Cisco Catalyst 4500 Series Supervisor Engine V

High-Density Enterprise Wiring Closet, Supervisor Engine

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

Figure 1.   Cisco Catalyst 4500 Series Supervisor Engine V

Overview

The Cisco Catalyst 4500 Series Supervisor Engine V continues the nonblocking, robust Layer 2–4 switching found in previous Cisco Catalyst 4500 Series Supervisor Engines. Additional performance, features, and throughput further enhance resilient control of converged data, voice, and video networks, with high availability enabling business resiliency for enterprise and metropolitan (metro) Ethernet customers. Network control extends from the backbone to the edge, with intelligent services such as granular quality of service (QoS), Internet security, and network management. The 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 while enabling services such as QoS and security. This helps meet today's network requirements, with ample room for future growth.

The Cisco Catalyst 4500 Series Supervisor Engine V offers port scalability for resilient Layer 2–4 and routing for both the enterprise and service provider market segments. Optimized for the enterprise wiring closet, branch office backbone, or Layer 3 distribution point, the Cisco Catalyst 4500 Series Supervisor Engine V provides the performance and scalability to handle the network applications of today and the future.

The Cisco Catalyst 4500 Series modular architecture provides a "pay as you grow" model, reducing operational expenses and capital expenditures. The Supervisor Engine V is backward-compatible with all the classic Cisco Catalyst 4500 Series line cards and can be used in both the classic Cisco Catalyst 4500 Series chassis (Cisco Catalyst 4503, Cisco Catalyst 4506, Cisco Catalyst 4507R, and Cisco Catalyst 4510R) and with the Cisco Catalyst 4500 E-Series chassis (Cisco Catalyst 4503-E, 4506-E, 4507R-E, 4507R+E, 4510R-E, and 4510R+E).

Chassis and Line Card Support

The Cisco Catalyst 4500 Series Supervisor Engine V can be deployed in single-chassis, nonredundant mode in the Cisco Catalyst 4503/4503-E and Cisco Catalyst 4506/4506-E chassis, or in redundant mode as an option in the Cisco Catalyst 4507R (slots 1 and 2)/4507R-E/4507R+E (slots 3 and 4) and Cisco Catalyst 4510R (slots 1 and 2)/4510R-E/4510R+E (slots 5 and 6) chassis. Table 1 shows the performance of the Supervisor Engine V for each chassis.

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

	Cisco Catalyst 4503/4503-E Chassis	Cisco Catalyst 4506/4506-E Chassis	Cisco Catalyst 4507R/4507R-E/4507R+E Chassis	Cisco Catalyst 4510R/4510R-E/4510R+E Chassis
Supervisor Engine V (WS-X4516)	Supported 28 Gbps, 21 mpps	Supported 64 Gbps, 48 mpps	Supported 68 Gbps, 51 mpps	Supported 96 Gbps 72 mpps*

* When the Supervisor Engine V is used in the Cisco Catalyst 4510R chassis, slot 10 (FlexSlot) will support a subset of line cards: the 2-port GBIC (WS-X43 02-GB) and Access Gateway Module (WS-X4604-GWY). Future Supervisor Engines will allow slot 10 to accommodate any and all line cards.

Predictable Performance and Scalability

The Cisco Catalyst 4500 Series Supervisor Engine V delivers a 96-Gbps switching fabric with a 72-mpps forwarding rate in hardware for Layer 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. Performance and Scalability Features of the Cisco Catalyst 4500 Series Enhanced Layer 3 Supervisor Engines

Feature and Description	Supervisor Engine IV	Supervisor Engine V	Supervisor Engine V-10GE	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	N/A*	N/A*	N/A*	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 via Bootflash (128 MB)	No via Bootflash (64 MB)
Security/QoS entries	64,000	64,000	64,000	128,000
NAC/DHCP snooping entries	3000/3000	3000/3000	6000/6000	6000
Mac addresses	32,000	32,000	55,000	55,000
Active VLANs	4000	4000	4000	4000
STP instance	3000	3000	3000	3000
Switched Virtual Interfaces (SVIS)	4000	4000	4000	4000
SPAN	2 ingress and 4 egress	2 ingress and 4 egress	2 ingress and 4 egress	8 ingress and 8 egress-future SW release

Feature and Description	Supervisor Engine IV	Supervisor Engine V	Supervisor Engine V-10GE	Supervisor Engine 6-E
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. The Supervisor Engine V supports Protocol Independent Multicast (PIM), Source-Specific Multicast (SSM), and Pragmatic General Multicast (PGM), providing end users with additional scalability to support multimedia applications. Also supported is 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 V Redundancy for Business Resiliency

The Cisco Catalyst 4500 Series was designed to maximize desktop user uptime, with noninterrupted hardware switching. The Cisco Catalyst 4507R, 4507R-E, 4507R+E, 4510R, 4510R-E, and 4510R+E support 1+1 supervisor redundancy, using the Supervisor Engine V. The primary supervisor is active and is responsible for normal system operation. The other supervisor serves as a secondary 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 customers 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 enables 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. They are essential for business-critical applications such as voice over IP (VoIP). As a result, VoIP calls are not dropped.

The redundancy scheme using the Supervisor Engine V is similar to that for the Supervisor Engine IV. Alerts are generated to the network monitoring software if either supervisor fails, and hot swapping of supervisors is supported without disrupting system operation. Switchover of supervisors can be forced by software, or by the user via Simple Network Management Protocol (SNMP). The resiliency features of the Cisco Catalyst 4500 Series prevent network outages that could result in lost business and revenue.

Table 3 shows the high availability and uplink options for all of the Cisco Catalyst 4500 Series Enhanced Layer 3 Supervisor Engines.

Table 3. High Availability and Uplink Options on the Cisco Catalyst 4500 Series Enhanced Layer 3 Supervisor Engines

Feature and Description	Supervisor Engine IV	Supervisor Engine V	Supervisor Engine V-10GE	Supervisor Engine 6-E
Redundant capable	Yes Cisco Catalyst 4507R Cisco Catalyst 4507R-E Cisco Catalyst 4507R+E	Yes Cisco Catalyst 4507R Cisco Catalyst 4507R-E Cisco Catalyst 4507R+E Cisco Catalyst 4510R Cisco Catalyst 4510R-E Cisco Catalyst 4510R+E	Yes Cisco Catalyst 4507R Cisco Catalyst 4507R-E Cisco Catalyst 4507R+E Cisco Catalyst 4510R Cisco Catalyst 4510R-E Cisco Catalyst 4510R+E	Yes Cisco Catalyst 4507R Cisco Catalyst 4507R-E Cisco Catalyst 4507R+E Cisco Catalyst 4510R Cisco Catalyst 4510R-E Cisco Catalyst 4510R+E

Feature and Description	Supervisor Engine IV	Supervisor Engine V	Supervisor Engine V-10GE	Supervisor Engine 6-E
Active supervisor uplinks in redundant mode	2 Gigabit Ethernet	Up to 4 Gigabit Ethernet	Up to 4 Gigabit Ethernet and 2 10 Gigabit Ethernet1	2 10 Gigabit (wire speed) Up to 4 10 Gigabit (2:1 oversubscribed) Up to 8 Gigabit Ethernet (TwinGig Converter)
Active Supervisor Engine uplinks (nonredundant mode)	2 Gigabit Ethernet	2 Gigabit Ethernet	4 Gigabit Ethernet and 2 10 Gigabit Ethernet*	2 10 Gigabit Ethernet or 1 10 Gigabit and 2 Gigabit Ethernet (TwinGig Converter) or 4 Gigabit Ethernet (TwinGig Converter)
TwinGig Converter support	No	No	No	Yes
Uplink optic types	GBIC	GBIC	SFP (Gigabit Ethernet) or X2 optics (10 Gigabit Ethernet ports)	SFP (Gigabit Ethernet) with TwinGig Converter or X2 optics (10 Gigabit Ethernet ports)
SSO/NSF/ISSU	Yes	Yes	Yes	Yes**

* Simultaneous use of Gigabit 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 "Features at a Glance" section of this data sheet for a complete list of supported features.

IPv6 Support

IPv6 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.

Intelligent Network Services with QoS and Sophisticated Traffic Management

The Cisco Catalyst 4500 Series Supervisor Engine V offers superior per-port QoS features, ensuring that network traffic is classified, prioritized, and scheduled optimally to efficiently handle bandwidth-hungry multimedia, time-sensitive (voice), and mission-critical applications. The Supervisor Engine V can classify, police, and mark incoming packets, allowing the administrator to differentiate between traffic flows and to enforce policies. Sharing, shaping, and strict priority configurations determine the scheduling of egress traffic. The Supervisor Engine V also supports Dynamic Buffer Limiting (DBL), a congestion avoidance feature. For details on the QoS features (including DBL) on the Supervisor Engine V, refer to the white paper "Quality of Service on Cisco Catalyst 4500 Series Supervisor Engines" at: http://www.cisco.com/en/US/products/hw/switches/ps4324/prod_white_papers_list.html.

Table 4 summarizes the QoS features of the Cisco Catalyst 4500 Series Enhanced Layer 3 Supervisor Engines.

Table 4.   QoS Feature Summary for the Cisco Catalyst 4500 Series Enhanced Layer 3 Supervisor Engines

Feature and Description	Supervisor Engine IV	Supervisor Engine V	Supervisor Engine V-10GE	Supervisor Engine 6-E
QoS HW 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 on-board NetFlow	Yes: 2 rate 3 color
Number of Tx queues	4	4	4	Flex queues up to 8*

Feature and Description	Supervisor Engine IV	Supervisor Engine V	Supervisor Engine V-10GE	Supervisor Engine 6-E
Max 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. See 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 compliant	No	No	No	Yes
Dynamic Buffer Limiting (DBL)	Yes	Yes	Yes	Yes
QoS sharing	Supported 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 "Features at a Glance" section of this data sheet for a list of supported features.

Comprehensive Management

The Cisco Catalyst 4500 Series Supervisor Engine V features a single console port and a single IP address to manage all features of the system. Remote in-band management is available via SNMP, Telnet client, Bootstrap Protocol (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. SmartPorts Macro is a Cisco Catalyst solution that is also supported, simplifying the configuration of the critical features for the Ethernet networks.

The Cisco Catalyst 4500 Series Supervisor Engine V 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, virtual LAN (VLAN), traffic, and policy management. The LAN management solution 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 summarizes the management features of the Cisco Catalyst 4500 Series Enhanced Layer 3 Supervisor Engines.

Table 5.   Management Feature Highlights of the Cisco Catalyst 4500 Series Enhanced Layer 3 Supervisor Engines

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 SW release
Compact Flash support	Yes; 64 MB or 128 MB options	Yes; 64 MB or 128 MB options	Yes; 64 MB or 128 MB options	Yes; 64 MB or 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 SW release

Please refer to the "Features at a Glance" section of this data sheet for a complete list of supported features.

Advanced Security

The Cisco Catalyst 4500 Series offers a rich set of integrated security features to proactively lock down your critical network infrastructure. It reduces network security risks with a rich set of Network Admission Control (NAC) capabilities and 802.1x-based user authentication, authorization, and accounting (AAA). The security policy enforcement is uncompromised, with 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) Protocol Version 1 and Version 2, Secure Copy Protocol (SCP), and SNMPv3, respectively.

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

NAC performs posture validation at the Layer 2 network edge for hosts with or without 802.1x enabled. Vulnerable and noncompliant hosts can be isolated, given reduced network access, or directed to remediation servers based on organizational policy. By ensuring that every host complies with security policy, organizations 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 summarizes the security features of the Cisco Catalyst 4500 Series Enhanced Layer 3 Supervisor Engines.

Table 6.   Security Feature Highlights of the Cisco Catalyst 4500 Series Enhanced Layer 3 Supervisor Engines

| 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
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, DHCP snooping	Yes	Yes	Yes	Yes
NAC	Yes	Yes	Yes	Yes*

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

Please refer to the "Features at a Glance" section of this data sheet for a complete list of supported features.

Cisco Catalyst 4500 Netflow Services Card for Supervisor Engine V

The Cisco Catalyst 4500 NetFlow Services Card (Figure 2) is an optional daughter card for the Cisco Catalyst 4500 Series Supervisor Engine IV or V, providing Layer 3 and 4 statistics and enhanced VLAN statistics without affecting the forwarding performance rates.

Figure 2.   Cisco Catalyst 4500 NetFlow Services Card
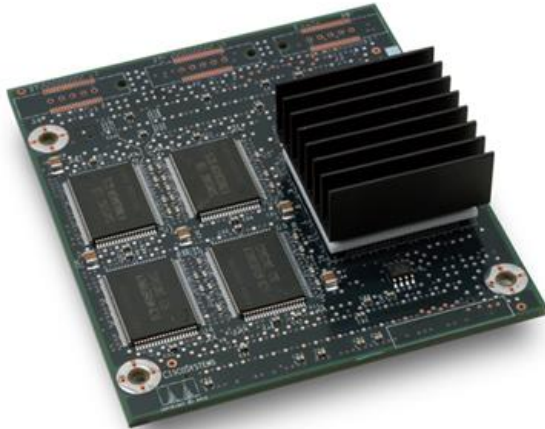
NetFlow Services Card Product Description

NetFlow is a versatile feature allowing customers to monitor traffic flows for the purpose of billing, network planning, and security. The NetFlow Services Card supports per-packet statistics capture in hardware for flow-based 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 with regard to specific flows, including details such as IP addresses, packet and byte counts, time stamps, and application ports. This data can then be exported, collected, and analyzed for numerous purposes, such as virus and denial-of-service mitigation.

NetFlow Services Card Applications

NetFlow technology efficiently provides the metering base for critical applications, including distributed denial-of-service (DDoS) detection and mitigation, network traffic accounting, usage-based network billing, network planning, network monitoring, and data mining capabilities for both service provider and enterprise customers. NetFlow is enabled without compromising hardware forwarding performance.

Enterprise and service provider customers are particularly finding the use of NetFlow to be a critical component in defending the network from security attacks. NetFlow export data is gathered for signature analysis and traffic profiling. Anomalies are flagged and mitigated at the prompting of the user. The Cisco Catalyst 4500 Series security toolkit was design to prevent malicious attackers from bringing down the network.

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 Service Card Features

With Cisco IOS Software Release 12.2(25)SG, the Cisco Catalyst 4500 Series Supervisor Engine V 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 versions 1, 5, and 8 are supported in Cisco IOS Software Release 12.2(25)SG.

The default is NetFlow Statistics Collection and NetFlow Data Export versions 1 and 5. The supported fields within NetFlow Data Export version 5 with Cisco IOS Software Release 12.2(25)SG are identified below:

- Source and destination IP address (hardware)
- IP protocol (hardware)

- Layer 4 source and destination ports (for TCP/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/destination autonomous system number (software)

- Source/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 on the Supervisor Engine IV and V with Cisco IOS Software and is not supported in the Cisco CatOS Software.

Software Requirements

The minimum software versions for the Netflow Services Card with Supervisor Engine V are as follows:

- Cisco IOS Software Release 12.2(25)SG or later

- NetFlow Collection and Network Data Analyzer requirements:

- Cisco CNS NetFlow Collection Engine Version 3.5 or higher

- Cisco Network Data Analyzer Version 3.6 or higher

- Hardware Requirements

- Cisco 4500 Series Supervisor Engine IV or V

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

The NetFlow Services Card can be shipped preinstalled with a Supervisor Engine IV or V from the factory or as a separate, field-replaceable unit. The Supervisor Engine V must be removed from the chassis to install the NetFlow Services Module; it is not hot-swappable.

Table 7 summaries additional NetFlow features for the Cisco 4500 Series Supervisor Engine IV and V.

Table 7.   Additional NetFlow Feature Comparison

NetFlow Features	Supervisor Engine IV/V	Supervisor Engine V-10GE
Daughter card	Required	Not required (integrated into supervisor)
Flow-table size	64,000	85,000
Aggregate policers	1000 ingress; 1000 egress	8000 ingress; 8000 egress
User-based rate-limiting profiles	Not supported	512
User-based rate-limiting flows	Not supported	85,000

Features at a Glance

Layer 2 Features

- Layer 2 hardware forwarding at 72 mpps
- Layer 2 switch ports and VLAN trunks
- IEEE 802.1Q VLAN encapsulation
- Inter-Switch Link (ISL) VLAN encapsulation (excluding blocking ports on WS-X4418-GB)
- 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 PortFast and PortFast guard
- Spanning-tree UplinkFast and BackboneFast
- 802.1s
- 802.1w
- 802.3ad
- Spanning-Tree Protocol root guard
- Cisco Discovery Protocol
- IGMP snooping v1, v2, and v3
- Cisco EtherChannel® technology, Fast EtherChannel, and 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 in hardware
- Layer 2 protocol tunneling
- Jumbo Frames (up to 9216 bytes)
- Baby Giants (up to 1600 bytes)
- Unidirectional Ethernet
- Stateful Switchover (SSO) in subsecond failover time
- Storm control (formally known as broadcast and multicast 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 protocol tunneling over trunk port
- CoS mutation
- Per-VLAN control traffic intercept

Layer 3 Features

- Hardware-based IP Cisco Express Forwarding routing at 72 mpps
- IP routing protocols: Enhanced Interior Gateway Routing Protocol (EIGRP), Open Shortest Path First (OSPF), Routing Information Protocol (RIP), RIP2
- Border Gateway Protocol Version 4 (BGP4) and Multicast Border Gateway Protocol (MBGP)
- BGP Route-Map Continue Support for Outbound Policy
- 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, Distance Vector Multicast Routing Protocol [DVMRP])
- Pragmatic General Multicast (PGM)
- Cisco Group Management Protocol (CGMP) server
- Full Internet Control Message Protocol (ICMP) support
- ICMP Router Discovery Protocol
- Policy-Based Routing (PBR)
- Virtual Route Forwarding-lite (VRF-lite)
- EIGRP stub
- Dynamic Host Configuration Protocol (DHCP) server
- DHCP option 82 with Circuit ID and Remote ID suboptions
- IP unnumbered for switch virtual interface (SVI)
- SVI Autostate Exclude
- Multicast Source Discovery Protocol (MSDP)
- Auto RP Listener (Multicast)

Sophisticated QoS and Traffic Management

- Per-port QoS configuration
- Support for four queues per port
- Strict priority queuing
- IP differentiated services code point (DSCP)
- 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 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 (Dynamic Buffer Limiting) congestion-avoidance feature
- No performance penalty for granular QoS functions
- Auto-QoS command-line interface (CLI) for voice-over-IP (VoIP) deployments
- Per-port, per-VLAN QoS
- Selective DBL

Predictable Performance

- 96-Gbps switching fabric

- Layer 2 hardware forwarding at 72 mpps

- Layer 3 hardware-based IP Cisco Express Forwarding routing at 72 mpps

- Layer 4 TCP/UDP hardware-based filtering at 72 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), VLAN ACLs

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

- SNMP v1, 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 (Switched Port 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 SmartPorts Macro

- 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

- Terminal Access Controller Access Control System (TACACS+) and Remote Authentication Dial-In User Service (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, 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 L2 802.1x
- NAC L2 IP
- Trusted boundary
- Router ACLs (RACLs) on all ports (no performance penalty)
- VLAN ACLs (VACLs)
- Port ACLs (PACLs)
- Private VLANs (PVLANs) on access and trunk ports
- DHCP snooping
- DHCP Option 82
- DHCP Option 82 insertion
- DHCP Option 82 Pass Through
- Port security
- Sticky port security
- SSH v1 and v2
- 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
- Secure Copy Protocol (SCP)
- EtherChannel trunk port security

- IP source guard for static hosts
- 802.1x multidomain authentication

High Availability

- Nonstop Forwarding with Stateful Switchover (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 SPF and link-state advertisement (LSA) throttling
- Cisco Generic Online Diagnostics (GOLD)
- VSS client

IPv6 (Software-Based Forwarding)

- Packets are forwarded in software
- Support for IPv6 addressing
- Cisco Discovery Protocol for IPv6
- DNS resolver for AAA over an IPv6 and IPv4 transport
- Extended ACL
- ICMP rate limiting
- ICMP v6
- ICMP v6 redirect
- IP MIB
- IPv6 over IEEE 802.1Q
- IPv6 over IPv4 generic routing encapsulation (GRE) tunnel
- Intra-site Automatic Tunnel Addressing Protocol (ISATAP)
- Loopback
- Multicast Listener Discovery (MLD) v1 and v2
- Maximum transmission unit (MTU) path discovery
- Multicast in IPv6 tunnel
- OSPF v3
- Ping
- Router alert option
- SSH over an IPv6 Transport
- Stateless autoconfiguration
- Static routes within IPv6
- AAA
- Telnet

- TFTP
- Traceroute
- Duplicate address detection
- Standard Access Control List (ACL)
- Tunnels in software
- Hop-by-hop option header, done in software
- RIP next gen for IPv6
- PIM v6 (Sparse Mode)

Technical Specifications

Management

- CiscoWorks LAN Management Solution (LMS), including CiscoWorks Resource Manager Essentials
- CiscoView
- Cisco Network Assistant
- BGP4-MIB.my
- BRIDGE-MIB.my* (RFC 1493)
- 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-RIP SAP-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, 10BASE-T
- Fast Ethernet: IEEE 802.3u, 100BASE-TX, 100BASE-FX
- Gigabit Ethernet: IEEE 802.3z, 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
- 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 (Small Form-Factor Pluggable [SFP])
- 1000BASE-SX
- 1000BASE-LX/LH
- 1000BASE-ZX
- RMON I and II standards

Table 8 shows supported line cards and modules, and Table 9 shows GBIC and SFP options.

Table 8.   Supported Line Cards and Modules

Part Number ("=" indicates "spare")	Product Name
WS-F4531	Cisco 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)

Part Number ("=" indicates "spare")	Product Name
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(=)	Cisco 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 9.   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 utilization load: 1 to 100 percent aggregate switching usage
- Console: RJ-45 female
- Reset (switch recessed protected)
- Uplinks: link and active
- Image management port: 10/100BASE-TX (RJ-45 female) data terminal equipment (DTE); green (good), orange (disabled), off (not connected)

Software Requirements

- The Cisco Catalyst 4500 Series Supervisor Engine V is supported only in Cisco IOS Software and is not supported in the Cisco CatOS Software. The minimum software versions are as follows:
- Supervisor Engine V, Cisco IOS Software Release 12.2(25)SG or later
- Supervisor Engine V with the NetFlow daughter card, Cisco IOS Software Release 12.2(25)SG

Environmental Conditions

- Operating temperature: 32º to 104ºF (0º to 40ºC)
- Storage temperature: -40º to 167ºF (-40º to 75ºC)
- Relative humidity: 10 to 90 percent, noncondensing

- Operating altitude: -60 to 2000m
- Regulatory Standards Compliance

Table 10 shows standards compliance information.

Table 10. Cisco Catalyst Supervisor Engine V Regulatory Standards Compliance

Specification	Standard
Regulatory Compliance	CE marking
Safety	- UL 60950 - CAN/CSA-C22.2 No. 60950 - EN 60950 - IEC 60950 - TS 001 - AS/NZS 3260
EMC	- 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	- 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

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 functionality, 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. Border Gateway Protocol (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 12.2(25)SG, IP Base image, with a few points to note:

The IP Base image will not support the following routing-related features: BGP, EIGRP, OSPF, IS-IS, IPX, AppleTalk, Virtual Route Forwarding-lite (VRF]-lite), and Policy-Based Routing (PBR).

The IP Base image will support EIGRP-Stub for Layer 3 routing on all Cisco Catalyst 4500 Series Supervisor Engines. For more information on EIGRP-Stub functionality, go to:
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 Engines IV, V, or V-10GE no longer need to purchase a separate BGP license (FR-IRC4); BGP capability is included in the Enterprises Services package.

Table 11 shows ordering information.

Table 11. Ordering Information

Product Number	Description
WS-X4516(=)	Cisco Catalyst 4500 Series Supervisor Engine V, 2 GE, Console RJ-45
WS-X4516/2	Cisco Catalyst 4500 Series Redundant Supervisor Engine V, (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	Cisco Catalyst 4500 Cisco IOS Software based Supervisor, compact Flash memory, 64-MB option
MEM-C4K-FLD128M	Cisco Catalyst 4500 Cisco IOS Software based Supervisor, compact Flash memory, 128-MB option

Warranty

Cisco Catalyst 4500 E-Series and Cisco 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 V 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—Extending Network Intelligence that Protects Your Network Investment. Now.

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 are:

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

Tables 12 and 13 describe the features of Cisco Technical Support Services.

Table 12. Cisco Technical Support Services—Components

Service Feature Overview	Benefit or Advantage
Software Support	Offers maintenance and minor and major updates for licensed feature set. Downloading new maintenance releases, patches, or updates of Cisco IOS Software helps to enhance and extend the useful life of Cisco devices. Through major software updates it is possible to extend the life of equipment and maximize application technology investments by: • Adding new functionality that, in many cases, requires no additional hardware investment • Increasing the performance of current functionality • Enhancing network and/or application availability, reliability, and stability
TAC Support	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.
Cisco.com	This award-winning Web site provides 24 x 7 access to an extensive collection of online product and technology information, interactive network management and troubleshooting tools, and knowledge transfer resources that can help customers reduce costs by increasing staff self-sufficiency and productivity.
Advance Hardware Replacement	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.

Table 13. Cisco Technical Support Services—Competitive Differentiators

Feature	Benefit or Advantage
Worldwide Virtual Lab	This extensive lab of Cisco equipment and Cisco IOS Software versions provides an invaluable engineering resource and knowledge base for training, product information, and recreation and testing of selected network issues to help decrease time-to-resolution.
TAC Training • Boot Camps • Tech Calls • Tech Forums	Cisco is committed to providing customers the latest in technology support. These TAC training programs assist customers in case avoidance as well as provide knowledge transfer of Cisco networking expertise.
Cisco Live	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.
Global Logistics	Delivers award-winning, worldwide hardware replacement support with 650 depots, covering 120 countries, at a $2.3 billion investment in inventory, and comprising 10,000 onsite field engineers.
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.

For More Information

To learn more about how you can take advantage of Cisco Technical Support Services, talk to your Cisco 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 on the Cisco Catalyst 4500 Series, 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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