Overview

This chapter provides these topics about the Catalyst 2970 switch software:

In this document, IP refers to IP version 4 (IPv4).

Features

Some features noted in this chapter are available only on the cryptographic (that is, supports encryption) version of the switch software image. You must obtain authorization to use this feature and to download the cryptographic version of the software from Cisco.com. For more information, refer to the release notes for this release.

The Catalyst 2970 switches have these features:

Ease-of-Use and Ease-of-Deployment 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
- User-defined SmartPort macros for creating custom switch configurations for simplified deployment across the network
- Cluster Management Suite (CMS) graphical user interface (GUI) for
  - Simplifying and minimizing switch and switch cluster management through a supported web browser from anywhere in your intranet.
  - Accomplishing multiple configuration tasks from a single CMS window 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).
  - Automated 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.
  - 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, redundant power system (RPS), and port LED colors on the images are similar to those used on the physical LEDs.
- Switch clustering technology for
  - Unified configuration, monitoring, authentication, and software upgrade of multiple, cluster-capable switches, regardless of their geographic proximity and interconnection media, including Ethernet, Fast Ethernet, Fast EtherChannel, small form-factor pluggable (SFP) modules, Gigabit Ethernet, and Gigabit EtherChannel connections. Refer to the release notes for a list of cluster-capable switches.

  - Automatic discovery of candidate switches and creation of clusters of up to 16 switches that can be managed through a single IP address.
  - Extended discovery of cluster candidates that are not directly connected to the command switch.

Performance Features

- 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 10/100/1000 Mbps interfaces that enables the interface to automatically detect the required cable connection type (straight through or crossover) and configure the connection appropriately
- 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 Gbps (Gigabit EtherChannel) or 800 Mbps (Fast EtherChannel) full duplex of bandwidth between switches, routers, and servers
- Port Aggregation Protocol (PAgP) and Link Aggregation Control Protocol (LACP) for automatic creation of EtherChannel links
- Forwarding of Layer 2 packets at Gigabit line rate
- 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
- Internet Group Management Protocol (IGMP) snooping for IGMP versions 1, 2, and 3 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)
- 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

Management Options

- CMS—CMS is a graphical user interface that can be launched from anywhere in your network through a web browser such as Netscape Communicator or Microsoft Internet Explorer. CMS is already installed on the switch. For more information about CMS, see Chapter 3, “Getting Started with CMS.”
- CLI—The Cisco IOS CLI software is enhanced to support desktop- and multilayer-switching features. You can access the CLI either by connecting your management station directly to the switch console port or by using Telnet from a remote management station. 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 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 25, “Configuring SNMP.”

Manageability Features

Note The encrypted Secure Shell (SSH) feature listed in this section is available only on the cryptographic (that is, supports encryption) version of the switch software image.

- Dynamic Host Configuration Protocol (DHCP) for automating configuration of switch information (such as IP address, default gateway, host name, and Domain Name System [DNS] and Trivial File Transfer Protocol (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
- Directed unicast requests to a DNS server for identifying a switch through its IP address and its corresponding host name 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 Media Access Control (MAC) address
- Unicast MAC address filtering to drop packets with specific source or destination MAC addresses
- Cisco Discovery Protocol (CDP) versions 1 and 2 for network topology discovery and mapping between the switch and other Cisco devices on the network
- Network Time Protocol (NTP) for providing a consistent timestamp 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
- In-band management access through CMS over a Netscape Communicator 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 [that is, supports encryption] version of the switch software image)
- In-band management access through SNMP versions 1 and 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

Note For additional descriptions of the management interfaces, see the "Network Configuration Examples" section on page 1-10.

Availability Features

- 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 balancing load across VLANs

  - Rapid PVST+ for balancing load across VLANs and providing rapid convergence of spanning-tree instances
  - UplinkFast and BackboneFast for fast convergence after a spanning-tree topology change and for achieving load balancing between redundant uplinks, including 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 IEEE 802.1W Rapid Spanning Tree Protocol (RSTP) for rapid convergence of the spanning tree by immediately transitioning 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 transition 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
- RPS support through the Cisco RPS 300 and Cisco RPS 675 for enhancing power reliability

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 full 1 to 4094 range 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 (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
- VLAN1 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.

Security Features

Note The Kerberos feature listed in this section is available only on the cryptographic (that is, supports encryption) version of the switch software image.

- Password-protected access (read-only and read-write access) to management interfaces (CMS and 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
- 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 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/User Datagram Protocol (UDP) headers
- Source and destination MAC-based ACLs for filtering non-IP traffic
- DHCP snooping to filter untrusted DHCP messages between untrusted hosts and DHCP servers
- IEEE 802.1X port-based authentication to prevent unauthorized devices (clients) from gaining access to the network
  - 802.1X with VLAN assignment for restricting 802.1X-authenticated users to a specified VLAN
  - 802.1X with port security for controlling access to 802.1X ports
  - 802.1X with voice VLAN to permit an IP phone access to the voice VLAN regardless of the authorized or unauthorized state of the port
  - 802.1X with guest VLAN to provide limited services to non-802.1X-compliant users
- Terminal Access Controller Access Control System Plus (TACACS+), a proprietary feature for managing network security through a TACACS server
- Remote Authentication Dial-In User Service (RADIUS) for verifying the identity of, granting access to, and tracking the actions of remote users through authentication, authorization, and accounting (AAA) services
- Kerberos security system to authenticate requests for network resources by using a trusted third party (requires the cryptographic [that is, supports encryption] version of the switch software image)

QoS and CoS Features

- Automatic QoS (auto-QoS) to simplify the deployment of existing QoS features by classifying traffic and configuring egress queues (voice over IP only)
- Classification
  - IP type-of-service/Differentiated Services Code Point (IP TOS/DSCP) and 802.1P CoS marking priorities on a per-port basis for protecting the performance of mission-critical applications
  - IP TOS/DSCP and 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
  - 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 determining the rate at which packets are dequeued to the 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 determining 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.

Monitoring Features

- Switch LEDs that provide port- and switch-level status
- 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 copper Ethernet 10/100/1000 ports

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-wide settings.

If you do not configure the switch at all, the switch operates with the default settings listed in Table 1-1. This table lists the key software features, their defaults, and where to find more information about the features.

For information about setting up the initial switch configuration and assigning basic IP information to the switch, refer to the hardware installation guide.

Table 1-1 Default Settings After Initial Switch Configuration

Feature	Default Setting	More information in...
Switch IP address, subnet mask, and default gateway	0.0.0.0	Chapter 4, "Assigning the Switch IP Address and Default Gateway"
Domain name	None	
DHCP	DHCP client enabled	
Switch cluster	Disabled	Chapter 5, "Clustering Switches"
Passwords	None defined	Chapter 6, "Administering the Switch"
TACACS+	Disabled	
RADIUS	Disabled	
System name and prompt	*Switch*	
NTP	Enabled	
DNS	Enabled	
802.1X	Disabled	Chapter 8, "Configuring 802.1X Port-Based Authentication"
Port parameters		
Operating mode	Layer 2 (switchport)	Chapter 9, "Configuring Interface Characteristics"
Interface speed and duplex mode	Autonegotiate	
Auto-MDIX	Disabled	
Flow control	Off	
SmartPort macros	None defined	Chapter 10, "Configuring SmartPort Macros"
VLANs		
Default VLAN	VLAN 1	Chapter 11, "Configuring VLANs"
VLAN trunking	Dynamic auto (DTP)	
Trunk encapsulation	Negotiate	
VTP mode	Server	Chapter 12, "Configuring VTP"
VTP version	1	
Voice VLAN	Disabled	Chapter 13, "Configuring Voice VLAN"
STP	PVST+ enabled on VLAN 1	Chapter 14, "Configuring STP"

Table 1-1 Default Settings After Initial Switch Configuration (continued)

Feature	Default Setting	More information in...
MSTP	Disabled	Chapter 15, "Configuring MSTP"
Optional spanning-tree features	Disabled	Chapter 16, "Configuring Optional Spanning-Tree Features"
DHCP snooping		
DHCP snooping	Disabled	Chapter 17, "Configuring DHCP Features"
DHCP snooping information option	Enabled	
IGMP snooping		
IGMP snooping	Enabled	Chapter 18, "Configuring IGMP Snooping and MVR"
IGMP filters	None applied	
IGMP throttling	Deny	
MVR	Disabled	
Port-based Traffic		
Broadcast, multicast, and unicast storm control	Disabled	Chapter 19, "Configuring Port-Based Traffic Control"
Protected ports	None defined	
Unicast and multicast traffic flooding	Not blocked	
Secure ports	None configured	
CDP	Enabled	Chapter 20, "Configuring CDP"
UDLD	Disabled	Chapter 21, "Configuring UDLD"
SPAN and RSPAN	Disabled	Chapter 22, "Configuring SPAN"
RMON	Disabled	Chapter 23, "Configuring RMON"
Syslog messages	Enabled; displayed on the console	Chapter 24, "Configuring System Message Logging"
SNMP	Enabled; version 1	Chapter 25, "Configuring SNMP"
ACLs	None configured	Chapter 26, "Configuring Network Security with ACLs"
QoS	Disabled	Chapter 27, "Configuring QoS"
EtherChannels	None configured	Chapter 28, "Configuring EtherChannels"

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 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 they use.

Table 1-2 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 1-2 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 1-3 describes some network demands and how you can meet those demands.

Table 1-3 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 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 Hot Standby Router Protocol (HSRP) for cluster command switch redundancy. • Use VLAN trunks 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.
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 802.1P/Q. The Catalyst 2970 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 2900 LRE XL and Catalyst 2950 LRE switches. Refer to the documentation sets specific to these switches for LRE information.

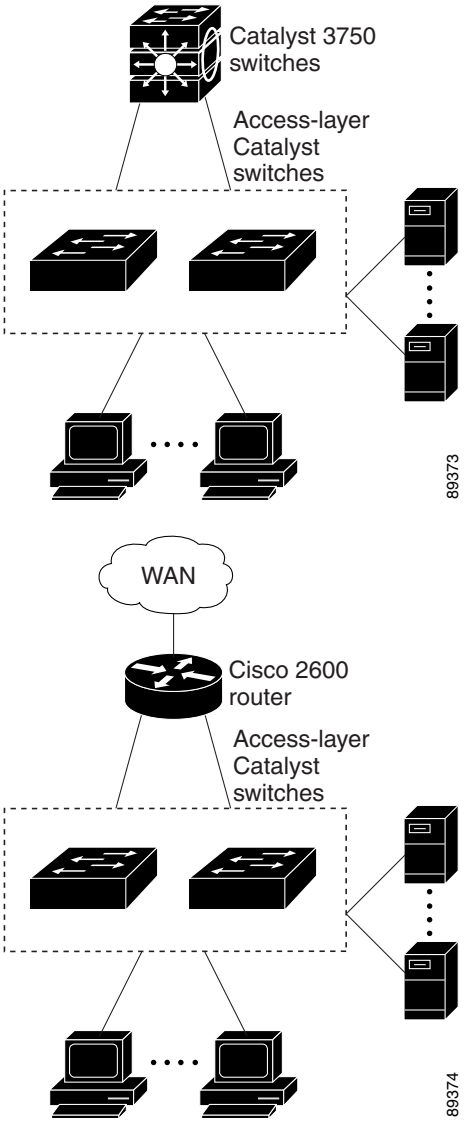
You can use the switches to create the following:

- Cost-effective Gigabit-to-the-desktop for high-performance workgroups (Figure 1-1)—For high-speed access to network resources, you can use Catalyst 2970 switches in the access layer to provide Gigabit Ethernet to the desktop. 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 with routing capability, such as a Catalyst3750 switch, or to a router

  The first illustration is of an isolated high-performance workgroup, where the Catalyst 2970 switches are connected to Catalyst 3750 switches in the distribution layer. The second illustration is of a high-performance workgroup in a branch office, where the Catalyst 2970 switches are connected to a router in the distribution layer.

  Each switch in this configuration provides users with a dedicated 1-Gbps connection to network resources. Using SFP modules also provides flexibility in media and distance options through fiber-optic connections.

Figure 1-1 High-Performance Workgroup (Gigabit-to-the-Desktop)



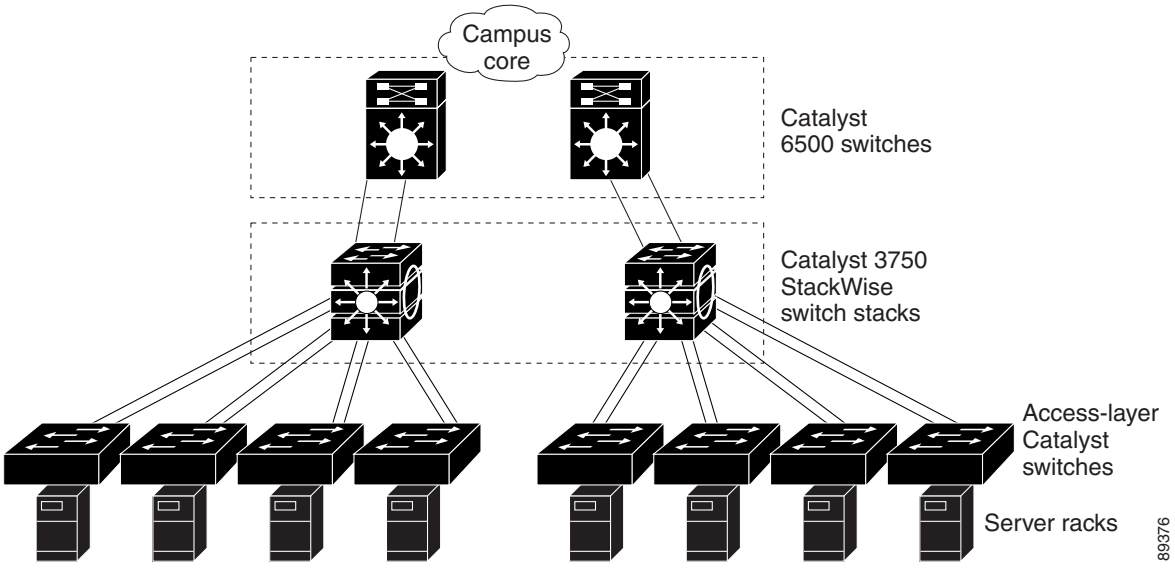
- Server aggregation (Figure 1-2)—You can use the switches to interconnect groups of servers, centralizing physical security and administration of your network. For high-speed IP forwarding at the distribution layer, connect the switches in the access layer to multilayer switches with routing capability.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

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

  Dual homing of servers to the switches with redundant Gigabit EtherChannel provides fault tolerance from the server racks to the core.

  Using dual SFP uplinks from the Catalyst 2970 switches provide redundant uplinks to the network core. Using SFP modules provides flexibility in media and distance options through fiber-optic connections.

Figure 1-2 Server Aggregation



Small to Medium-Sized Network Using Catalyst 2970 Switches

Figure 1-3 shows a configuration for a network of up to 500 employees. This network uses Catalyst 2970 switches with high-speed connections to two routers. For network reliability and load balancing, this network has HSRP enabled on the routers. This ensures connectivity to the Internet, WAN, and mission-critical network resources in case one of the routers fails. The switches are using EtherChannel for load sharing.

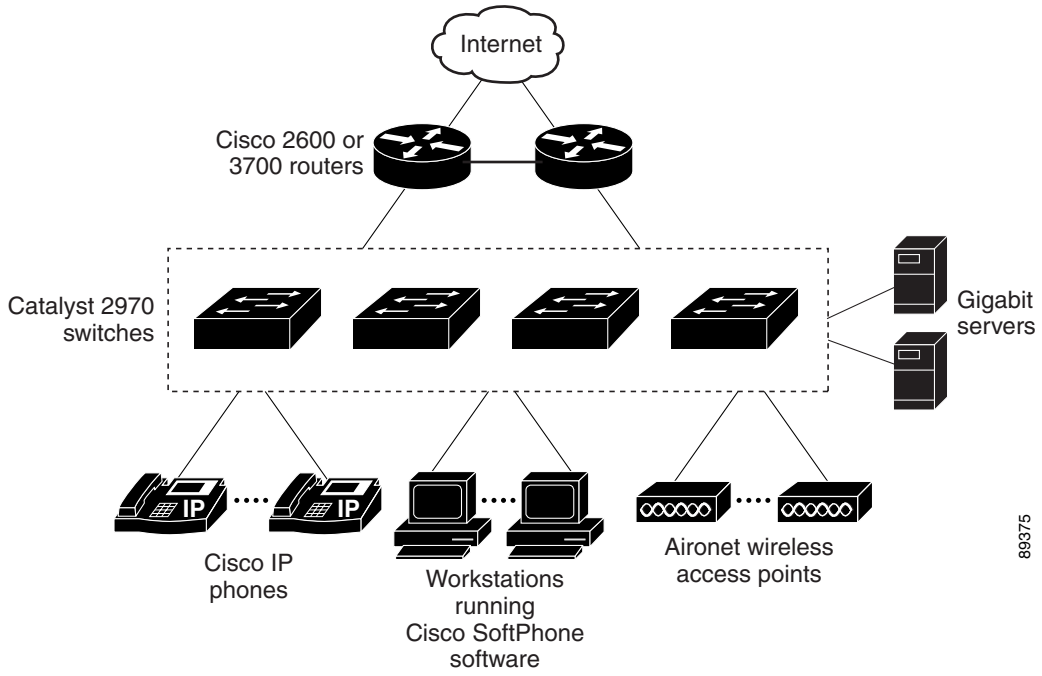
The switches are connected to workstations, Cisco IP Phones, and local servers. The switches are interconnected through Gigabit interfaces. This network uses VLANs to logically segment the network into well-defined broadcast groups and for security management. Data and multimedia traffic are configured on the same VLAN. Voice traffic from the Cisco IP Phones are 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. For any switch port connected to Cisco IP Phones, 802.1P/Q QoS gives voice traffic forwarding-priority over data traffic. Cisco IP Phones not connected to Catalyst Power over Ethernet (PoE) switches must be connected to AC power sources to receive power.

When an end station in one VLAN needs to communicate with an end station in another VLAN, a router routes the traffic to the appropriate destination VLAN. In this network, the routers are providing inter-VLAN routing. VLAN access control lists (VLAN maps) provide intra-VLAN security and prevent unauthorized users from accessing critical pieces of the network.

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

The routers also provide firewall services, Network Address Translation (NAT) services, voice-over-IP (VoIP) gateway services, and WAN and Internet access.

Figure 1-3 Catalyst 2970 Switches in a Collapsed Backbone Configuration



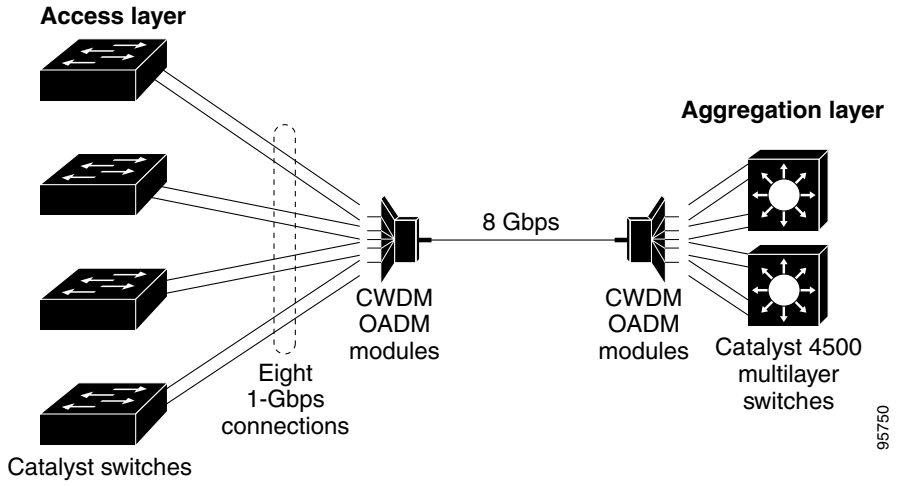
Long-Distance, High-Bandwidth Transport Configuration

Figure 1-4 shows a configuration for transporting 8 Gigabits of data over a single fiber-optic cable. The Catalyst switches have Coarse Wave Division Multiplexer (CWDM) fiber-optic SFP modules installed. Depending on the CWDM SFP module, data is sent at wavelengths from 1470 nm to 1610 nm. The higher the wavelength, the farther the transmission can travel. A common wavelength used for long-distance transmissions is 1550 nm.

The CWDM SFP modules connect to CWDM optical add/drop multiplexer (OADM) modules over distances of up to 393,701 feet (74.5 miles or 120 km). The CWDM OADM modules combine (or *multiplex*) the different CWDM wavelengths, allowing them to travel simultaneously on the same fiber-optic cable. The CWDM OADM modules on the receiving end separate (or *demultiplex*) the different wavelengths.

For more information about the CWDM SFP modules and CWDM OADM modules, refer to the *Cisco CWDM GBIC and CWDM SFP Installation Note*.

Figure 1-4 Long-Distance, High-Bandwidth Transport Configuration



Where to Go Next

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

- Chapter 2, “Using the Command-Line Interface”
- Chapter 3, “Getting Started with CMS”
- Chapter 4, “Assigning the Switch IP Address and Default Gateway”