CHAPTER 1

Overview

This chapter provides these topics about the switch software:

The term *switch* refers to a standalone switch and to a switch stack.

In this document, *IP* refers to IP Version 4 (IPv4) unless there is a specific reference to IP Version 6 (IPv6).

Note on WS-CBS3125G-S and WS-CBS3125X-S switch models:

- The WS-CBS3125G-S is the same product as the WS-CBS3120G-S.
- The WS-CBS3125X-S is the same product as the WS-CBS3120X-S.

The functionality and the performance of WS-CBS3125 switches are same as those of WS-CBS3120 switches. All Cisco Catalyst Blade Switch 3120/3125 for HP models are HP BladeSystem c-Class compatible.

HP BladeSystem c-Class Compatible

Features

The switch supports either the cryptographic (supports encryption) or the noncryptographic universal software image. The cryptographic and noncryptographic universal software images support the IP base and IP services feature sets. To enable a specific feature set, you must have a Cisco IOS software license for that feature set. For more information about the software license, see the *Cisco Software Activation for HP* document on Cisco.com.

Some features described in this chapter are only available on the cryptographic software image. You must obtain authorization to use these features and to download the cryptographic software from Cisco.com. For more information, see the release notes for this release.

The switch supports one of these feature sets:

- IP base feature set, which provides Layer 2+ features (enterprise-class intelligent services). These features include access control lists (ACLs), quality of service (QoS), static routing, EIGRP stub routing, PIM stub routing, the Hot Standby Router Protocol (HSRP), Routing Information Protocol (RIP), and basic IPv6 management. Switches with the IP base feature set can be upgraded to the IP services feature set.
- IP services feature set, which provides a richer set of enterprise-class intelligent services and full IPv6 support. It includes all IP base features plus full Layer 3 routing (IP unicast routing, IP multicast routing, and fallback bridging). The IP services feature set includes protocols such as the Enhanced Interior Gateway Routing Protocol (EIGRP) and the Open Shortest Path First (OSPF) Protocol. This feature set also supports all IP service features with IPv6 routing and IPv6 ACLs and Multicast Listener Discovery (MLD) snooping.

  IP services-only Layer 3 features are described in the "Layer 3 Features" section on page 1-12.

  For more information, see Chapter 25, "Configuring IPv6 MLD Snooping," and Chapter 35, "Configuring IPv6 ACLs."

  For more information on IPv6 routing, see Chapter 39, "Configuring IPv6 Unicast Routing."

  For more information about IPv6 ACLs, see Chapter 35, "Configuring IPv6 ACLs."

Note Unless otherwise noted, all features described in this chapter and in this guide are supported on both the IP base and IP services feature sets.

The switch has these features:

Deployment Features

The switch ships with these features:

- Express Setup for quickly configuring a switch for the first time with basic IP information, contact information, switch and Telnet passwords, and Simple Network Management Protocol (SNMP) information through a browser-based program. For more information about Express Setup, see the getting started guide.
- User-defined and Cisco-default Smartports macros for creating custom switch configurations for simplified deployment across the network.
- Local web authentication banner so that custom banner or image file can be displayed at a web authentication login screen.
- An embedded device manager GUI for configuring and monitoring a single switch through a web browser. For information about starting the device manager, see the getting started guide. For more information about the device manager, see the switch online help.
- Cisco Network Assistant (referred to as *Network Assistant*) for
  - Managing communities, which are device groups like clusters, except that they can contain routers and access points and can be made more secure.
  - Simplifying and minimizing switch and switch stack management from anywhere in your intranet.
  - Accomplishing multiple configuration tasks from a single graphical interface without needing to remember command-line interface (CLI) commands to accomplish specific tasks.
  - Interactive guide mode that guides you in configuring complex features such as VLANs, ACLs, and quality of service (QoS).
  - Configuration wizards that prompt you to provide only the minimum required information to configure complex features such as QoS priorities for video traffic, priority levels for data applications, and security.
  - Downloading an image to a switch.
  - Applying actions to multiple ports and multiple switches at the same time, such as VLAN and QoS settings, inventory and statistic reports, link- and switch-level monitoring and troubleshooting, and multiple switch software upgrades.
  - Viewing a topology of interconnected devices to identify existing switch clusters and eligible switches that can join a cluster and to identify link information between switches.
  - Monitoring real-time status of a switch or multiple switches from the LEDs on the front-panel images. The system and port LED colors on the images are similar to those used on the physical LEDs.
- Cisco StackWise Plus technology on stacking-capable switches for
  - Connecting up to nine switches through their StackWise Plus ports that operate as a single switch or switch-router in the network.
  - Creating a bidirectional 32-Gb/s switching fabric across the switch stack, with all stack members having full access to the system bandwidth.
  - Using a single IP address and configuration file to manage the entire switch stack.
  - Automatic Cisco IOS version-check of new stack members with the option to automatically load images from the stack master or from a TFTP server.

  - Adding, removing, and replacing switches in the stack without disrupting the operation of the stack.
  - Provisioning a new member for a switch stack with the offline configuration feature. You can configure in advance the interface configuration for a specific stack member number and for a specific switch type of a new switch that is not part of the stack. The switch stack retains this information across stack reloads whether or not the provisioned switch is part of the stack.
  - Displaying stack-ring activity statistics (the number of frames sent by each stack member to the ring).
- Stack troubleshooting enhancements

Performance Features

The switch ships with these performance features:

- Cisco EnergyWise to manage the energy usage of power over Ethernet (PoE) entities
- Autosensing of port speed and autonegotiation of duplex mode on all switch ports for optimizing bandwidth
- Automatic-medium-dependent interface crossover (auto-MDIX) capability on 10/100- and 10/100/1000-Mb/s interfaces and on 10/100/1000 BASE-TX SFP module interfaces that enables the interface to automatically detect the required cable connection type (straight-through or crossover) and to configure the connection appropriately
- Support for the maximum packet size or maximum transmission unit (MTU) size for these types of frames:
  - Up to 9216 bytes for routed frames
  - Up to 9216 bytes for frames that are bridged in hardware and software through Gigabit Ethernet ports and 10-Gigabit Ethernet ports
- IEEE 802.3x flow control on all ports (the switch does not send pause frames)
- EtherChannel for enhanced fault tolerance and for providing up to 8 Gb/s (Gigabit EtherChannel) or 80 Gb/s (10-Gigabit EtherChannel) full-duplex bandwidth among switches, routers, and servers
- Port Aggregation Protocol (PAgP) and Link Aggregation Control Protocol (LACP) for automatic creation of EtherChannel links
- Support for up to 64 EtherChannels
- Forwarding of Layer 2 and Layer 3 packets at Gigabit line rate
- Forwarding of Layer 2 and Layer 3 packets at Gigabit line rate across the switches in the stack
- Per-port storm control for preventing broadcast, multicast, and unicast storms
- Port blocking on forwarding unknown Layer 2 unknown unicast, multicast, and bridged broadcast traffic
- Cisco Group Management Protocol (CGMP) server support and Internet Group Management Protocol (IGMP) snooping for IGMP Versions 1, 2, and 3:
  - (For CGMP devices) CGMP for limiting multicast traffic to specified end stations and reducing overall network traffic
  - (For IGMP devices) IGMP snooping for efficiently forwarding multimedia and multicast traffic
- IGMP report suppression for sending only one IGMP report per multicast router query to the multicast devices (supported only for IGMPv1 or IGMPv2 queries)

- IGMP snooping querier support to configure switch to generate periodic IGMP General Query messages
- IGMP Helper to allow the switch to forward a host request to join a multicast stream to a specific IP destination address
- Multicast Listener Discovery (MLD) snooping to enable efficient distribution of IP Version 6 (IPv6) multicast data to clients and routers in a switched network.
- Multicast VLAN registration (MVR) to continuously send multicast streams in a multicast VLAN while isolating the streams from subscriber VLANs for bandwidth and security reasons
- IGMP filtering for controlling the set of multicast groups to which hosts on a switch port can belong
- IGMP throttling for configuring the action when the maximum number of entries is in the IGMP forwarding table
- IGMP leave timer for configuring the leave latency for the network
- Switch Database Management (SDM) templates for allocating system resources to maximize support for user-selected features
- Web Cache Communication Protocol (WCCP) for redirecting traffic to wide-area application engines, for enabling content requests to be fulfilled locally, and for localizing web-traffic patterns in the network (requires the IP services feature set)Configurable small-frame arrival threshold to prevent storm control when small frames (64 bytes or less) arrive on an interface at a specified rate (the threshold)
- RADIUS server load balancing to allow access and authentication requests to be distributed evenly across a server group

Management Options

These are the options for configuring and managing the switch:

- An embedded device manager—The device manager is a GUI that is integrated in the universal software image. You use it to configure and to monitor a single switch. For information about starting the device manager, see the getting started guide. For more information about the device manager, see the switch online help.
- Network Assistant—Network Assistant is a network management application that can be downloaded from Cisco.com. You use it to manage a single switch, a cluster of switches, or a community of devices. For more information about Network Assistant, see *Getting Started with Cisco Network Assistant*, available on Cisco.com.
- CLI—The Cisco IOS software supports desktop- and multilayer-switching features. You can access the CLI by connecting your management station directly to the switch console port, by connecting your PC directly to the Ethernet management port, or by using Telnet from a remote management station or PC. You can manage the switch stack by connecting to the console port or Ethernet management port of any stack member. For more information about the CLI, see Chapter 2, “Using the Command-Line Interface.”
- SNMP—SNMP management applications such as CiscoWorks2000 LAN Management Suite (LMS) and HP OpenView. You can manage from an SNMP-compatible management station or a PC that is running platforms such as HP OpenView or SunNet Manager. The switch supports a comprehensive set of MIB extensions and four remote monitoring (RMON) groups. For more information about using SNMP, see Chapter 33, “Configuring SNMP.”

- Cisco IOS Configuration Engine (previously known to as the Cisco IOS CNS agent)-—Configuration service automates the deployment and management of network devices and services. You can automate initial configurations and configuration updates by generating switch-specific configuration changes, sending them to the switch, executing the configuration change, and logging the results.

  For more information about CNS, see Chapter 5, "Configuring Cisco IOS Configuration Engine."
- Onboard Administrator GUI—The internal Ethernet management port (also referred to as the *Fa0 or fastethernet0 port*) on the switch sends and receives only management traffic between the switch and the Onboard Administrator. The port is connected to the Onboard Administrator through the backplane connector.

Manageability Features

These are the manageability features:

- CNS embedded agents for automating switch management, configuration storage, and delivery
- DHCP for automating configuration of switch information (such as IP address, default gateway, hostname, and Domain Name System [DNS] and TFTP server names)
- DHCP relay for forwarding User Datagram Protocol (UDP) broadcasts, including IP address requests, from DHCP clients
- DHCP server for automatic assignment of IP addresses and other DHCP options to IP hosts
- DHCP server port-based address allocation for the preassignment of an IP address to a switch port
- Directed unicast requests to a DNS server for identifying a switch through its IP address and its corresponding hostname and to a TFTP server for administering software upgrades from a TFTP server
- Address Resolution Protocol (ARP) for identifying a switch through its IP address and its corresponding MAC address
- Unicast MAC address filtering to drop packets with specific source or destination MAC addresses
- Configurable MAC address scaling that allows disabling MAC address learning on a VLAN to limit the size of the MAC address table
- Cisco Discovery Protocol (CDP) Versions 1 and 2 for network topology discovery and mapping between the switch and other Cisco devices on the network
- Link Layer Discovery Protocol (LLDP) and LLDP Media Endpoint Discovery (LLDP-MED) for interoperability with third-party IP phones
- Support for the LLDP-MED location TLV that provides location information from the switch to the endpoint device
- Network Time Protocol (NTP) for providing a consistent time stamp to all switches from an external source
- Cisco IOS File System (IFS) for providing a single interface to all file systems that the switch uses
- Configuration logging to log and to view changes to the switch configuration
- Configuration replacement and rollback to replace the running configuration on a switch with any saved Cisco IOS configuration file
- Unique device identifier to provide product identification information through a **show inventory** user EXEC command display

- In-band management access through the device manager over a Netscape Navigator or Microsoft Internet Explorer browser session
- In-band management access for up to 16 simultaneous Telnet connections for multiple CLI-based sessions over the network
- In-band management access for up to five simultaneous, encrypted Secure Shell (SSH) connections for multiple CLI-based sessions over the network (requires the cryptographic universal software image)
- In-band management access through SNMP Versions 1, 2c, and 3 get and set requests
- Out-of-band management access through the switch console port to a directly attached terminal or to a remote terminal through a serial connection or a modem
- Out-of-band management access through the internal Ethernet management port to a PC
- Secure Copy Protocol (SCP) feature to provide a secure and authenticated method for copying switch configuration or switch image files (requires the cryptographic universal software image)
- Wired location service that sends location and attachment tracking information for connected devices to a Cisco Mobility Services Engine (MSE)
- LLDP-MED network-policy profile time, length, value (TLV) for creating a profile for voice and voice-signalling by specifying the values for VLAN, class of service (CoS), differentiated services code point (DSCP), and tagging mode CPU utilization threshold trap to monitor CPU utilization
- The HTTP client in Cisco IOS supports can send requests to both IPv4 and IPv6 HTTP servers, and the HTTP server in Cisco IOS can service HTTP requests from both IPv4 and IPv6 HTTP clients.
- SNMP can be configured over IPv6 transport so that an IPv6 host can send SNMP queries and receive SNMP notifications from a device running IPv6.
- IPv6 supports stateless autoconfiguration to manage link, subnet, and site addressing changes, such as management of host and mobile IP addresses.

Note For additional descriptions of the management interfaces, see the "Network Configuration Examples" section on page 1-17.

Availability and Redundancy Features

These are the availability and redundancy features:

- HSRP for command switch and Layer 3 router redundancy
- Automatic stack master re-election (failover support) for replacing stack masters that become unavailable

  The newly elected stack master begins accepting Layer 2 traffic in less than 1 second and Layer 3 traffic between 3 to 5 seconds.
- Cross-stack EtherChannel for providing redundant links across the switch stack
- UniDirectional Link Detection (UDLD) and aggressive UDLD for detecting and disabling unidirectional links on fiber-optic interfaces caused by incorrect fiber-optic wiring or port faults
- IEEE 802.1D Spanning Tree Protocol (STP) for redundant backbone connections and loop-free networks. STP has these features:
  - Up to 128 spanning-tree instances supported
  - Per-VLAN spanning-tree plus (PVST+) for load-balancing across VLANs

  - Rapid PVST+ for load-balancing across VLANs and providing rapid convergence of spanning-tree instances
  - UplinkFast, cross-stack UplinkFast , and BackboneFast for fast convergence after a spanning-tree topology change and for achieving load-balancing between redundant uplinks, including Gigabit uplinks and cross-stack Gigabit uplinks
- IEEE 802.1s Multiple Spanning Tree Protocol (MSTP) for grouping VLANs into a spanning-tree instance and for providing multiple forwarding paths for data traffic and load-balancing and rapid per-VLAN Spanning-Tree plus (rapid-PVST+) based on the IEEE 802.1w Rapid Spanning Tree Protocol (RSTP) for rapid convergence of the spanning tree by immediately changing root and designated ports to the forwarding state
- Optional spanning-tree features available in PVST+, rapid-PVST+, and MSTP mode:
  - Port Fast for eliminating the forwarding delay by enabling a port to immediately change from the blocking state to the forwarding state
  - BPDU guard for shutting down Port Fast-enabled ports that receive bridge protocol data units (BPDUs)
  - BPDU filtering for preventing a Port Fast-enabled port from sending or receiving BPDUs
  - Root guard for preventing switches outside the network core from becoming the spanning-tree root
  - Loop guard for preventing alternate or root ports from becoming designated ports because of a failure that leads to a unidirectional link
- Equal-cost routing for link-level and switch-level redundancy
- Flex Link Layer 2 interfaces to back up one another as an alternative to STP for basic link redundancy
- Link-state tracking to mirror the state of the ports that carry upstream traffic from connected hosts and servers and to allow the failover of the server traffic to an operational link on another Cisco Ethernet switch

VLAN Features

These are the VLAN features:

- Support for up to 1005 VLANs for assigning users to VLANs associated with appropriate network resources, traffic patterns, and bandwidth
- Support for VLAN IDs in the 1 to 4094 range as allowed by the IEEE 802.1Q standard
- VLAN Query Protocol (VQP) for dynamic VLAN membership
- Inter-Switch Link (ISL) and IEEE 802.1Q trunking encapsulation on all ports for network moves, adds, and changes; management and control of broadcast and multicast traffic; and network security by establishing VLAN groups for high-security users and network resources
- Dynamic Trunking Protocol (DTP) for negotiating trunking on a link between two devices and for negotiating the type of trunking encapsulation (IEEE 802.1Q or ISL) to be used
- VLAN Trunking Protocol (VTP) and VTP pruning for reducing network traffic by restricting flooded traffic to links destined for stations receiving the traffic
- Voice VLAN for creating subnets for voice traffic from Cisco IP Phones
- Dynamic voice virtual LAN (VLAN) for multidomain authentication (MDA) to allow a dynamic voice VLAN on an MDA-enabled port

- VLAN 1 minimization for reducing the risk of spanning-tree loops or storms by allowing VLAN 1 to be disabled on any individual VLAN trunk link. With this feature enabled, no user traffic is sent or received on the trunk. The switch CPU continues to send and receive control protocol frames.
- Private VLANs to address VLAN scalability problems, to provide a more controlled IP address allocation, and to allow Layer 2 ports to be isolated from other ports on the switch
- Port security on a PVLAN host to limit the number of MAC addresses learned on a port, or define which MAC addresses may be learned on a port
- VLAN Flex Link Load Balancing to provide Layer 2 redundancy without requiring Spanning Tree Protocol (STP). A pair of interfaces configured as primary and backup links can load balance traffic based on VLAN.

Security Features

The switch ships with these security features:

- Web authentication to allow a supplicant (client) that does not support IEEE 802.1x functionality to be authenticated using a web browser.
- Password-protected access (read-only and read-write access) to management interfaces (device manager, Network Assistant, and the CLI) for protection against unauthorized configuration changes
- Multilevel security for a choice of security level, notification, and resulting actions
- Static MAC addressing for ensuring security
- Protected port option for restricting the forwarding of traffic to designated ports on the same switch
- Port security option for limiting and identifying MAC addresses of the stations allowed to access the port
- VLAN aware port security option to shut down the VLAN on the port when a violation occurs, instead of shutting down the entire port
- Port security aging to set the aging time for secure addresses on a port
- BPDU guard for shutting down a Port Fast-configured port when an invalid configuration occurs
- Standard and extended IP access control lists (ACLs) for defining security policies in both directions on routed interfaces (router ACLs) and VLANs and inbound on Layer 2 interfaces (port ACLs)
- Extended MAC access control lists for defining security policies in the inbound direction on Layer 2 interfaces
- VLAN ACLs (VLAN maps) for providing intra-VLAN security by filtering traffic based on information in the MAC, IP, and TCP/UDP headers
- Source and destination MAC-based ACLs for filtering non-IP traffic
- IPv6 ACLs to be applied to interfaces to filter IPv6 traffic
- DHCP snooping to filter untrusted DHCP messages between untrusted hosts and DHCP servers
- IP source guard to restrict traffic on nonrouted interfaces by filtering traffic based on the DHCP snooping database and IP source bindings
- Dynamic ARP inspection to prevent malicious attacks on the switch by not relaying invalid ARP requests and responses to other ports in the same VLAN

- IEEE 802.1Q tunneling so that customers with users at remote sites across a service-provider network can keep VLANs segregated from other customers and Layer 2 protocol tunneling to ensure that the customer's network has complete STP, CDP, and VTP information about all users
- Layer 2 point-to-point tunneling to facilitate the automatic creation of EtherChannels
- Layer 2 protocol tunneling bypass feature to provide interoperability with third-party vendors
- Flexible-authentication sequencing to configure the order of the authentication methods that a port tries when authenticating a new host
- IEEE 802.1x with open access to allow a host to access the network before being authenticated
- IEEE 802.1x port-based authentication to prevent unauthorized devices (clients) from gaining access to the network. These features are supported:
  - Multidomain authentication (MDA) to allow both a data device and a voice device, such as an IP phone (Cisco or non-Cisco), to independently authenticate on the same IEEE 802.1x-enabled switch port
  - VLAN assignment for restricting IEEE 802.1x-authenticated users to a specified VLAN
  - Port security for controlling access to IEEE 802.1x ports
  - Voice VLAN to permit a Cisco IP Phone to access the voice VLAN regardless of the authorized or unauthorized state of the port
  - IP phone detection enhancement to detect and recognize a Cisco IP phone
  - Guest VLAN to provide limited services to non-IEEE 802.1x-compliant users
  - Restricted VLAN to provide limited services to users who are IEEE 802.1x compliant, but do not have the credentials to authenticate via the standard IEEE 802.1x processes
  - IEEE 802.1x accounting to track network usage
  - IEEE 802.1x with wake-on-LAN to allow dormant PCs to be powered on based on the receipt of a specific Ethernet frame
  - Voice aware IEEE 802.1x and MAC authentication bypass (MAB) security violation to shut down only the data VLAN on a port when a security violation occurs
  - IEEE 802.1x readiness check to determine the readiness of connected end hosts before configuring IEEE 802.1x on the switch
  - Network Edge Access Topology (NEAT) with 802.1x switch supplicant, host authorization with Client Information Signalling Protocol (CISP), and auto enablement to authenticate a switch outside a wiring closet as a supplicant to another switch
  - IEEE 802.1x authentication with downloadable ACLs and redirect URLs to allow per-user ACL downloads from a Cisco Secure ACS server to an authenticated switch
  - Multiple-user authentication to allow more than one host to authenticate on an 802.1x-enabled port.
- MAC authentication bypass to authorize clients based on the client MAC address.
- Network Admission Control (NAC) features:
  - NAC Layer 2 IEEE 802.1x validation of the antivirus condition or *posture* of endpoint systems or clients before granting the devices network access.

    For information about configuring NAC Layer 2 IEEE 802.1x validation, see the "Configuring NAC Layer 2 IEEE 802.1x Validation" section on page 10-55.

  - NAC Layer 2 IP validation of the posture of endpoint systems or clients before granting the devices network access.

    For information about configuring NAC Layer 2 IP validation, see the *Network Admission Control Software Configuration Guide*.

  - IEEE 802.1x inaccessible authentication bypass.

    For information about configuring this feature, see the "Configuring the Inaccessible Authentication Bypass Feature" section on page 10-51.

  - Authentication, authorization, and accounting (AAA) down policy for a NAC Layer 2 IP validation of a host if the AAA server is not available when the posture validation occurs.

    For information about this feature, see the *Network Admission Control Software Configuration Guide*.

- TACACS+, a proprietary feature for managing network security through a TACACS server
- RADIUS for verifying the identity of, granting access to, and tracking the actions of remote users through AAA services
- Kerberos security system to authenticate requests for network resources by using a trusted third party (requires the cryptographic universal software image)
- Secure Socket Layer (SSL) Version 3.0 support for the HTTP 1.1 server authentication, encryption, and message integrity and HTTP client authentication to allow secure HTTP communications (requires the cryptographic universal software image)

QoS and CoS Features

These are the QoS and CoS features:

- Automatic QoS (auto-QoS) to simplify the deployment of existing QoS features by classifying traffic and configuring egress queues
- Cross-stack QoS for configuring QoS features to all switches in a switch stack rather than on an individual-switch basis
- Classification
  - IP type-of-service/Differentiated Services Code Point (IP ToS/DSCP) and IEEE 802.1p CoS marking priorities on a per-port basis for protecting the performance of mission-critical applications
  - IP ToS/DSCP and IEEE 802.1p CoS marking based on flow-based packet classification (classification based on information in the MAC, IP, and TCP/UDP headers) for high-performance quality of service at the network edge, allowing for differentiated service levels for different types of network traffic and for prioritizing mission-critical traffic in the network
  - Trusted port states (CoS, DSCP, and IP precedence) within a QoS domain and with a port bordering another QoS domain
  - Trusted boundary for detecting the presence of a Cisco IP Phone, trusting the CoS value received, and ensuring port security

- Policing
  - Traffic-policing policies on the switch port for managing how much of the port bandwidth should be allocated to a specific traffic flow
  - If you configure multiple class maps for a hierarchical policy map, each class map can be associated with its own port-level (second-level) policy map. Each second-level policy map can have a different policer.
  - Aggregate policing for policing traffic flows in aggregate to restrict specific applications or traffic flows to metered, predefined rates
- Out-of-Profile
  - Out-of-profile markdown for packets that exceed bandwidth utilization limits
- Ingress queueing and scheduling
  - Two configurable ingress queues for user traffic (one queue can be the priority queue)
  - Weighted tail drop (WTD) as the congestion-avoidance mechanism for managing the queue lengths and providing drop precedences for different traffic classifications
  - Shaped round robin (SRR) as the scheduling service for specifying the rate at which packets are sent to the stack or internal ring (sharing is the only supported mode on ingress queues)
- Egress queues and scheduling
  - Four egress queues per port
  - WTD as the congestion-avoidance mechanism for managing the queue lengths and providing drop precedences for different traffic classifications
  - SRR as the scheduling service for specifying the rate at which packets are dequeued to the egress interface (shaping or sharing is supported on egress queues). Shaped egress queues are guaranteed but limited to using a share of port bandwidth. Shared egress queues are also guaranteed a configured share of bandwidth, but can use more than the guarantee if other queues become empty and do not use their share of the bandwidth.
- Automatic quality of service (QoS) voice over IP (VoIP) enhancement for port -based trust of DSCP and priority queuing for egress traffic

Layer 3 Features

These are the Layer 3 features:

Note Some features noted in this section are available only in the IP services feature set.

- HSRP Version 1 (HSRPv1) and HSRP Version 2 (HSRPv2) for Layer 3 router redundancy
- HSRP for IPv6 (requires the IP services feature set)
- IPv6 default router preference (DRP) for improving the ability of a host to select an appropriate router.
- IP routing protocols for load balancing and for constructing scalable, routed backbones:
  - RIP Versions 1 and 2
  - OSPF (requires the IP services feature set)
  - HSRP for IPv6 (requires the IP services feature set)

  - Enhanced IGRP (EIGRP) (requires the IP services feature set)
  - Border Gateway Protocol (BGP) Version 4 (requires the IP services feature set)
- IP routing between VLANs (inter-VLAN routing) for full Layer 3 routing between two or more VLANs, allowing each VLAN to maintain its own autonomous data-link domain
- Policy-based routing (PBR) for configuring defined policies for traffic flows
- Multiple VPN routing/forwarding (multi-VRF) instances in customer edge devices to allow service providers to support multiple virtual private networks (VPNs) and overlap IP addresses between VPNs (requires the IP services feature set)
- VRF Lite for configuring multiple private routing domains for network virtualization and virtual private multicast networks
- Support for these IP services, making them VRF aware so that they can operate on multiple routing instances: HSRP, uRPF, ARP, SNMP, IP SLA, TFTP, FTP, syslog, traceroute, and ping
- Fallback bridging for forwarding non-IP traffic between two or more VLANs (requires the IP services feature set)
- Static IP routing for manually building a routing table of network path information
- Equal-cost routing for load-balancing and redundancy
- Internet Control Message Protocol (ICMP) and ICMP Router Discovery Protocol (IRDP) for using router advertisement and router solicitation messages to discover the addresses of routers on directly attached subnets
- Protocol-Independent Multicast (PIM) for multicast routing within the network, allowing for devices in the network to receive the multicast feed requested and for switches not participating in the multicast to be pruned. Includes support for PIM sparse mode (PIM-SM), PIM dense mode (PIM-DM), and PIM sparse-dense mode (requires the IP services feature set)
- Multicast Source Discovery Protocol (MSDP) for connecting multiple PIM-SM domains (requires the IP services feature set)
- Distance Vector Multicast Routing Protocol (DVMRP) tunneling for interconnecting two multicast-enabled networks across nonmulticast networks (requires the IP services feature set)
- DHCP relay for forwarding UDP broadcasts, including IP address requests, from DHCP clients
- DHCP for IPv6 relay, client, server address assignment and prefix delegation
- IPv6 unicast routing capability for forwarding IPv6 traffic through configured interfaces (requires the IP services feature set)
- IPv6 default router preference (DRP) for improving the ability of a host to select an appropriate router
- IPv6 unicast routing capability for forwarding IPv6 traffic through configured interfaces (requires the IP services feature set)
- Support for EIGRP IPv6, which utilizes IPv6 transport, communicates with IPv6 peers, and advertises IPv6 routes
- IP unicast reverse path forwarding (unicast RPF) for confirming source packet IP addresses
- Nonstop forwarding (NSF) awareness to enable the Layer 3 switch to continue forwarding packets from an NSF-capable neighboring router when the primary route processor (RP) is failing and the backup RP is taking over, or when the primary RP is manually reloaded for a nondisruptive software upgrade (requires the IP services feature set)

- NSF-capable routing for OSPF and EIGRP that allows the switch to rebuild routing tables based on information from NSF-aware and NSF-capable neighbors The ability to exclude a port in a VLAN from the SVI line-state up or down calculation
- Intermediate System-to-Intermediate System (IS-IS) routing supports dynamic routing protocols for Connectionless Network Service (CLNS) networks (requires the IP services feature set)

Monitoring Features

These are the monitoring features:

- MAC address notification traps and RADIUS accounting for tracking users on a network by storing the MAC addresses that the switch has learned or removed
- Switched Port Analyzer (SPAN) and Remote SPAN (RSPAN) for traffic monitoring on any port or VLAN
- SPAN and RSPAN support of Intrusion Detection Systems (IDS) to monitor, repel, and report network security violations
- Four groups (history, statistics, alarms, and events) of embedded RMON agents for network monitoring and traffic analysis
- Syslog facility for logging system messages about authentication or authorization errors, resource issues, and time-out events
- Layer 2 traceroute to identify the physical path that a packet takes from a source device to a destination device
- Time Domain Reflector (TDR) to diagnose and resolve cabling problems on 10/100 and 10/100/1000 copper Ethernet ports
- SFP module diagnostic management interface to monitor physical or operational status of an SFP module
- Online diagnostics to test the hardware functionality of the supervisor engine, modules, and switch while the switch is connected to a live network
- On-board failure logging (OBFL) to collect information about the switch and the power supplies connected to it
- Digital optical monitoring (DOM) to check status of X2 small form-factor pluggable (SFP) modules
- Enhanced object tracking (EOT) for HSRP to determine the proportion of hosts in a LAN by tracking the routing table state or to trigger the standby router failover
- IP Service Level Agreements (IP SLAs) support to measure network performance by using active traffic monitoring
- IP SLAs EOT to use the output from IP SLAs tracking operations triggered by an action such as latency, jitter, or packet loss for a standby router failover takeover

Default Settings After Initial Switch Configuration

The switch is designed for plug-and-play operation, requiring only that you assign basic IP information to the switch and connect it to the other devices in your network. If you have specific network needs, you can change the interface-specific and system- and stack-wide settings.

Note For information about assigning an IP address by using the browser-based Express Setup program, see the getting started guide. For information about assigning an IP address by using the CLI-based setup program, see the hardware installation guide.

If you do not configure the switch at all, the switch operates with these default settings:

- Default switch IP address, subnet mask, and default gateway is 0.0.0.0. For more information, see Chapter 3, "Assigning the Switch IP Address and Default Gateway," and Chapter 22, "Configuring DHCP Features and IP Source Guard."
- Default domain name is not configured. For more information, see Chapter 3, "Assigning the Switch IP Address and Default Gateway."
- DHCP client is enabled, the DHCP server is enabled (only if the device acting as a DHCP server is configured and is enabled), and the DHCP relay agent is enabled (only if the device is acting as a DHCP relay agent is configured and is enabled). For more information, see Chapter 3, "Assigning the Switch IP Address and Default Gateway," and Chapter 22, "Configuring DHCP Features and IP Source Guard."
- Switch stack is enabled (not configurable). For more information, see Chapter 6, "Managing Switch Stacks."
- No passwords are defined. For more information, see Chapter 7, "Administering the Switch."
- System name and prompt is *Switch*. For more information, see Chapter 7, "Administering the Switch."
- NTP is enabled. For more information, see Chapter 7, "Administering the Switch."
- DNS is enabled. For more information, see Chapter 7, "Administering the Switch."
- TACACS+ is disabled. For more information, see Chapter 8, "Configuring Switch-Based Authentication."
- RADIUS is disabled. For more information, see Chapter 8, "Configuring Switch-Based Authentication."
- The standard HTTP server and Secure Socket Layer (SSL) HTTPS server are both enabled. For more information, see Chapter 8, "Configuring Switch-Based Authentication."
- IEEE 802.1x is disabled. For more information, see Chapter 10, "Configuring IEEE 802.1x Port-Based Authentication."
- Port parameters
  - Operating mode is Layer 2 (switchport). For more information, see Chapter 11, "Configuring Interface Characteristics."
  - Interface speed and duplex mode is autonegotiate. For more information, see Chapter 11, "Configuring Interface Characteristics."
  - Auto-MDIX is enabled. For more information, see Chapter 11, "Configuring Interface Characteristics."
  - Flow control is off. For more information, see Chapter 11, "Configuring Interface Characteristics."
- No Smartports macros are defined. For more information, see Chapter 12, "Configuring Smartports Macros."
- VLANs
  - Default VLAN is VLAN 1. For more information, see Chapter 13, "Configuring VLANs."

  - VLAN trunking setting is dynamic auto (DTP). For more information, see Chapter 13, "Configuring VLANs."
  - Trunk encapsulation is negotiate. For more information, see Chapter 13, "Configuring VLANs."
  - VTP mode is server. For more information, see Chapter 14, "Configuring VTP."
  - VTP version is Version 1. For more information, see Chapter 14, "Configuring VTP."
  - No private VLANs are configured. For more information, see Chapter 16, "Configuring Private VLANs."
  - Voice VLAN is disabled. For more information, see Chapter 15, "Configuring Voice VLAN."
- IEEE 802.1Q tunneling and Layer 2 protocol tunneling are disabled. For more information, see Chapter 17, "Configuring IEEE 802.1Q and Layer 2 Protocol Tunneling."
- STP, PVST+ is enabled on VLAN 1. For more information, see Chapter 18, "Configuring STP."
- MSTP is disabled. For more information, see Chapter 19, "Configuring MSTP."
- Optional spanning-tree features are disabled. For more information, see Chapter 20, "Configuring Optional Spanning-Tree Features."
- Flex Links are not configured. For more information, see Chapter 21, "Configuring Flex Links and the MAC Address-Table Move Update Feature."
- DHCP snooping is disabled. The DHCP snooping information option is enabled. For more information, see Chapter 22, "Configuring DHCP Features and IP Source Guard."
- IP source guard is disabled. For more information, see Chapter 22, "Configuring DHCP Features and IP Source Guard."
- Dynamic ARP inspection is disabled on all VLANs. For more information, see Chapter 23, "Configuring Dynamic ARP Inspection."
- IGMP snooping is enabled. No IGMP filters are applied. For more information, see Chapter 24, "Configuring IGMP Snooping and MVR."
- IGMP throttling setting is deny. For more information, see Chapter 24, "Configuring IGMP Snooping and MVR."
- The IGMP snooping querier feature is disabled. For more information, see Chapter 24, "Configuring IGMP Snooping and MVR."
- MVR is disabled. For more information, see Chapter 24, "Configuring IGMP Snooping and MVR."
- Port-based traffic
  - Broadcast, multicast, and unicast storm control is disabled. For more information, see Chapter 26, "Configuring Port-Based Traffic Control."
  - No protected ports are defined. For more information, see Chapter 26, "Configuring Port-Based Traffic Control."
  - Unicast and multicast traffic flooding is not blocked. For more information, see Chapter 26, "Configuring Port-Based Traffic Control."
  - No secure ports are configured. For more information, see Chapter 26, "Configuring Port-Based Traffic Control."
- CDP is enabled. For more information, see Chapter 27, "Configuring CDP."
- UDLD is disabled. For more information, see Chapter 29, "Configuring UDLD."
- SPAN and RSPAN are disabled. For more information, see Chapter 30, "Configuring SPAN and RSPAN."

- RMON is disabled. For more information, see Chapter 31, “Configuring RMON.”
- Syslog messages are enabled and appear on the console. For more information, see Chapter 32, “Configuring System Message Logging.”
- SNMP is enabled (Version 1). For more information, see Chapter 33, “Configuring SNMP.”
- No ACLs are configured. For more information, see Chapter 34, “Configuring Network Security with ACLs.”
- QoS is disabled. For more information, see Chapter 36, “Configuring QoS.”
- No EtherChannels are configured. For more information, see Chapter 37, “Configuring EtherChannels and Link-State Tracking.”
- IP unicast routing is disabled. For more information, see Chapter 38, “Configuring IP Unicast Routing.”
- No HSRP groups are configured. For more information, see Chapter 40, “Configuring HSRP.”
- IP multicast routing is disabled on all interfaces. For more information, see Chapter 44, “Configuring IP Multicast Routing.”
- MSDP is disabled. For more information, see Chapter 45, “Configuring MSDP.”
- Fallback bridging is not configured. For more information, see Chapter 46, “Configuring Fallback Bridging.”

Network Configuration Examples

This section provides network configuration concepts and includes examples of using the switch to create dedicated network segments and interconnecting the segments through Gigabit Ethernet and 10-Gigabit Ethernet connections.

Design Concepts for Using the Switch

As your network users compete for network bandwidth, it takes longer to send and receive data. When you configure your network, consider the bandwidth required by your network users and the relative priority of the network applications that they use.

Table 1-1 describes what can cause network performance to degrade and how you can configure your network to increase the bandwidth available to your network users.

Table 1-1 Increasing Network Performance

Network Demands	Suggested Design Methods
Too many users on a single network segment and a growing number of users accessing the Internet	• Create smaller network segments so that fewer users share the bandwidth, and use VLANs and IP subnets to place the network resources in the same logical network as the users who access those resources most. • Use full-duplex operation between the switch and its connected workstations.
• Increased power of new PCs, workstations, and servers • High bandwidth demand from networked applications (such as e-mail with large attached files) and from bandwidth-intensive applications (such as multimedia)	• Connect global resources—such as servers and routers to which the network users require equal access—directly to the high-speed switch ports so that they have their own high-speed segment. • Use the EtherChannel feature between the switch and its connected servers and routers.

Bandwidth alone is not the only consideration when designing your network. As your network traffic profiles evolve, consider providing network services that can support applications for voice and data integration, multimedia integration, application prioritization, and security. Table 1-2 describes some network demands and how you can meet them.

Table 1-2 Providing Network Services

Network Demands	Suggested Design Methods
Efficient bandwidth usage for multimedia applications and guaranteed bandwidth for critical applications	• Use IGMP snooping to efficiently forward multimedia and multicast traffic. • Use other QoS mechanisms such as packet classification, marking, scheduling, and congestion avoidance to classify traffic with the appropriate priority level, thereby providing maximum flexibility and support for mission-critical, unicast, and multicast, and multimedia applications. • Use optional IP multicast routing to design networks better suited for multicast traffic. • Use MVR to continuously send multicast streams in a multicast VLAN but to isolate the streams from subscriber VLANs for bandwidth and security reasons.
High demand on network redundancy and availability to provide *always on* mission-critical applications	• Use switch stacks, where all stack members are eligible stack masters in case of stack-master failure. All stack members have synchronized copies of the saved and running configuration files of the switch stack. • Use cross-stack EtherChannels for providing redundant links across the switch stack. • Use Hot Standby Router Protocol (HSRP) for cluster command switch and router redundancy. • Use VLAN trunks, cross-stack UplinkFast, and BackboneFast for traffic-load balancing on the uplink ports so that the uplink port with a lower relative port cost is selected to carry the VLAN traffic.

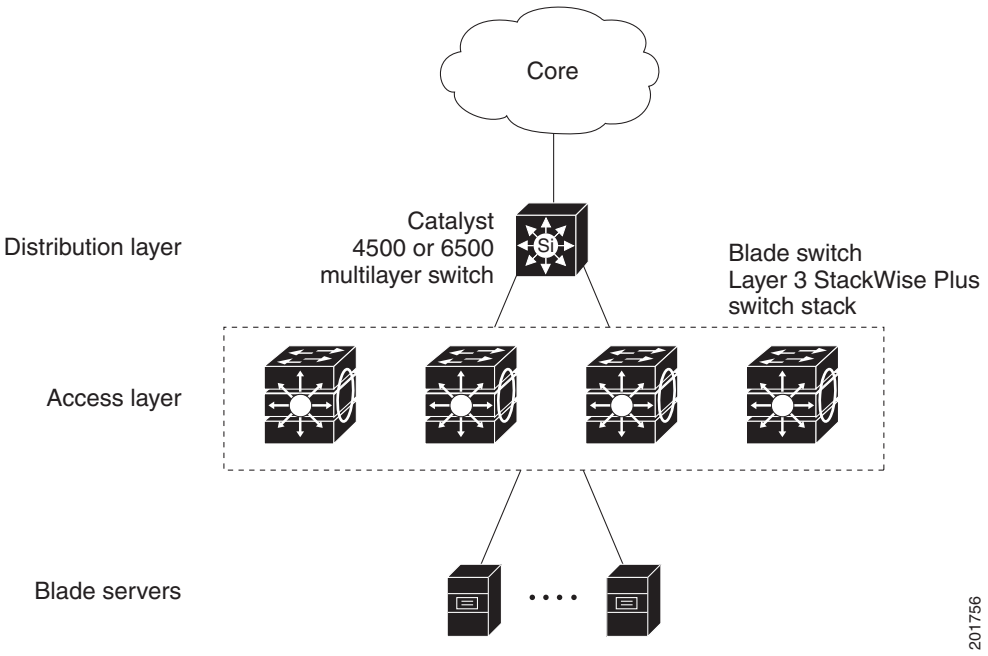
Table 1-2 Providing Network Services (continued)

Network Demands	Suggested Design Methods
An evolving demand for IP telephony	• Use QoS to prioritize applications such as IP telephony during congestion and to help control both delay and jitter within the network. • Use switches that support at least two queues per port to prioritize voice and data traffic as either high- or low-priority, based on IEEE 802.1p/Q. The switch supports at least four queues per port. • Use voice VLAN IDs (VVIDs) to provide separate VLANs for voice traffic.
A growing demand for using existing infrastructure to transport data and voice from a home or office to the Internet or an intranet at higher speeds	Use the Catalyst Long-Reach Ethernet (LRE) switches to provide up to 15 Mb of IP connectivity over existing infrastructure, such as existing telephone lines. **Note** LRE is the technology used in the Catalyst 2950 LRE switch. See the documentation sets specific to this switch for LRE information.

You can use the switches and switch stacks to create the following:

- Data center (Figure 1-1)—For high-speed access to network resources, you can use switches and switch stacks in the access layer to provide Gigabit Ethernet access to the blade servers. To prevent congestion, use QoS DSCP marking priorities on these switches. For high-speed IP forwarding at the distribution layer, connect the switches in the access layer to a Gigabit multilayer switch in the backbone, such as a Catalyst 4500 Gigabit switch or Catalyst 6500 Gigabit switch.

Figure 1-1 Data Center



- Expanded data center (Figure 1-2)—You can use standalone switches and switch stacks to interconnect groups of servers, centralizing physical security and administration of your network. For high-speed IP forwarding at the distribution layer, connect the switches in the access layer to multilayer switches with routing capability. The Gigabit interconnections minimize latency in the data flow.

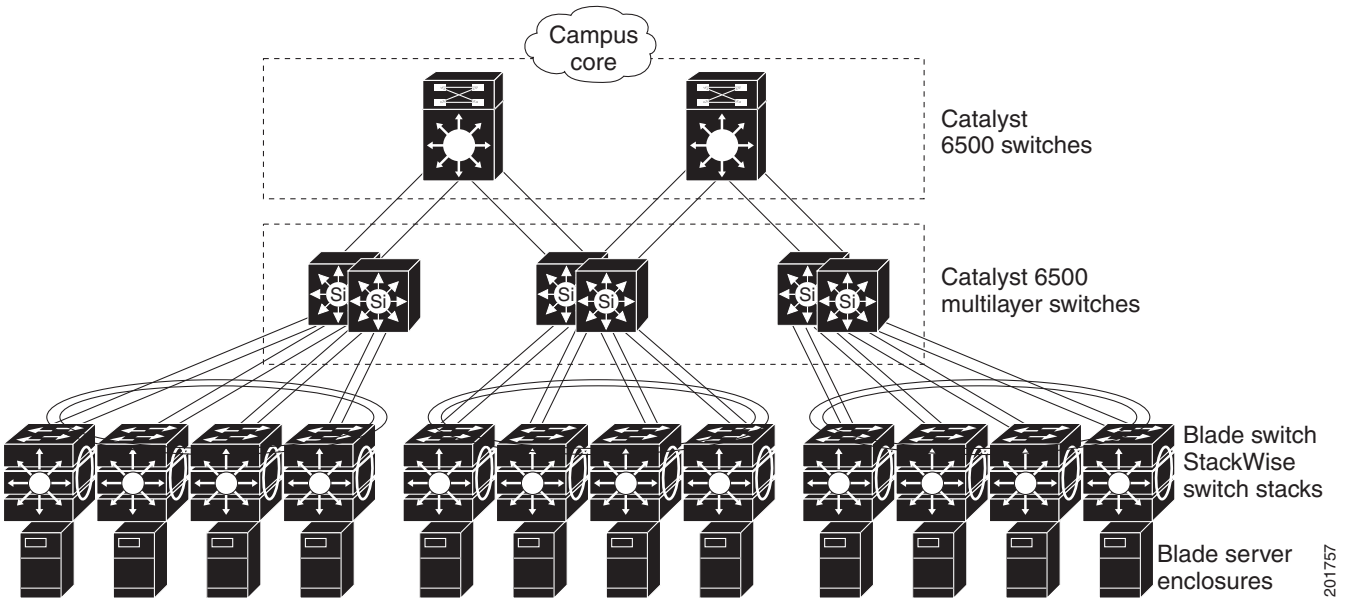
QoS and policing on the switches provide preferential treatment for certain data streams. They segment traffic streams into different paths for processing. Security features on the switch ensure rapid handling of packets.

Fault tolerance from the server racks to the core is achieved through dual homing of servers connected to dual switch stacks or the switches, which have redundant Gigabit EtherChannels and cross-stack EtherChannels.

Using dual SFP module uplinks from the switches provides redundant uplinks to the network core. Using SFP modules provides flexibility in media and distance options through fiber-optic connections.

The various lengths of stack cable available, ranging from 0.5 meter to 3 meters, provide extended connections to the switch stacks across multiple server racks, for multiple stack aggregation.

Figure 1-2 Expanded Data Center



Small to Medium-Sized Network

Figure 1-3 shows a configuration for a network of up to 500 employees. This network uses a Layer 3 switch stack with high-speed connections to two routers. For network reliability and load-balancing, this network has HSRP enabled on the routers and on the switches. This ensures connectivity to the Internet, WAN, and mission-critical network resources in case one of the routers or switches fails. The switches are using routed uplinks for faster failover. They are also configured with equal-cost routing for load sharing and redundancy. A Layer 2 switch stack can use cross-stack EtherChannel for load sharing.

The switches are connected to local servers. The server farm includes a call-processing server running Cisco CallManager software. Cisco CallManager controls call processing and routing. The switches are interconnected through Gigabit interfaces.

This network uses VLANs to logically segment the network into well-defined broadcast groups and for security management. Data and multimedia traffic are configured on the same VLAN. Voice traffic is configured on separate VVIDs. If data, multimedia, and voice traffic are assigned to the same VLAN, only one VLAN can be configured per wiring closet.

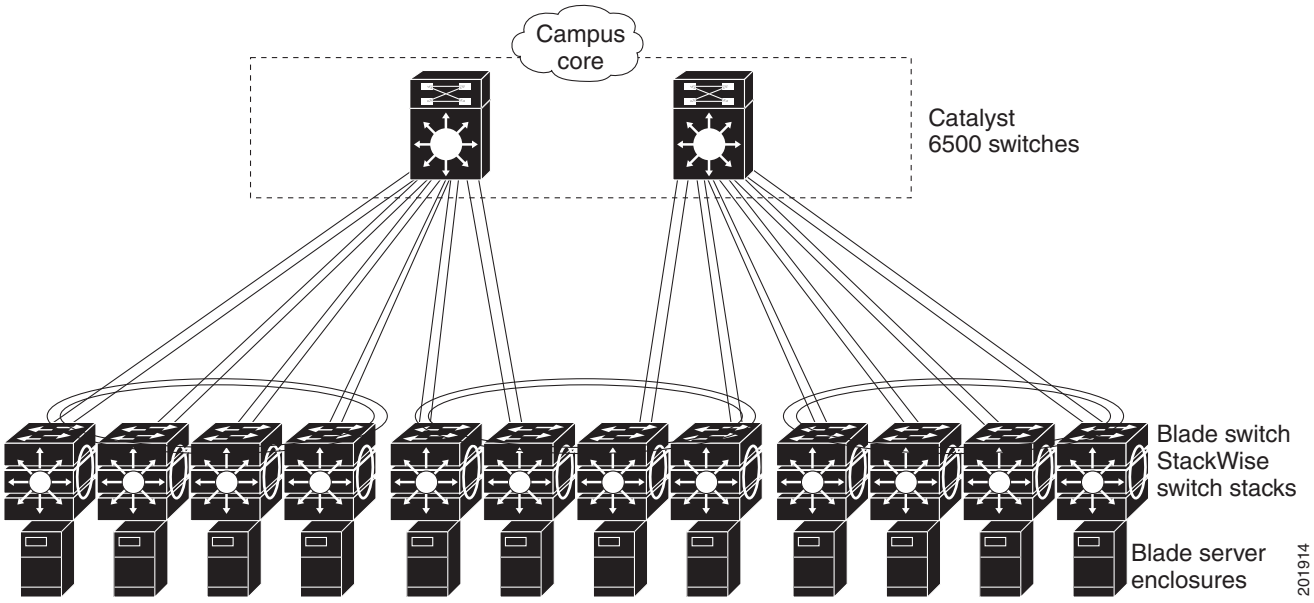
When an end station in one VLAN needs to communicate with an end station in another VLAN, a router or Layer 3 switch routes the traffic to the destination VLAN. In this network, the switch stack is providing inter-VLAN routing. VLAN access control lists (VLAN maps) on the switch stack or switch provide intra-VLAN security and prevent unauthorized users from accessing critical areas of the network.

In addition to inter-VLAN routing, the multilayer switches provide QoS mechanisms such as DSCP priorities to prioritize the different types of network traffic and to deliver high-priority traffic. If congestion occurs, QoS drops low-priority traffic to allow delivery of high-priority traffic.

Cisco CallManager controls call processing and routing. Users with workstations running Cisco SoftPhone software can place, receive, and control calls from their PCs. Using Cisco CallManager software and Cisco SoftPhone software integrates telephony and IP networks, and the IP network supports both voice and data.

With the multilayer switches providing inter-VLAN routing and other network services, the routers focus on firewall services, Network Address Translation (NAT) services, voice-over-IP (VoIP) gateway services, and WAN and Internet access.

Figure 1-3 Switch Stack in a Collapsed Backbone



Where to Go Next

Before configuring the switch, review these sections for startup information:

- Chapter 2, “Using the Command-Line Interface”
- Chapter 3, “Assigning the Switch IP Address and Default Gateway”