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Cisco Catalyst 4500 Supervisor Engine 6-E with CenterFlex Technology: Secure, Flexible, Nonstop Communications

Overview

The Cisco® Catalyst® 4500 Supervisor Engine 6-E with CenterFlex technology is an intelligent, high-performance, next-generation extension to the Cisco Catalyst 4500 Series optimized for customers deploying business-critical applications (Figure 1). Cisco developed application-specific integrated circuits (ASICs) specific to the Supervisor Engine 6-E that enable CenterFlex technology and deliver industry-leading centralized performance and configuration flexibility. CenterFlex technology enables granular optimization of real-time voice, video, and data communications to help ensure workforce productivity and profitability and customer success for organizations of all sizes.

Figure 1. Cisco Catalyst 4500 Supervisor Engine 6-E



Cisco Catalyst 4500 Supervisor Engine 6-E with CenterFlex Technology Feature Highlights

Centralized

- Centralized 320-Gbps switching capacity with 250 Mpps of throughput
- IPv6 support in hardware, providing wire-rate forwarding for IPv6 networks
- Dual 10 Gigabit Ethernet uplinks (X2 optics)
- Hardware forwarding entries: 256,000
- Quality-of-service (QoS) services hardware entries: 64,000
- Security services entries: 64,000
- Low latency

Flexible

- Flexibility to operate at 6 or 24 Gbps per line-card slot
- Ability to mix and match 6-Gbps classic and 24-Gbps E-Series line cards, with no performance degradation
- Twin gigabit converter modules that enable flexibility for up to 4 Gigabit Ethernet (Small Form-Factor Pluggable [SFP]) uplinks in the X2 optic slots
- Dynamic hardware forwarding table allocations for ease of IPv4-to-IPv6 migration

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- Advanced QoS support with up to 8 queues per port, dynamic queue sizing, and hierarchical policing to provide flexibility and control
- Enhanced security with Unicast Reverse Path Forwarding (URPF) for added protection against network spoofing attacks
- File allocation table (FAT)-based file system for easier network administration

The Cisco Catalyst 4500 Supervisor Engine 6-E is compatible with classic Cisco Catalyst 4500 line cards, chassis, and power supplies, providing full investment protection. The Supervisor Engine 6-E delivers 24 Gbps per slot of switching capacity when deployed with the E-Series line cards in a Cisco Catalyst 4500 E-Series chassis. You can mix and match classic line cards and E-Series line cards within a Cisco Catalyst 4500 E-Series chassis with no performance degradation. When you deploy the Cisco Catalyst Supervisor Engine 6-E with classic line cards, all of the new features except the 24-Gbps per-slot switching capacity are inherited.

The Cisco Catalyst Supervisor Engine 6-E also provides flexibility and an easy migration path to 10 Gigabit Ethernet uplinks with dual-purpose X2 slots that can accommodate wire-speed 10 Gigabit Ethernet optics or Cisco Twin Gigabit Converter modules (Figure 2), enabling Gigabit Ethernet SFP optics.

The Cisco Twin Gigabit Converter Module, which ships standard with the Supervisor Engine 6-E (unless you order 10 Gigabit Ethernet optics on the configuration tool), converts a single 10 Gigabit Ethernet X2 interface into two Gigabit Ethernet port slots that can be populated with appropriate SFP optics, providing a total of 4 Gigabit Ethernet uplinks if used in both X2 interface slots. With the flexibility offered by the Cisco Twin Gigabit Converter Module, you can initially use the gigabit uplinks and then, as your business demands change, you can simply remove the Cisco Twin Gigabit Converter Module and insert 10 Gigabit Ethernet X2 optics to provide full line-rate 10 Gigabit Ethernet uplinks without having to upgrade. The ability to support both Gigabit Ethernet uplinks and 10 Gigabit Ethernet uplinks on a single supervisor engine further demonstrates the flexibility and the investment protection of the Cisco Catalyst 4500 Series.

Figure 2. Cisco Twin Gigabit Converter Module: Converting 10 Gigabit Ethernet X2 Interface Into Two Gigabit Ethernet SFP Interfaces



The increased capabilities and investment protection provided by the Supervisor Engine 6-E and CenterFlex technology facilitates not only scalability for today's network requirements but also investment protection by providing significant hardware resources for future growth.

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Predictable Performance and Scalability

The Supervisor Engine 6-E provides a fourfold increase in per-slot switching capacity from previous-generation Cisco Catalyst 4500 supervisor engines: from 6 to 24 Gbps per slot. Table 1 highlights the performance and scalability enhancements of the Cisco Catalyst 4500 Supervisor Engine 6-E.

Table 1. Cisco Catalyst 4500 Supervisor Engine 6-E Performance and Scalability Features

Feature and Description	Supervisor Engine 6-E
Centralized switching capacity	320 Gbps
Per-slot switching capacity	24 Gbps
Throughput	250 Mpps for IPv4 125 Mpps for IPv6 250 Mpps for L2 Bridging
IPv4 Routing entries	256,000
IPv6 Routing entries	128,000
Multicast routes	32,000
CPU	1.3 GHz
CPU queues	64
Synchronous Dynamic RAM (SDRAM)	512 MB upgradable to 1 GB
Nonvolatile RAM (NVRAM)	No through Boot flash (64 MB)
Security and QoS hardware entries	128,000
Cisco Network Admission Control (NAC) and Dynamic Host Configuration Protocol (DHCP) Snooping entries	12,000
MAC addresses	55,000
Active VLANs	4096
Spanning Tree Protocol instances	10,000
Switched virtual interfaces (SVIs)	4096
Switched Port Analyzer (SPAN)	Maximum of 8 sessions: ingress and or egress

The Supervisor Engine 6-E is also optimized for multimedia applications with its advanced multicast support offered by features such as Protocol Independent Multicast (PIM) and Source-Specific Multicast (SSM), giving your network additional scalability to support multimedia applications.

Chassis and Line-Card Support

Already-installed Cisco Catalyst 4500 chassis with classic line cards can take advantage of the new features and functions of the Supervisor Engine 6-E on all ports with a simple supervisor engine upgrade. However, to take advantage of the increased switching capacity of 24 Gbps per slot, the Cisco Catalyst 4500 E-Series chassis and E-Series line cards are required. You can mix and match Cisco Catalyst 4500 E-Series line cards and classic line cards in an E-Series chassis with no performance degradation to either line card type. Table 2 shows the supervisor engine and line-card slot-assignment options in the Cisco Catalyst 4500 E-Series chassis.

Table 2. Cisco Catalyst 4500-E Chassis Slot-Assignment Options

Chassis	Single Supervisor Engine 6-E Slot Assignments	Redundant Supervisor Engine 6-E Slot Assignments	E-Series Line-Card Slot Options	Classic Line-Card Slot Options
Cisco Catalyst 4503-E	Slot 1	-	Slots 2 and 3	Slots 2 and 3
Cisco Catalyst 4506-E	Slot 1	-	Slots 2 through 6	Slots 2 through 6

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Chassis	Single Supervisor Engine 6-E Slot Assignments	Redundant Supervisor Engine 6-E Slot Assignments	E-Series Line-Card Slot Options	Classic Line-Card Slot Options
Cisco Catalyst 4507R+E	Slot 3 or 4	Slots 3 or 4	Slots 1, 2, and 5 to 7	Slots 1, 2, and 5 to 7
Cisco Catalyst 4510R+E	Slots 5 or 6	Slots 5 or 6	Slots 1 to 4, and 7	Slots 1 to 4, and 7 to 10
Cisco Catalyst 4507R-E	Slot 3 or 4	Slots 3 or 4	Slots 1, 2, and 5 to 7	Slots 1, 2, and 5 to 7
Cisco Catalyst 4510R-E	Slots 5 or 6	Slots 5 or 6	Slots 1 to 4 and 7 (Refer to Note.)	Slots 1 to 4 and 7 to 10

Note: The Cisco Catalyst 4510R-E supports only classic line cards in slots 8 to 10 with Supervisor Engine 6-E.

Table 3 summarizes the performance capacities of the Supervisor Engine 6-E on a per-chassis basis.

Table 3. Cisco Catalyst 4500 Supervisor Engine 6-E Bandwidth Capacity per Chassis

	Cisco Catalyst 4503-E Chassis	Cisco Catalyst 4506-E Chassis	Cisco Catalyst 4507R-E and 4507R+E Chassis	Cisco Catalyst 4510R-E and 4510R+E Chassis
Supervisor Engine 6-E (WS-X45-Sup6-E)	136 Gbps	280 Gbps	280 Gbps	320 Gbps

High Availability and Uplinks

The Cisco Catalyst 4500 Series was designed for nonstop communications with uninterrupted hardware switching. In addition to redundant power supplies, fans, and clock modules, the Cisco Catalyst 4510R-E, 4510R+E, 4507R+E, and 4507R-E chassis models support 1 + 1 supervisor engine redundancy, using the Supervisor Engine 6-E. The primary supervisor engine is active and is responsible for normal system operation. The other supervisor engine serves as a secondary standby, monitoring the operation of the primary supervisor engine.

Alerts are generated to the network monitoring software if either of the redundant supervisors fails. Hot-swapping of supervisor engines is supported without disrupting system operation. You can configure software to force switchover of supervisor engines, or you can use the Simple Network Management Protocol (SNMP) to perform switchover. The resiliency features of the Cisco Catalyst 4500 prevent network outages that could result in lost business and revenue.

Nonstop Forwarding with Stateful Switchover (NSF/SSO) offers continuous packet forwarding during supervisor engine switchover. Information is fully synchronized between supervisor engines to allow the standby supervisor engine 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 network disruption when using a redundant Cisco Catalyst 4500 E-Series system with dual supervisor engines. Facilitating rapid, undisruptive 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 releases.

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). These features help ensure that VoIP calls are not dropped.

Table 4 shows the high-availability and uplink options for the Supervisor Engine 6-E.

Table 4. Supervisor Engine 6-E High Availability and Uplink Options

Feature and Description	Supervisor Engine 6-E
Redundant-capable	• Yes

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Feature and Description	Supervisor Engine 6-E
	• Cisco Catalyst 4507R, 4507R-E, and 4507R+E models • Cisco Catalyst 4510R, 4510R-E, and 4510R+E models
Active supervisor engine uplinks in redundant mode	• Two 10 Gigabit Ethernet (wire-speed) or • Four 10 Gigabit Ethernet (2:1 oversubscribed) or • Four Gigabit Ethernet (Cisco Twin Gig Converter Module) or • Eight Gigabit Ethernet (Cisco Twin Gig Converter Module)*
Active supervisor engine uplinks (nonredundant mode)	• Two 10 Gigabit Ethernet or • Four Gigabit Ethernet (Cisco Twin Gig Converter Module)
Uplink optic types	SFP (Gigabit Ethernet) with Cisco Twin Gig Converter Module or X2 optics (10 Gigabit Ethernet ports)
SSO/NSF and ISSU	Yes

Please refer to the “Features at a Glance” section of this data sheet for a complete listing 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. This protocol has been supported on the Cisco Catalyst 4500 Supervisor Engine II-Plus to V-10GE engines since Cisco IOS Software Release 12.2(20)EW with software forwarding. The Cisco Catalyst 4500 Supervisor Engine 6-E supports IPv6 Unicast and Multicast in hardware for full line-rate forwarding performance of up to 125 Mpps. The Supervisor Engine 6-E also dynamically allocates hardware table space between IPv4 and IPv6 routes to maximize table-space usage for optimal IPv4-to-IPv6 migration. The Supervisor Engine 6-E supports Multicast Listener Discovery (MLD) Snooping for IPv6, enhancing performance and reducing network traffic by allowing a switch to dynamically add and remove hosts from a multicast group.

Table 5 highlights the IPv6 capabilities of the Supervisor Engine 6-E.

Table 5. Summary of Supervisor Engine 6-E IPv6 Capabilities

Feature and Description	Supervisor Engine 6-E
IPv6 support	Unicast and Multicast forwarding done in hardware
IPv6 performance	125 Mpps
IPv6 Routing entries	128,000
Dynamic Hardware Route Table allocations	Yes
MLD Snooping for IPv6	Yes, in hardware
URPFv6: Strict mode	Yes, in hardware

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

For more information about IPv6 feature support and configuration, please refer to the Cisco Catalyst 4500 with Cisco IOS Software Release 12.2(40)SG release notes at http://www.cisco.com/en/US/products/hw/switches/ps4324/prod_release_notes_list.html and the Cisco IOS Software configuration library at http://www.cisco.com/en/US/products/sw/iosswrel/ps1839/products_feature_guide09186a00807fcf4b.html.

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Intelligent Network Services with QoS and Sophisticated Traffic Management

The Cisco Catalyst 4500 Supervisor Engine 6-E provides enhanced QoS features to help ensure that network traffic is classified, prioritized, and scheduled optimally to efficiently deploy a unified communications network that comprises bandwidth-hungry multimedia, time-sensitive (voice), and mission-critical applications. This type of network allows the administrator to differentiate between traffic flows and enforce policies. QoS capabilities include sharing, shaping, and strict-priority configurations for optimal scheduling of egress traffic as well as Dynamic Buffer Limiting (DBL), a flow-based congestion-avoidance feature. The Supervisor Engine 6-E extends the capabilities of previous-generation supervisor engines by providing flexible queuing with up to 8 transmit queues per port with dynamic queue sizing for greater flexibility in classifying and prioritizing traffic. Classification has also been enhanced by providing configurable classification mapping tables applied on a per-port basis, providing greater flexibility in marking traffic. Policing has also been enhanced to include 2-Rate, 3-Color Policing for more granular control and enforcement of traffic policies. Table 6 summarizes the enhanced QoS features of the Supervisor Engine 6-E.

Table 6. Summary of Supervisor Engine 6-E Enhanced QoS Features

Feature and Description	Supervisor Engine 6-E
QoS hardware entries	64,000
Policers	16,000 with flexible assignment for input/output
Hierarchical policies	Yes: 2-Rate, 3-Color
Number of Tx queues	Flex queues up to 8
Maximum Tx queue size	Dynamic 16 to 8184 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	Yes
Configurable classification mapping tables	Yes
Match IP on MAC Header	Yes
Modular QoS-compliant	Yes
DBL: Congestion-avoidance feature	Yes
QoS sharing	Supported on all ports
Shaping	Yes, per Tx queue
Broadcast suppression	Supported in hardware for all ports
Multicast suppression	Supported in hardware for all ports

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

Comprehensive Security with Cisco TrustSec

The Cisco Catalyst 4500E Supervisor Engine 6-E is a validated component of the Cisco TrustSec® 2.1 architecture. This allows the Cisco Catalyst 4500E Supervisor Engine 6-E to be transparently integrated into campus switching environments for a comprehensive security solution based on Cisco TrustSec. The Cisco Catalyst Supervisor Engine 6-E is a foundational element of the Cisco TrustSec architecture with support for the following functionalities:

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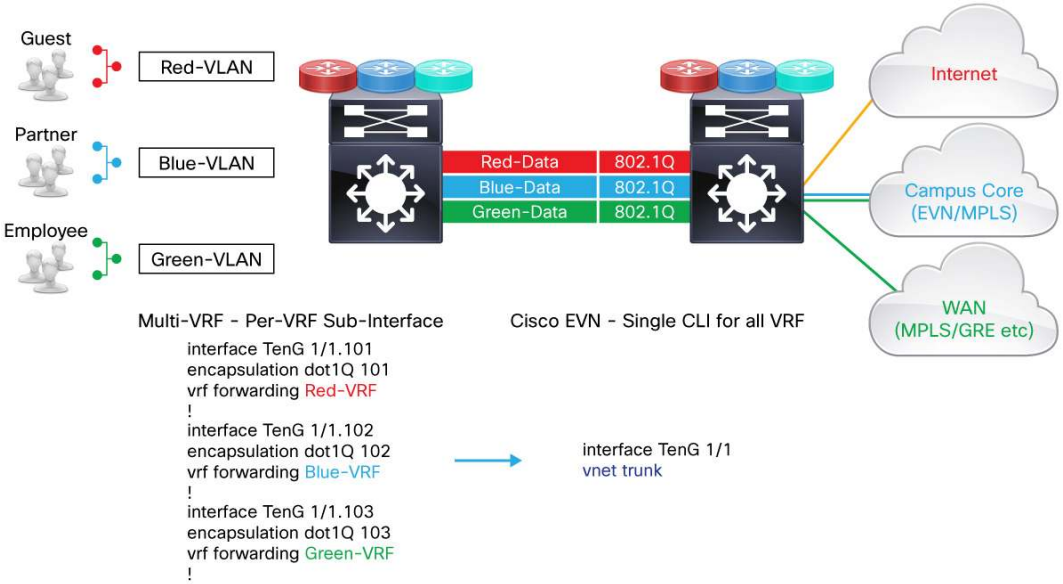
- **Device sensor**: The device sensor on the Cisco Catalyst 4500E Supervisor Engine 6-E enables the ability to recognize the devices connected to the switch. This feature also interoperates with the Cisco Identity Services Engine, providing for a centralized view of all devices' access to the network in a scalable manner. When combined with AutoSmartPorts (ASP), it also provides the ability to dynamically apply policies on the switch based on the device type. For more information, visit http://www.cisco.com/en/US/docs/ios-xml/ios/sec_usr_aaa/configuration/15-1sg/sec-dev-sensor.html.
- **Identity-based networking:** The Cisco Catalyst 4500E Supervisor Engine 6-E has the most rich and robust set of IEEE 802.1X based identity features to provide the right level of authenticated access to users. It also simplifies identity deployments with features such as Flexible Authentication, WebAuth, and MAC Authentication Bypass (MAB), as well as open mode for undisrupted operations while providing visibility of network access. The identity features also provide integrated support for IP telephony. It also provides for flexible authorization policies with VLAN assignment and dynamic ACLs.

  For more information, visit:
  http://www.cisco.com/en/US/docs/switches/lan/catalyst4500/15.1/XE_330SG/configuration/guide/dot1x.html
  http://www.cisco.com/go/trustsec

Simplified and Scalable Network Virtualization with Easy Virtual Network (EVN)

Enterprise networks use single foundational infrastructure to build multiple logical overlay networks for diversified closed usergroups, regulatory, secure IT applications, etc. On campuses the traditional Multi-VRF solution is widely adopted and deployed to solve such network segmentation challenges. The Cisco Catalyst 4500E Series platform simplifies virtual network operation and maximizes scalability with the Cisco campus end-to-end Easy Virtual Network (EVN) technology.

Figure 3. Simplified Campus Network Virtualization with Cisco EVN



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Cisco EVN is a successor solution that offers numerous advantages over traditional Multi-VRF technology:

- Simplified: To simplify campus virtual-network solutions, the Cisco EVN is designed with following three major components:
  - Virtual network (VNET) trunk: The Cisco EVN solution reduces 98 to 99 percent of configuration complexities.
  - Route replication: A simplified unicast and multicast route-leaking capability enables shared network and application services to virtual-network users. It replaces traditional Border Gateway Protocol (BGP)-based route-leaking mechanics.
  - Routing context: Simplified and optimized virtual-network operation and troubleshooting are supported on a per-VRF basis.
- Scalable: Cisco EVN enables flexibility to scale up to 32 virtual network solutions - operationally 4x virtual-network scalability capacity over Multi-VRF technology.
- Interoperable: Cisco EVN provides network topology isolation based on an RFC-defined control plane; for example, Enhanced IGRP (EIGRP), Open Shortest Path First (OSPF), Multicast etc. The data-plane security and protection are maintained through industry-standard IEEE 802.1Q. In addition, the Cisco EVN-supported system interoperates with peer Cisco EVN, Multi-VRF, and MPLS systems.

Comprehensive Centralized Management

The Cisco Catalyst Supervisor Engine 6-E features a single console port and a single IP address to manage all system features. Remote in-band management is available with 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. USB drive support will be provided in a future software release. The Cisco Smartports macro for Cisco Catalyst switches is also supported, simplifying the configuration of the critical features for Ethernet networks.

The Cisco Catalyst 4500 Supervisor Engine 6-E is also FAT file system-capable, allowing images to be copied, saved, etc. with Windows-based machines with a Compact Flash. This capability will be available in a future software release.

Table 7. Key Supervisor Engine 6-E Management Features

Feature and Description	Supervisor Engine 6-E
USB drive support	Yes, future software release
Compact Flash support	Yes, 64- and 128-MB options
FAT file system support	Yes
SPAN	Up to 8 sessions: ingress and egress

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

The Cisco Catalyst 4500 Supervisor Engine 6-E also 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.

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Lower Total Cost of Ownership and Ease of Use with Smart Install Director

Smart Install Director simplifies management of images and configurations for enterprise switches in campus and branch networks. The Cisco Catalyst 4500E, now acting as Smart Install Director, provides a single management point for images and configuration of directly or indirectly connected Cisco Catalyst 2960, 3560, 3750, and 3850 Series Switches. It provides for:

- Plug and play in switch deployment
- Zero-touch replacement of switches with the same configuration and image as the switch it is replacing
- Single point of image and configuration management, in which configuration and image management are centralized
- On-demand image and configuration updates across all downstream switches from a single touchpoint

Smart Install Director reduces the customer's TCO and operational expense, while providing ease of use to the user.

For details about Smart Install, go to http://www.cisco.com/en/US/docs/switches/lan/smart_install/configuration/guide/concepts.html.

Advanced Security

The Cisco Catalyst 4500 Supervisor Engine 6-E extends the rich set of industry-leading, integrated security features (Table 8) to proactively lock down a critical network infrastructure by supporting URPF in hardware. URPF helps prevents traffic spoofing by identifying traffic coming in on an unexpected port. The Cisco Catalyst 4500 Supervisor Engine 6-E also reduces network security risks with a rich set of Cisco 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 Supervisor Engine 6-E 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 Versions 1 and 2) Protocol, Secure Copy Protocol (SCP), and SNMPv3, respectively.

Table 8. Supervisor Engine 6-E Security Features

Feature and Description	Supervisor Engine 6-E
Security hardware entries	64,000
Cisco NAC and DHCP Snooping entries	12,000
URPF	Yes, supported in hardware
802.1X	Yes
802.1X extensions	Yes
IP Source Guard, Dynamic ARP Inspection (DAI), and DHCP Snooping	Yes
Cisco NAC	Yes

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

Features at a Glance

For a comprehensive list of features, please visit Cisco Feature Navigator at http://tools.cisco.com/ITDIT/CFN/jsp/index.jsp.

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Layer 2 Features

- Layer 2 hardware forwarding at 250 Mpps
- Layer 2 switch ports and VLAN trunks
- IEEE 802. 1Q VLAN Encapsulation
- Dynamic Trunking Protocol (DTP)
- VLAN Trunking Protocol (VTP) and VTP domains
- VTP Pruning
- Port Security on trunk port
- Port Security on Private VLAN
- Port Security on Voice VLAN
- QinQ Passthrough
- Support for 4096 VLANs per switch
- Per-VLAN Spanning Tree Plus (PVST+) and Per-VLAN Rapid Spanning Tree (PVRST)
- Spanning Tree PortFast and PortFast Guard
- Spanning Tree UplinkFast and BackboneFast
- 802.1s
- 802.1w
- 802.3ad
- 802.3af (Power over Ethernet [PoE])
- Spanning Tree Root Guard
- Cisco Discovery Protocol
- Internet Group Management Protocol (IGMP) Snooping v1, v2, and v3
- IPv6 MLD Snooping v1 and v2
- Cisco EtherChannel technology, Cisco Fast EtherChannel technology, and Cisco Gigabit EtherChannel technology across line cards
- Port Aggregation Protocol (PAgP)
- Link Aggregation Control Protocol (LACP)
- IGMP Querier
- IGMP Fast Leave
- VMPS client
- Unidirectional Link Detection (UDLD) and aggressive UDLD
- Voice VLAN and VLAN ID (VVID)
- Jumbo Frames (up to 9216 bytes)
- Baby Giants (up to 1600 bytes)
- Traffic Storm Control (formally known as Broadcast/Multicast Suppression)
- Forced 10/100 Autonegotiation
- Bridge Protocol Data Unit (BPDU) Guard
- Link Layer Discovery Protocol (LLDP)

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Layer 3 Features

- Hardware-based IP Cisco Express Forwarding routing at 250 Mpps
- IP routing protocols: Enhanced Interior Gateway Routing Protocol (EIGRP), Open Shortest Path First (OSPF), Routing Information Protocol (RIP), and RIPv2
- Static Routing
- Inter-VLAN Routing
- Border Gateway Protocol Version 4 (BGPv4) and Multicast Border Gateway Protocol (MBGP): Q1CY'08 Release
- Virtual Route Forwarding Lite (VRF-Lite)
- Software-based generic routing encapsulation (GRE) tunneling
- IGMP Filtering on access and trunk ports
- IP Multicast routing protocols: Protocol Independent Multicast (PIM), SSM, and Distance Vector Multicast Routing Protocol (DVMRP)
- Pragmatic General Multicast Source Discovery Protocol (MSDP)
- Internet Control Message Protocol (ICMP)
- ICMP Router Discovery Protocol
- DHCP Server
- Per-port Multicast Suppression
- IP Service-Level Agreement (SLA): Q1 CY'08 Release

IPv6 Support in Hardware

- IPv6 Unicast and Multicast Forwarding (done in hardware)
- IPv6 route entries: 128,000
- IPv6 addressing architecture
- IPv6: Cisco Discovery Protocol IPv6 address family
- IPv6: Cisco Express Forwarding in hardware
- IPv6: Domain Name System (DNS) resolver for AAAA over an IPv4 and IPv6 transport
- IPv6: DNS resolver for AAAA over an IPv6 transport
- IPv6: Extended ACL
- IPv6: ICMP Rate Limiting
- IPv6: ICMPv6
- IPv6: ICMPv6 Redirect
- IPv6: IP MIB
- IPv6 over IEEE 802.1Q
- IPv6: IPv6 over IPv4 GRE tunnel (tunnel support in software)
- IPv6: Loopback
- IPv6: Multicast Forwarding Information Base (MFIB) for IPv6
- IPv6: MLDv1 and v2

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- IPv6: Maximum Transmission Unit (MTU) Path Discovery for IPv6
- IPv6: Multicast in IPv6 tunnel
- IPv6: OSPFv3
- IPv6: EIGRP for IPv6
- 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
- IPv6: URPF strict mode
- PIMv6 (Sparse Mode)
- BGP: Q1CY'08 Release

High Availability Features

- NSF/SSO: Q1CY'08 Release
- Full-image ISSU: Q1CY'08 Release
- NSF awareness
- Hot Standby Router Protocol (HSRP)
- SSO-Aware Hot Standby Router Protocol
- Virtual Router Redundancy Protocol (VRRP)
- Gateway Load Balancing Protocol (GLBP)

Sophisticated QoS and Traffic Management

- Modular QoS CLI (MQC)
- Per-port, per-VLAN QoS
- Eight queues per port
- Dynamic Tx Queue Sizing: Q1CY'08 Release
- Strict Priority Queuing
- IP differentiated services code point (DSCP)

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- 802.1p: Class of service
- Flexible Classification Marking
- 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 16,000 policers with flexible assignment for input and output
- 2-Rate, 3-Color Policing
- Shaping and sharing output queue management
- DBL: Congestion-avoidance feature
- Auto-QoS command-line interface (CLI) for VoIP deployments
- Table Map Support

Predictable Performance

- 320-Gbps switching fabric
- Layer 2 hardware forwarding at 250 Mpps
- Layer 3 hardware-based IP Cisco Express Forwarding routing at 250 Mpps
- Layer 4 TCP/User Datagram Protocol (UDP) hardware-based filtering at 250 Mpps
- No performance penalty with advanced Layer 3 and Layer 4 services enabled
- Software-based learning at a sustained rate of 10,000 hosts per second
- Support for 55,000 unicast MAC addresses
- Support for 16,000 multicast MAC addresses
- Support for 256,000 entries in routing table (shared between unicast and multicast)
- Scalability to 4,096 virtual ports (VLAN port instances)
- Bandwidth aggregation up to 16 Gbps through Cisco Gigabit EtherChannel technology
- Bandwidth aggregation up to 160 Gbps for 10 Gigabit Ethernet through 10 Gigabit Ethernet Cisco EtherChannel technology
- Hardware-based multicast management
- Hardware-based ACLs

Comprehensive Management

- Single console port and single IP address to manage all system features
- Software configuration management, including local and remote storage
- Optional Compact Flash memory card to store software images for backup and easy software upgrades
- USB drive support: Future software release
- FAT file system support
- 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

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- Remote Monitoring (RMON) software agent to support four RMON groups (history, statistics, alarms, and events) for enhanced traffic management, monitoring, and analysis
- Analysis support, including ingress port, egress port, and VLAN SPAN
- Layer 2 Traceroute
- Remote SPAN (RSPAN): Q1 CY'08 Release
- Cisco Smartports macros
- SPAN ACL filtering
- DHCP Client Autoconfiguration
- Enhanced SNMP MIB support
- Network Timing Protocol (NTP)

Advanced Security

- TACACS+ and RADIUS, which 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 port security)
- 802.1x with VLAN assignment, voice VLAN: Q1CY`08 Release
- 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 and Option 82 insertion
- Port Security
- Sticky Port Security on Voice VLAN
- SSHv1 and v2
- Unicast Port Flood Blocking
- DAI
- IP Source Guard
- VLAN Management Policy Server (VMPS) client
- Cisco NAC Layer 2 802.1X
- Cisco NAC LAN Port IP
- 802.1X Inaccessible Authentication Bypass
- Voice VLAN Sticky Port Security
- SCP
- URPF Strict Mode (in hardware)

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Technical Specifications

Management

- CiscoWorks LMS; includes CiscoWorks Resource Manager Essentials
- CiscoView
- SNMP v1, v2, and v3
- RMON I and II
- RFC 1213-MIB (MIB II)
- UDP-MIB
- TCP-MIB
- CISCO-FLASH-MIB
- CISCO-IMAGE-MIB
- RFC 2233 (IF-MIB)
- CISCO-CONFIG-MAN-MIB
- CISCO-MEMORY-POOL
- CISCO-CDP-MIB
- RMON-MIB lite (RFC 1757)
- RMON2-MIB lite (RFC 2021)
- HC-RMON-MIB
- SMON-MIB
- ENTITY-MIB (V1-RFC 2037) (V2- RFC 2737)
- CISCO-PROCESS-MIB
- CISCO-CONFIG-COPY-MIB
- CISCO-ENTITY-EXT-MIB
- CISCO-ENTITY-ASSET-MIB
- CISCO-ENTITY-FRU-CONTROL-MIB
- CISCO-ENTITY-SENSOR-MIB
- CISCO-ENVMON-MIB
- BRIDGE-MIB (RFC 1493)
- CISCO-PAGP-MIB
- CISCO-PRIVATE-VLAN-MIB
- CISCO-STP-EXTENSIONS-MIB
- CISCO-VLAN-MEMBERSHIP-MIB
- CISCO-VLAN-IFTABLE-RELATIONSHIP-MIB
- IGMP-MIB
- PIM-MIB
- OSPF-MIB
- CISCO-ENTITY-VENDORTYPE-OID-MIB

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- CISCO-SYSLOG-MIB
- CISCO-BULK-FILE-MIB
- CISCO-CLASS-BASED-QOS-MIB
- CISCO-FTP-CLIENT-MIB
- CISCO-HSRP-MIB
- CISCO-IGMP-FILTER-MIB
- CISCO-IPMROUTE-MIB
- CISCO-PORT-SECURITY-MIB
- CISCO-RMON-CONFIG-MIB
- CISCO-VTP-MIB
- ETHERLIKE-MIB
- EXPRESSION-MIB
- CISCO-PORT-STORM-CONTROL-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
- 10 Gigabit Ethernet: IEEE 802.3ae
- 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 802.3 ad LACP
- IEEE 802. 1p 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

Supported Cisco Catalyst 4500 E-Series Line Cards and Modules

- WS-X4648-RJ45V-E: Cisco Catalyst 4500 E-Series, 48-port 802.3af PoE 10/100/1000 (RJ-45)
- WS-X4648-RJ45V+E: Cisco Catalyst 4500 E-Series, 48-port Premium PoE 10/100/1000 (RJ-45)
- WS-X4648-RJ45-E: Cisco Catalyst 4500 E-Series, 48-port 10/100/1000 (RJ-45)

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- WS-X4606-X2-E: Cisco Catalyst 4500 E-Series, 6-port 10 Gigabit Ethernet (X2)
- WS-X4624-SFP-E: Cisco Catalyst 4500 E-Series, 24-port Gigabit Ethernet (SFP)
- WS-X4612-SFP-E: Cisco Catalyst 4500 E-Series, 12-port Gigabit Ethernet (SFP)
- CVR-X2-SFP: Twin gigabit converter module

Supported Cisco Catalyst 4500 Classic Line Cards and Modules

- WS-X4148-FE-BD-LC: Cisco Catalyst 4500 Fast Ethernet Switching Module, 48-port 100BASE-BX-D SMF (LC)
- WS-X4124-FX-MT: Cisco Catalyst 4000 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 multimode fiber (MMF)
- 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 802.3af 10/100, 48 ports (RJ-21)
- WS-X4224-RJ45V: Cisco Catalyst 4500 PoE 803.3af 10/100, 24 ports (RJ-45)
- WS-X4248-RJ45V: Cisco Catalyst 4500 PoE 802.3af 10/100, 48 ports (RJ-45)
- WS-X4248-FE-SFP: Cisco Catalyst 4500 Fast Ethernet Switching Module, 48-port 100BASE-X (SFP)
- WS-X4232-GB-RJ: Cisco Catalyst 4500 32-Port 10/100 (RJ-45), 2 Gigabit Ethernet (GBIC) modules
- 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-X4506-GB-T: Cisco Catalyst 4500 Gigabit Ethernet Module, 6 ports 10/100/1000 802.3af PoE or 1000BASE-X (SFP)
- 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 ports 1000BASE-X (optional SFPs)
- 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 802.3af 10/100/1000, 24 ports (RJ-45)
- WS-X4548-GB-RJ45V: Cisco Catalyst 4500 PoE 802.3af 10/100/1000, 48 ports (RJ-45)

Supported Pluggables

- GLC-T: 1000BASE-T SFP
- GLC-SX-MM: Gigabit Ethernet SFP, LC connector, SX transceiver
- GLC-LH-SM: Gigabit Ethernet SFP, LC connector, LX/LH transceiver
- GLC-ZX-SM: 1000BASE-ZX SFP
- Cisco Coarse Wavelength-Division Multiplexing (CWDM) Gigabit Interface Converter (GBIC) solution
- Cisco CWDM SFP solution
- X2-10GE-LR: 10GBASE-LR X2 module

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- X2-10GE-CX4: 10GBASE-CX4 X2 module
- X2-10GE-LX4: 10GBASE-LX4 X2 module
- X2-10GE-SR: 10GBASE-SR X2 module
- X2-10GE-ER: 10GBASE-ER X2 module

X2-10GE-LRM - 10GBASE-LRM X2 module: For a comprehensive list of optical modules and the minimum Cisco IOS Software release required for each of the supported optical modules, visit http://www.cisco.com/en/US/products/hw/modules/ps5455/products_device_support_tables_list.html.

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 recessed protected)
- Uplinks: Link and active
- Image management port: 10/100/1000 BASE-TX (RJ-45 female) data terminal equipment (DTE); green (good); orange (disabled); off (not connected)

Software Requirements

The Cisco Catalyst 4500 Series Supervisor Engine 6-E is supported only in Cisco IOS Software and is not supported in the Cisco Catalyst Operating System Software. The minimum software version is as follows:

- Supervisor Engine 6-E, Cisco IOS Software Release 12.2(40)SG or later

Environmental Conditions

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

Power and MTBF Information

Active supervisor power = 260W

Standby supervisor power = 185W

This result is not indicative of the actual power draw during operation. It is the absolute maximum value recommended for facility power and cooling capacity planning. Typical power draw is about 20 percent lower than the maximum value shown.

MTBF = 160,735 hours

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Regulatory Standards Compliance

Table 9 shows regulatory standards, and Table 10 shows ordering information.

Table 9. Cisco Catalyst 4500 Supervisor Engine 6-E Regulatory Standards Compliance

Specification	Standard
Regulatory compliance	CE marking
Safety	• UL 60950CAN/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 Standards (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

Table 10. Ordering Information

Product Number	Description
WS-X45-Sup6-E	Cisco Catalyst 4500 E Series Supervisor Engine 6-E, 2x10GE (X2) or 4x1GE (SFP), Console RJ-45, USB
WS-X45-Sup6-E/2	Cisco Catalyst 4500 Redundant Supervisor Engine 6-E, 2x10GE (X2) or 4x1GE (SFP), Console RJ-45, USB
S45EIPB-12240SG(=)	Cisco IOS Software for Supervisor Engine 6-E (IP Base image)
S45EIPBK9-12240SG(=)	Cisco IOS Software for Supervisor Engine 6-E (IP Base image with 3DES)
S45EES-12240SG(=)	Cisco IOS Software for Supervisor Engine 6-E (Enterprise Services image)
S45EESK9-12240SG(=)	Cisco IOS Software for Supervisor Engine 6-E (Enterprise Services image with 3DES)
MEM-C4K-FLD64M	Cisco Catalyst 4500 Cisco IOS Software-Based Supervisor Engine, Compact Flash memory, 64-MB option
MEM-C4K-FLD128M	Cisco Catalyst 4500 Cisco IOS Software-Based Supervisor Engine, Compact Flash memory, 128-MB option
MEM-X45-512MB-E	Cisco Catalyst 4500 512MB to 1 GB SDRAM Upgrade for Supervisor Engine 6-E

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EIGRP, OSPF, BGP and VRF-Lite, NSF, Multicast Routing, IGMP, and MLD are included with Enterprise Services Software image.

Warranty

Cisco Catalyst 4500 E-Series and Cisco Catalyst 4500 switches are covered by the Cisco Limited Lifetime Hardware Warranty. For more information, refer to: http://www.cisco.com/en/US/docs/general/warranty/English/LH2DEN__.html.

Note: If you purchased the Cisco Catalyst 4500 Supervisor Engine 6-E before May 1, 2009, it is covered by the Cisco 90-Day Limited Hardware Warranty. For more information, refer to: http://www.cisco.com/en/US/docs/general/warranty/English/901DEN__.html.

Cisco Technical Support Services

Cisco Technical Support Services (Tables 11 and 12) help to ensure that your products from Cisco 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 the Cisco Technical Assistance Center (TAC)
- Registered access to http://www.cisco.com

Table 11. Components of Cisco Technical Support Services

Service Feature Overview	Benefit or Advantage
Software support	Software support offers maintenance and minor and major updates for licensed feature sets. 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 functions that, in many cases, require no additional hardware investment • Increasing the performance of current functions • Enhancing network or application availability, reliability, and stability
Cisco 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 data, voice, and video 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 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 customers reduce costs by increasing staff self-sufficiency and productivity.
Advance Replacement of hardware	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.

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Table 12. Cisco Technical Support Services: Competitive Differentiators

Service Feature Overview	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 problems to help decrease time to resolution.
Cisco 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 and 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	This feature delivers award-winning, worldwide hardware-replacement support with 650 depots, covering 120 countries, at a $2.3 billion investment in inventory, taking advantage of 10,000 onsite field engineers.
Cisco IOS Software	Cisco IOS Software employs 100 discrete technologies with more than 2000 features. Each year 400 new features are added. 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 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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