control of the switch and restrict unauthorized users from altering the configuration
- Standard and extended ACLs on all ports
- 802.1x user authentication (with VLAN assignment, voice VLAN, port security, and guest VLAN)
- 802.1x Accounting
- 802.1x Authentication Failure
- 802.1x Private VLAN Assignment
- 802.1x Private Guest VLAN

- 802.1x RADIUS-supplied time out
- NAC Layer 2 802.1x
- NAC Layer 2 IP
- Trusted Boundary
- ACLs on all ports (no performance penalty)
- VACLs
- Port ACLs (PACLs)
- Private VLANs (PVLANS) on access and trunk ports
- DHCP Snooping
- DHCP Option 82
- DHCP Option 82 Insertion
- DHCP Option 82 Passthrough
- Port Security
- Sticky Port Security
- SSHv1 and SSHv2
- VLAN Management Policy Server (VMPS) client
- Unicast MAC Filtering
- Unicast Port Flood Blocking
- Dynamic Address Resolution Protocol (ARP) Inspection
- IP Source Guard
- Community Private VLANs
- Trunk Port Security
- 802.1x Inaccessible Authentication Bypass
- MAC Authentication Bypass
- Control Plane Policing
- 802.1x Unidirectional Controlled Port
- Voice VLAN Sticky Port Security
- SCP
- Cisco EtherChannel Trunk Port Security
- IP Source Guard for Static Hosts
- IEEE 802.1x Multi Domain Authentication

High Availability

- NSF/SSO
- In Service Software Upgrade (ISSU)
- NSF Awareness
- SSO in subsecond failover time
- Hot Standby Router Protocol (HSRP)
- SSO-Aware Hot Standby Router Protocol
- Virtual Router Redundancy Protocol (VRRP)

- Gateway Load Balancing Protocol (GLBP)
- OSPF Fast Convergence: Incremental Shortest Path First (SPF) and Link-State Advertisement (LSA) Throttling
- Cisco Generic Online Diagnostics (GOLD)
- Virtual Server Services (VSS) Client

IPv6 (Software-Based Forwarding)

- Packets forwarded in software
- Support for IPv6 Addressing
- Cisco Discovery Protocol for IPv6
- IPv6 Domain Name System (DNS) resolver for AAAA over an IPv6 and IPv4 transport
- Extended ACL
- IPv6: Extended ACL
- IPv6: ICMP Rate Limiting
- IPv6: ICMPv6
- IPv6: ICMPv6 Redirect
- IPv6: IP MIB
- IPv6: IPv6 over IEEE 802.1Q
- IPv6: IPv6 over IPv4 Generic Routing Encapsulation (GRE) Tunnel
- IPv6: Intra-Site Automatic Tunnel Addressing Protocol (ISATAP)
- IPv6: Loopback
- IPv6: Multicast Listener Discovery (MLD) Versions 1 and 2
- IPv6: Maximum Transmission Unit (MTU) Path Discovery for IPv6
- IPv6: Multicast in IPv6 Tunnel
- IPv6: OSPFv3
- IPv6: Ping
- IPv6: Router Alert Option
- IPv6: SSH over an IPv6 Transport
- IPv6: Stateless Autoconfiguration
- IPv6: Static Routes within IPv6
- IPv6: AAA
- IPv6: Telnet
- IPv6: TFTP
- IPv6: Traceroute
- IPv6: Duplicate Address Detection
- IPv6: Standard ACL
- IPv6 Tunnels in software
- IPv6: Hop-by-Hop Option Header: Done in software
- IPv6: RIP next generation for IPv6
- PIM v6 (sparse mode)

Technical Specifications

Management

- CiscoWorks LAN Management Solution (LMS), including Cisco Works Resource Manager Essentials (RME)
- CiscoView
- Cisco Network Assistant
- BGP4-MIB.my
- CISCO-BULK-FILE-MIB.my
- CISCO-CDP-MIB.my
- CISCO-CLASS-BASED-QOS-MIB.my
- CISCO-CONFIG-COPY-MIB.my
- CISCO-CONFIG-MAN-MIB.my
- CISCO-ENTITY-ASSET-MIB.my
- CISCO-ENTITY-EXT-MIB.my
- CISCO-ENTITY-FRU-CONTROL-MIB.my
- CISCO-ENTITY-SENSOR-MIB.my
- CISCO-ENTITY-VENDORTYPE-OID-MIB.my
- CISCO-ENVMON-MIB.my
- CISCO-FLASH-MIB.my
- CISCO-FTP-CLIENT-MIB.my
- CISCO-HSRP-MIB.my
- CISCO-IETF-IP-MIB.my
- CISCO-IETF-IP-FORWARD-MIB.my
- CISCO-IETF-ISIS-MIB.my
- CISCO-IF-EXTENSION-MIB.my
- CISCO-IGMP-FILTER-MIB.my
- CISCO-IMAGE-MIB.my
- CISCO-IPMROUTE-MIB.my
- CISCO-L2-TUNNEL-CONFIG-MIB.my
- CISCO-L2L3-INTERFACE-CONFIG-MIB.my
- CISCO-LAG-MIB.my
- CISCO-MEMORY-POOL-MIB.my
- CISCO-NDE-MIB.my
- CISCO-PAGP-MIB.my
- CISCO-PAE-MIB.my
- CISCO-PING-MIB.my
- CISCO-PORT-SECURITY-MIB.my
- CISCO-PORT-STORM-CONTROL-MIB.my
- CISCO-PRIVATE-VLAN-MIB.my

- CISCO-PROCESS-MIB.my
- CISCO-PRODUCTS-MIB.my
- CISCO-RF-MIB.my
- CISCO-RMON-CONFIG-MIB.my
- CISCO-RTTMON-MIB.my
- CISCO-STP-EXTENSIONS-MIB.my
- CISCO-SYSLOG-MIB.my
- CISCO-VLAN-IFTABLE-RELATIONSHIP-MIB.my
- CISCO-VLAN-MEMBERSHIP-MIB.my
- CISCO-VTP-MIB.my DOT3-MAU-MIB.my (RFC 3636)
- ENTITY-MIB.my
- ETHERLIKE-MIB.my
- EXPRESSION-MIB.my
- HC-RMON-MIB.my
- IEEE8021-PAE-MIB.my
- IEEE8023-LAG-MIB.my (802.3ad)
- IF-MIB.my
- IGMP-MIB.my
- IPMROUTE-MIB.my
- NOVELL-IPX-MIB.my
- NOVELL-RIPSAP-MIB.my
- OLD-CISCO-TS-MIB.my
- PIM-MIB.my
- RFC1213-MIB.my (MIB-II)
- RFC1243-MIB.my (APPLETALK MIB)
- RFC1253-MIB.my (OSPF-MIB)
- RMON-MIB.my (RFC 1757)
- RMON2-MIB.my (RFC 2021)
- SMON-MIB.my (Internet-Draft)
- SNMP-FRAMEWORK-MIB.my (RFC 2571)
- SNMP-MPD-MIB.my (RFC 2572)
- SNMP-NOTIFICATION-MIB.my (RFC 2573)
- SNMP-TARGET-MIB.my (RFC 2573)
- SNMP-USM-MIB.my (RFC 2574)
- SNMP-VACM-MIB.my (RFC 2575)
- SNMPv2-MIB.my
- TCP-MIB.my
- UDP-MIB.my
- RIP SNMP MIB

Industry Standards

- Ethernet: IEEE 802.3 and 10BASE-T
- Fast Ethernet: IEEE 802.3u, 100BASE-TX, and 100BASE-FX
- Gigabit Ethernet: IEEE 802.3z and 802.3ab
- IEEE 802.3af Power over Ethernet (PoE)
- IEEE 802.1D Spanning Tree Protocol
- IEEE 802.1w rapid reconfiguration of spanning tree
- IEEE 802.1s multiple VLAN instances of Spanning Tree Protocol
- IEEE 802.3ad Link Aggregation Control Protocol (LACP)
- IEEE 802.1p class-of-service (CoS) prioritization
- IEEE 802.1Q VLAN
- IEEE 802.1x user authentication
- 1000BASE-X (GBIC)
- 1000BASE-X (SFP)
- 1000BASE-SX
- 1000BASE-LX/LH
- 1000BASE-ZX
- RMON I and II standards

Table 7. Supported Line Cards and Modules

Part Number (“=” indicates “spare”)	Product Name
WS-F4531	Catalyst 4500 NetFlow Services Card (Sup IV/V)
WS-X4248-FE-SFP(=)	Cisco Catalyst 4500 Fast Ethernet Switching Module, 48-port 100BASE-X (SFP)
WS-X4124-FX-MT(=)	Cisco Catalyst 4500 Fast Ethernet Switching Module, 24-port 100BASE-FX (MT-RJ)
WS-X4148-FX-MT(=)	Cisco Catalyst 4500 Fast Ethernet Switching Module, 48-port 100BASE-FX MMF
WS-X4148-FE-BD-LC(=)	Cisco Catalyst 4500 Series 48-port 100BASE-BX10-D Fast Ethernet Line Card for single strand of SMF
WS-X4124-RJ45(=)	Cisco Catalyst 4500 10/100 Module, 24 ports (RJ-45)
WS-X4148-RJ(=)	Cisco Catalyst 4500 10/100 Module, 48 ports (RJ-45)
WS-X4148-RJ21(=)	Cisco Catalyst 4500 10/100 Module, 48-port telco (4 x RJ-21)
WS-X4248-RJ21V(=)	Cisco Catalyst 4500 PoE IEEE 802.3af 10/100, 48 ports (RJ-21)
WS-X4224-RJ45V(=)	Cisco Catalyst 4500 PoE IEEE 802.3af 10/100, 24 ports (RJ-45)
WS-X4248-RJ45V(=)	Cisco Catalyst 4500 PoE IEEE 802.3af 10/100, 48 ports (RJ-45)
WS-X4506-GB-T(=)	Cisco Catalyst 4500 6-port 10/100/1000 RJ-45 PoE IEEE 802.3af and 1000BASE-X (SFP)
WS-X4302-GB(=)	Cisco Catalyst 4500 Gigabit Ethernet Module, 2 ports (GBIC)
WS-X4306-GB(=)	Cisco Catalyst 4500 Gigabit Ethernet Module, 6 ports (GBIC)
WS-X4418-GB(=)	Cisco Catalyst 4500 Gigabit Ethernet Module, server switching 18 ports (GBIC)
WS-X4448-GB-SFP(=)	Catalyst 4500 Gigabit Ethernet Module, 48-port 1000X (SFP)
WS-X4424-GB-RJ45(=)	Cisco Catalyst 4500 24-port 10/100/1000 Module (RJ-45)
WS-X4448-GB-RJ45(=)	Cisco Catalyst 4500 48-port 10/100/1000 Module (RJ-45)
WS-X4548-GB-RJ45(=)	Cisco Catalyst 4500 Enhanced 48-port 10/100/1000 Module (RJ-45)

WS-X4524-GB-RJ45V(=)	Cisco Catalyst 4500 PoE IEEE 802.3af 10/100/1000, 24 ports (RJ-45)
WS-X4548-GB-RJ45V(=)	Cisco Catalyst 4500 PoE IEEE 802.3af 10/100/1000, 48 ports (RJ-45)

Table 8. GBIC, SFP Options

Interface Type	Name	Max Distance	Cable Type	Part Number
1000BASE-T	Category 5 twisted pair	100m	Category 5	SFP: GLC-T GBIC: WS-G5483
1000BASE-SX	Short wavelength	550m	Multimode fiber (MMF)	SFP: GLC-SX-MM GBIC: WS-G5484
1000BASE-LX	Long wavelength/long haul	10 km on SMF 5 km on MMF	SMF	SFP: GLC-LH-SM GBIC: WS-G5486
1000BASE-ZX	Extended distance	70 km to 100 km	SMF	SFP: GLC-ZX-SM GBIC: WS-G5487
CWDM	Coarse wavelength-division multiplexing	100 km	SMF	SFP: CWDM-SFP-XXXX GBIC: CWDM-GBIC-XXXX
DWDM	Dense wavelength-division multiplexing	–	–	GBIC only

Indicator and Port Specifications

- System status: Green (operational); red (faulty)
- Switch usage load: 1- to 100-percent aggregate switching usage
- Console: RJ-45 female
- Reset (switch recess protected)
- Uplinks: Link and active
- Image management port: 10/100BASE-TX (RJ-45 female) data terminal equipment (DTE); green (good), orange (disabled), and off (not connected)

Software Requirements

The Cisco Catalyst 4500 Series Supervisor Engine IV is supported only in Cisco IOS Software and is not supported in the Cisco Catalyst OS Software. The minimum software versions are as follows:

- Supervisor engine IV: Cisco IOS Software Release 12.2(25)SG or later
- Supervisor engine IV with the NetFlow daughter card: Cisco IOS Software Release 12.2(25)SG

Environmental Conditions

- Operating temperature: 32 to 104°F (0 to 40°C)
- Storage temperature: –40 to 167°F (–40 to 75°C)
- Relative humidity: 10 to 90 percent, noncondensing
- Operating altitude: –60 to 2000m

Regulatory Standards Compliance

Table 9 gives standards compliance information for the Cisco Catalyst Supervisor Engine IV.

Table 9. Cisco Catalyst Supervisor Engine IV Regulatory Standards Compliance

Specification	Standard
Regulatory Compliance	CE marking
Safety	<ul style="list-style-type: none"> • UL 60950 • CAN/CSA-C22.2 No. 60950 • EN 60950 • IEC 60950 • TS 001 • AS/NZS 3260
EMC	<ul style="list-style-type: none"> • FCC Part 15 (CFR 47) Class A • ICES-003 Class A • EN55022 Class A • CISPR22 Class A • AS/NZS 3548 Class A • VCCI Class A • ETS 300 386 • EN 55022 • EN 55024 • EN 61000-6-1 • EN 50082-1 • EN 61000-3-2 • EN 61000-3-3
Industry EMC, Safety, and Environmental Standards	<ul style="list-style-type: none"> • GR-63-Core Network Equipment Building Systems (NEBS) Level 3 • GR-1089-Core Level 3 • ETS 300 019 Storage Class 1.1 • ETS 300 019 Transportation Class 2.3 (pending) • ETS 300 019 Stationary Use Class 3.1 • ETS 300 386

Ordering Information

New Cisco IOS Software Packaging for the Cisco Catalyst 4500 Series

Cisco announces a new Cisco IOS Software package for the Cisco Catalyst 4500 Series switches. This package creates a new foundation for features and functions, and provides consistency across all Cisco Catalyst switches. The new Cisco IOS Software release train is designated as 12.2SG.

Prior Cisco IOS Software images for the Cisco Catalyst 4500 Series, formally known as Basic L3 and Enhanced L3 images, now map to IP Base and Enterprise Services, respectively. BGP is now included in the Enterprise Services image. Unless otherwise specified, all currently shipping Cisco Catalyst 4500 software features based on Cisco IOS Software are supported in the Cisco IOS Software Release 12.2(25)SG, IP Base image with a few points to note:

- The IP Base image does not support the following routing-related features: BGP, EIGRP, OSPF, IS-IS, IPX, Apple Talk, VRF-lite, and PBR.
- The IP Base image supports EIGRP Stub for Layer 3 routing on all Cisco Catalyst 4500 Series Supervisor Engines. For more information about EIGRP Stub functions, visit: http://www.cisco.com/en/US/technologies/tk648/tk365/technologies_white_paper0900aecd8023df6f.shtml.

- The Enterprise Services image supports all Cisco Catalyst 4500 Series software features based on Cisco IOS Software, including enhanced routing. Customers planning to enable BGP on supervisor engine IV, V, or V-10GE models no longer need to purchase a separate BGP license (FR-IRC4); BGP capability is included in the Enterprises Services package.

Table 10 gives ordering information for the Cisco Catalyst 4500 Series Supervisor Engine IV.

Table 10. Cisco Catalyst 4500 Series Supervisor Engine IV Ordering Information

Product Number	Description
WS-X4515(=)	Cisco Catalyst 4500 Supervisor Engine IV, 2 GE, Console RJ-45
WS-X4515/2	Cisco Catalyst 4507R Redundant Supervisor Engine IV, 2 GE, Console RJ-45
WS-F4531(=)	Cisco Catalyst 4500 NetFlow Services Card
S45IPB-12231SG	Cisco IOS Software for the Cisco Catalyst 4500 Series (IP Base image with EIGRP-stub support)
S45IPBK9-12231SG	Cisco IOS Software for the Cisco Catalyst 4500 Series (IP Base image with Triple Data Encryption Standard [3DES] and EIGRP-stub support)
S45ES-12231SG	Cisco IOS Software for the Cisco Catalyst 4500 Series Supervisor Engines IV, V, and V-10GE (Enterprise Services image with BGP support)
S45ESK9-12231SG	Cisco IOS Software for the Cisco Catalyst 4500 Series Supervisor Engines IV, V, and V-10GE (Enterprise Services image with 3DES and BGP support)
MEM-C4K-FLD64M	Cat 4500 IOS-based Supervisor, Compact Flash memory, 64-MB option
MEM-C4K-FLD128M	Cat 4500 IOS-based Supervisor, Compact Flash memory, 128-MB option

Warranty

Cisco Catalyst 4500 E-Series and Catalyst 4500 switches are covered by the Cisco Limited Lifetime Hardware Warranty. For more information, see this document on Cisco.com:

http://www.cisco.com/en/US/docs/general/warranty/English/LH2DEN_.html.

Note: If you purchased the Cisco Catalyst 4500 Series Supervisor Engine IV before May 1, 2009, it is covered by the Cisco 90-Day Limited Hardware Warranty. For more information, see this document on Cisco.com:

http://www.cisco.com/en/US/docs/general/warranty/English/901DEN_.html.

Cisco Technical Support Services

Cisco Technical Support Services help ensure that your Cisco products operate efficiently, remain highly available, and benefit from current system software to assist you in effectively managing your network service while controlling operational costs.

Cisco Technical Support Services provide significant benefits that go beyond what is offered under the Cisco warranty policy.

Services available under a Cisco SMARTnet service contract that are not covered under a warranty include the following:

- Latest software updates
- Rapid replacement of hardware in next day, 4-hour, or 2-hour dispatch options
- Ongoing technical support through Cisco Technical Assistance Center (TAC)
- Registered access to <http://www.cisco.com>

Tables 11 and 12 provide more information about Cisco Technical Support Services.

Table 11. Benefits of Cisco Technical Support Services

Service Feature Overview	Benefit
Software support	<p>Cisco Technical Support Services offers maintenance and minor and major updates for licensed feature sets. Downloading new maintenance releases, patches, or updates of Cisco IOS Software helps enhance and extend the useful life of Cisco devices. Through major software updates you can extend the life of equipment and maximize application technology investments by:</p> <ul style="list-style-type: none"> • Adding new functions; in many cases, additions require no additional hardware investment • Increasing the performance of current functions • Enhancing network or application availability, reliability, and stability
Cisco TAC support	<p>With more than 1000 highly trained customer support engineers, 390 CCIE[®] experts, and access to 13,000 R&D engineers, Cisco TAC complements your in-house staff with a high level of knowledge in voice, video, and data communications networking technology. Its sophisticated call routing system quickly routes calls to the correct technology personnel. The Cisco TAC is available 24 hours a day, 365 days a year.</p>
Cisco.com	<p>This award-winning Website provides 24-hour access to an extensive collection of online product and technology information, interactive network management and troubleshooting tools, and knowledge transfer resources that can help you reduce costs by increasing the self-sufficiency and productivity of your staff.</p>
Advance Hardware Replacement	<p>Advance Replacement and onsite field engineer options supply fast access to replacement hardware and field resources for installing hardware, minimizing the risk of potential network downtime.</p>

Table 12. Competitive Differentiators of Cisco Technical Support Services

Feature	Benefit
Worldwide virtual lab	<p>This extensive lab of Cisco equipment and Cisco IOS Software releases provides an invaluable engineering resource and knowledge base for training, product information, and recreation and testing of selected network problems to help decrease time to resolution.</p>
TAC training: <ul style="list-style-type: none"> • Boot camps • Tech calls • Tech forums 	<p>Cisco is committed to providing customers the latest in technology support. These TAC training programs assist customers in case avoidance as well as providing knowledge transfer of Cisco networking expertise.</p>
Cisco Live	<p>A powerful suite of Internet-enabled tools with firewall-friendly features, these secure, encrypted Java applets can turn a simple phone call into an interactive collaboration session, allowing a customer and Cisco TAC support engineer to work together more effectively.</p>
Global logistics	<p>Global logistics delivers award-winning, worldwide hardware replacement support with 650 depots, covering 120 countries, at a \$2.3 billion investment in inventory, taking full advantage of 10,000 onsite field engineers.</p>
Cisco IOS Software	<p>Cisco IOS Software employs 100 discrete technologies with more than 2000 features; 400 new features are added each year. Cisco IOS Software is installed in more than 10 million devices and is running on more than 10,000 networks worldwide. It operates on the world's largest IPv6 and VoIP networks and in all major service provider networks worldwide.</p>

For More Information

To learn more about how you can take advantage of Cisco Technical Support Services, talk to your local Cisco account representative or visit Cisco Technical Support Services at:

http://www.cisco.com/en/US/products/svcs/ps3034/ps2827/serv_category_home.html.

For additional information about the Cisco Catalyst 4500, visit:

<http://www.cisco.com/go/catalyst4500>.

For additional information about Cisco products, contact:

- United States and Canada: 800 553-NETS (6387)
- Europe: 32 2 778 4242
- Australia: 612 9935 4107
- Other: 408 526-7209
- <http://www.cisco.com>



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