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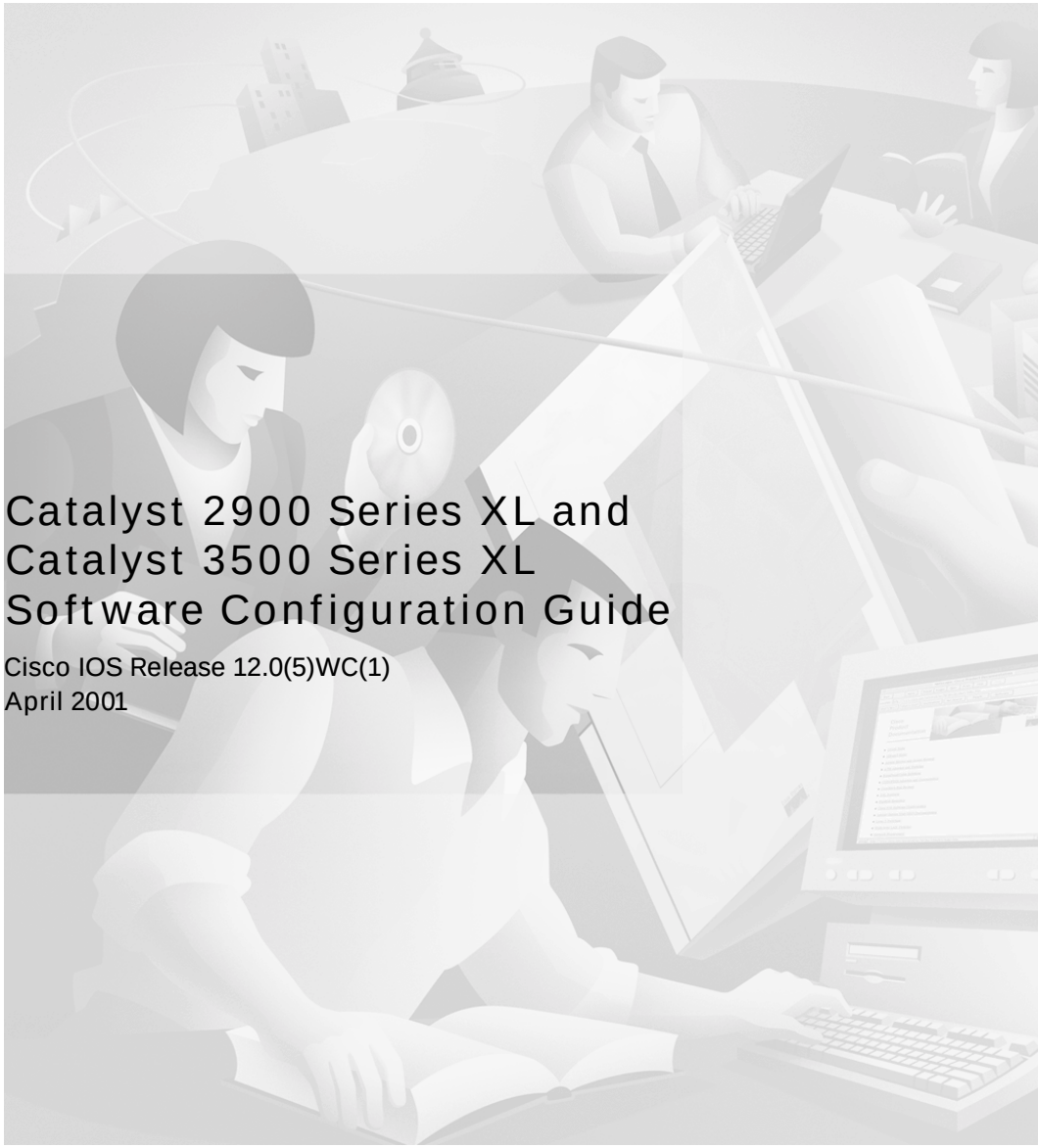
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Catalyst 2900 Series XL and Catalyst 3500 Series XL Software Configuration Guide

Cisco IOS Release 12.0(5)WC(1)
April 2001

Corporate Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 526-4100

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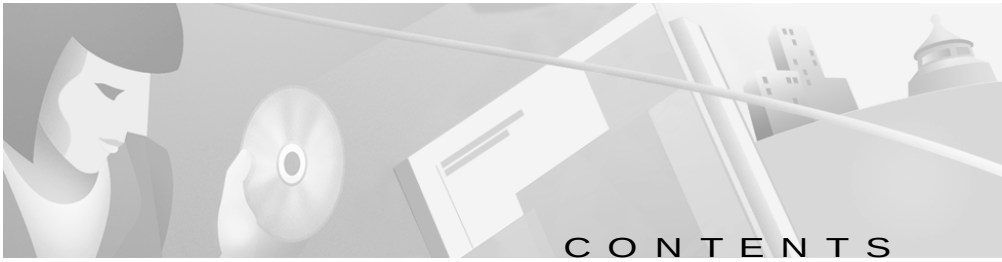
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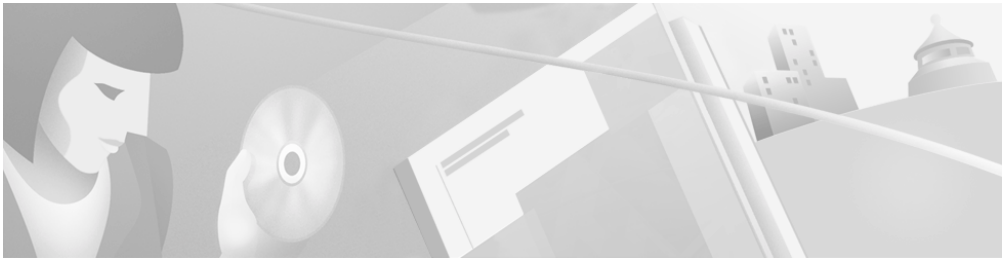
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Preface

Audience

The *Catalyst 2900 Series XL and Catalyst 3500 Series XL Software Configuration Guide* is for the network manager responsible for configuring the Catalyst 2900 series XL and Catalyst 3500 series XL switches, hereafter referred to as the switches. Before using this guide, you should be familiar with the concepts and terminology of Ethernet and local area networking.

Purpose

This guide provides information about configuring and troubleshooting a switch or switch clusters. This guide also provides information about configuring the Cisco 575 Long-Reach Ethernet (LRE) customer premises equipment (CPE). It includes descriptions of the management interface options and the features supported by the switch software.

Use this guide in conjunction with other documents for the following topics:

- Requirements—This guide assumes you have met the hardware and software requirements and cluster compatibility requirements, as described in the release notes.
- Start up information—This guide assumes you have assigned switch IP information and passwords by using the setup program, which is described in the release notes.

- Cluster Management Suite (CMS) information—This guide provides an overview of the CMS web-based, switch management interface. For information about CMS requirements and the procedures for browser and plug-in configuration and accessing CMS, refer to the release notes. For CMS field-level window descriptions and procedures, refer to the CMS online help.
- Cluster configuration—This guide provides information about planning for, creating, and maintaining switch clusters. Because configuring switch clusters is most easily performed through CMS, this guide does not provide the command-line interface (CLI) procedures. For the cluster commands, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.
- CLI command information—This guide provides an overview for using the CLI. For complete syntax and usage information about the commands that have been specifically created or changed for the Catalyst 2900 XL or Catalyst 3500 XL switches, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.



Note This guide does not repeat the concepts and CLI procedures provided in the standard Cisco IOS Release 12.0 documentation. For switch features that use standard Cisco IOS Release 12.0 commands, refer to the Cisco IOS Release 12.0 documentation on Cisco.com for additional information and CLI procedures.

Organization

The organization of this guide is as follows:

Chapter 1, "Overview," lists the software features of this release and provides examples of how the switch can be deployed in a network.

Chapter 2, "Getting Started with CMS," describes the Cluster Management Suite (CMS) web-based, switch management interface. Refer to the release notes for the procedures for configuring your web browser and accessing CMS. Refer to the online help for field-level descriptions of all CMS windows and procedures for using the CMS windows.

Chapter 3, "Getting Started with the CLI," describes the basics for using the Cisco IOS CLI.

Chapter 4, "General Switch Administration," includes the switch-configuration default settings and information about software releases, accessing the management interfaces, and using Simple Network Management Protocol (SNMP).

Chapter 5, "Clustering Switches," describes switch clusters and the considerations for creating and maintaining them. The online help provides the CMS procedures for configuring switch clusters. Cluster commands are described in the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

Chapter 6, "Configuring the System," provides the considerations and CLI procedures for configuring switch-wide settings. The online help provides the CMS procedures for configuring switch-wide settings.

Chapter 7, "Configuring the Switch Ports," provides the considerations and CLI procedures for configuring the switch ports. The online help provides the CMS procedures for configuring the switch ports.

Chapter 8, "Configuring VLANs," provides the considerations and CLI procedures for configuring VLANs. The online help provides the CMS procedures for configuring VLANs.

Chapter 9, "Troubleshooting," provides information about avoiding and resolving problems that might arise when you configure and maintain the switch.

Appendix A, "System Error Messages," lists the IOS system error messages for the switch.

Conventions

This guide uses the following conventions to convey instructions and information:

Command descriptions use these conventions:

- Commands and keywords are in **boldface** text.
- Arguments for which you supply values are in *italic*.
- Square brackets ([ ]) indicate optional elements.
- Braces ({ }) group required choices, and vertical bars (|) separate the alternative elements.
- Braces and vertical bars within square brackets ([{ | }]) indicate a required choice within an optional element.

Interactive examples use these conventions:

- Terminal sessions and system displays are in `screen` font.
- Information you enter is in **`boldface screen`** font.
- Nonprinting characters, such as passwords or tabs, are in angle brackets (< >).

Notes, cautions, and tips use the following conventions and symbols:



Note Means *reader take note*. Notes contain helpful suggestions or references to materials not contained in this manual.



Caution Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.



Tips Means *the following will help you solve a problem*. The tips information might not be troubleshooting or even an action, but could be useful information.

Related Publications

You can order printed copies of documents with a DOC-xxxxxx= number. See the "Ordering Documentation" section on page xxi.

The following publications provide more information about the switches:

- *Release Notes for the Catalyst 2900 Series XL and Catalyst 3500 Series XL Cisco IOS Release 12.0(5)WC(1)* (not orderable but is available on Cisco.com)
- Cluster Management Suite (CMS) online help
- Catalyst 2900 XL and Catalyst 3500 XL Documentation CD (not orderable)

Note This product-specific CD contains only the Catalyst 2900 XL and Catalyst 3500 XL switch documents and related hardware documents. This CD is not the same as the Cisco Documentation CD-ROM, which contains the documentation for all Cisco products and is shipped with all Cisco products.

The Catalyst 2900 XL and Catalyst 3500 XL Documentation CD is shipped with the switch and has the following publications:

- This *Catalyst 2900 Series XL and Catalyst 3500 Series XL Software Configuration Guide, Cisco IOS Release 12.0(5)WC(1)* (order number DOC-786511=)
- *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference, Cisco IOS Release 12.0(5)WC(1)* (order number DOC-7812155=)
- *Catalyst 2900 Series XL Hardware Installation Guide* (order number DOC-786461=)
- *Catalyst 3500 Series XL Hardware Installation Guide* (order number DOC-786456=)
- *Catalyst 2900 Series XL Modules Installation Guide* (order number DOC-CAT2900-IG=)
- *Catalyst 2900 Series XL ATM Modules Installation and Configuration Guide* (order number DOC-785472=)

- *1000BASE-T Gigabit Interface Converter Installation Note* (not orderable but is available on Cisco.com)
- *Catalyst GigaStack Gigabit Interface Converter Hardware Installation Guide* (order number DOC-786460=)
- *Cisco 575 LRE CPE Hardware Installation Guide* (order number DOC-7811469=)

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Note This CD contains the documentation for all Cisco products and is shipped with all Cisco products. This CD is not the same as the Catalyst 2900 XL and Catalyst 3500 XL Documentation CD, which contains only the Catalyst 2900 XL and Catalyst 3500 XL switch documents and related hardware documents.

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- Nonregistered CCO users can order documentation through a local account representative by calling Cisco corporate headquarters (California, USA) at 408 526-7208 or, in North America, by calling 800 553-NETS(6387).

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Cisco provides Cisco.com as a starting point for all technical assistance. Customers and partners can obtain documentation, troubleshooting tips, and sample configurations from online tools. For Cisco.com registered users, additional troubleshooting tools are available from the TAC website.

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If you have a priority level 3 (P3) or priority level 4 (P4) problem, contact TAC by going to the TAC website:

http://www.cisco.com/tac

P3 and P4 level problems are defined as follows:

- P3—Your network performance is degraded. Network functionality is noticeably impaired, but most business operations continue.
- P4—You need information or assistance on Cisco product capabilities, product installation, or basic product configuration.

In each of the above cases, use the Cisco TAC website to quickly find answers to your questions.

To register for Cisco.com, go to the following website:

http://www.cisco.com/register/

If you cannot resolve your technical issue by using the TAC online resources, Cisco.com registered users can open a case online by using the TAC Case Open tool at the following website:

http://www.cisco.com/tac/caseopen

Contacting TAC by Telephone

If you have a priority level 1 (P1) or priority level 2 (P2) problem, contact TAC by telephone and immediately open a case. To obtain a directory of toll-free numbers for your country, go to the following website:

http://www.cisco.com/warp/public/687/Directory/DirTAC.shtml

P1 and P2 level problems are defined as follows:

- P1—Your production network is down, causing a critical impact to business operations if service is not restored quickly. No workaround is available.
- P2—Your production network is severely degraded, affecting significant aspects of your business operations. No workaround is available.



Overview

This chapter provides the following topics about the Catalyst 2900 XL and Catalyst 3500 XL switch software:

- Features
- Management options
- Examples of the Catalyst 2900 XL and Catalyst 3500 XL switches in different network topologies

Features

The Catalyst 2900 XL and Catalyst 3500 XL software supports the switches and modules listed in the *Release Notes for the Catalyst 2900 Series XL and Catalyst 3500 Series XL Cisco IOS Release 12.0(5)WC(1)*. This software also supports the Cisco 575 Long-Reach Ethernet (LRE) customer premises equipment (CPE).

Table 1-1 describes the features supported in this release.

Note Table 4-2 on page 4-9 lists the defaults for all key features. It also includes references to where you can find additional information about each feature.

Table 1-1 Features

Ease of Use and Ease of Deployment
• Cluster Management Suite (CMS) software for simplified switch and switch cluster management through a web browser, such as Netscape Communicator or Microsoft Internet Explorer, from anywhere in your intranet • Switch clustering technology, in conjunction with CMS, for – Unified configuration, monitoring, authentication, and software upgrade of multiple switches (refer to the release notes for a list of eligible cluster members). – 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. • Hot Standby Router Protocol (HSRP) for command-switch redundancy **Note** See the "Advantages of Using CMS and Clustering Switches" section on page 1-8. Refer to the release notes for the CMS and cluster hardware, software, and browser requirements.
Performance
• Autosensing of speed on the 10/100 ports and autonegotiation of duplex mode on all switch ports for optimizing bandwidth • IEEE 802.3x flow control on 100-Mbps and Gigabit ports operating in full-duplex mode • Fast EtherChannel and Gigabit EtherChannel for enhanced fault tolerance and for providing up to 4 Gbps of bandwidth between switches, routers, and servers • Per-port broadcast storm control for preventing faulty end stations from degrading overall system performance with broadcast storms • Cisco Group Management Protocol (CGMP) for limiting multicast traffic to specified end stations and reducing overall network traffic • CGMP Fast Leave for accelerating the removal of unused CGMP groups to reduce superfluous traffic on the network • Multicast VLAN registration (MVR) to continuously send multicast streams in a multicast VLAN, but to isolate the streams from subscriber VLANs for bandwidth and security reasons • Protected port (private VLAN edge port) option for restricting the forwarding of traffic to designated ports on the same switch

Table 1-1 Features (continued)

Manageability
• Dynamic Host Configuration Protocol (DHCP)-based autoconfiguration for automatically configuring the switch during startup with IP address information and a configuration file that it receives during DHCP-based autoconfiguration **Note** DHCP replaces the Bootstrap Protocol (BOOTP) feature autoconfiguration to ensure retrieval of configuration files by unicast TFTP messages. BOOTP is available in earlier software releases for this switch. • Directed unicast requests to a Domain Name System (DNS) server for identifying a switch through its IP address and its corresponding host name • Address Resolution Protocol (ARP) for identifying a switch through its IP address and its corresponding MAC address • 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 • Directed unicast requests to a Trivial File Transfer Protocol (TFTP) server for administering software upgrades from a TFTP server • Default configuration stored in Flash memory to ensure that the switch can be connected to a network and can forward traffic with minimal user intervention • In-band management access through a CMS web-based session • In-band management access through up to 16 simultaneous Telnet connections for multiple command-line interface (CLI)-based sessions over the network • In-band management access through Simple Network Management Protocol (SNMP) set and get 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 and a modem **Note** For additional descriptions of the management interfaces, see the "Management Options" section on page 1-7.

Table 1-1 Features (continued)

Redundancy
• HSRP for command switch redundancy • UniDirectional link detection (UDLD) on all Ethernet ports 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 – Per-VLAN Spanning Tree (PVST) for balancing load across virtual LANs (VLANs) – Port Fast mode for eliminating forward delay by enabling a port to immediately change from a blocking state to a forwarding state – 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 – STP root guard for preventing switches outside the core of the network from becoming the STP root **Note** Depending on the model, a switch can support up to 64 or 250 instances of STP (see Table 8-1 on page 8-3).
VLAN Support
• Depending on the switch model, up to 64 or 250 port-based VLANs are supported for assigning users to VLANs associated with appropriate network resources, traffic patterns, and bandwidth **Note** For information about the maximum number of VLANs supported on each Catalyst 2900 XL and Catalyst 3500 XL switch, see the Table 8-1 on page 8-3. • Inter-Switch Link (ISL) and IEEE 802.1Q trunking protocol on all ports for simplified network moves, adds, and changes; better management and control of broadcast and multicast traffic; and improved network security by establishing VLAN groups for high-security users and network resources • VLAN Membership Policy Server (VMPS) for dynamic VLAN membership • VLAN Trunk Protocol (VTP) pruning for reducing network traffic by restricting flooded traffic to links destined for stations receiving the traffic

Table 1-1 Features (continued)

Quality of Service and Class of Service
• IEEE 802.1p class of service (CoS) with two priority queues on the 10/100 and LRE switch ports and eight priority queues on the Gigabit ports for prioritizing mission-critical and time-sensitive traffic from data, voice, and telephony applications • Voice VLAN (VVID) for creating subnets for voice traffic from Cisco IP Phones
Security
• 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 • Dynamic address learning for enhanced security • MAC-based port-level security for restricting the use of a switch port to a specific group of source addresses and preventing switch access from unauthorized stations • Terminal Access Controller Access Control System Plus (TACACS+), a proprietary feature for managing network security through a TACACS server
Monitoring
• Switch LEDs that provide visual management of port- and switch-level status • Switch Port Analyzer (SPAN) for complete traffic monitoring on any port • Four groups (history, statistics, alarm, and events) of embedded remote monitoring (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

Table 1-1 Features (continued)

Catalyst 2912 LRE and Catalyst 2924 LRE XL Switch-Specific Support
• Long-Reach Ethernet (LRE) technology for – Data and voice transmission through existing telephone lines (categorized and noncategorized unshielded twisted-pair cable) in multidwelling or tenant buildings. – Up to 15 Mbps of bandwidth to remote Ethernet devices at distances of up to 4921 ft (1500 m) on each switch LRE port. – Compliance with American National Standards Institute (ANSI) and European Telecommunication Standards Institute (ETSI) standards for spectral-mode compatibility with asymmetric digital subscriber line (ADSL), Integrated Services Digital Network (ISDN), and digital telephone networks. – Configuration and monitoring of connections between • Switch LRE ports and the Ethernet ports on remote LRE customer premises equipment (CPE) devices, such as the Cisco 575 LRE CPE. • CPE Ethernet ports and remote Ethernet devices, such as a PC. – Support for connecting to the Public Switched Telephone Network (PSTN) through *plain old telephone service* (POTS) splitters such as the Cisco LRE 48 POTS Splitter (PS-1M-LRE-48). For information about the Cisco 575 LRE CPE, refer to the *Cisco 575 LRE CPE Hardware Installation Guide*. For information about the nonhomologated Cisco LRE 48 POTS Splitter (PS-1M-LRE-48), refer to the *Cisco LRE 48 POTS Splitter Installation Note*.
Catalyst 3524-PWR XL Switch-Specific Support
• Ability to provide inline power to Cisco IP Phones from all 24 10/100 Ethernet ports • Autodetection and control of inline phone power on a per-port basis on all 10/100 ports • Fan-fault and over-temperature detection through Visual Switch Manager (VSM)

Management Options

The Catalyst 2900 XL and Catalyst 3500 XL switches are designed for plug-and-play operation: you only need to 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 configure and monitor the switch—on an individual basis or as part of a switch cluster—through its various management interfaces.

This section discusses these topics:

- Interface options for managing the switches
- Advantages of clustering switches and using CMS

Management Interface Options

You can configure and monitor individual switches and switch clusters by using the following interfaces:

- 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. Using CMS, you can fully configure and monitor a standalone switch, a specific cluster member, or an entire switch cluster. You can also display network topologies to gather link information and to display switch images to modify switch- and port-level settings.

  For more information about CMS, see Chapter 2, “Getting Started with CMS.”

- CLI—The switch IOS CLI software is enhanced to support desktop-switching features. You can fully configure and monitor the switch and switch cluster members from the CLI. 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 3, “Getting Started with the CLI.”

- SNMP—SNMP provides a means to monitor and control the switch and switch cluster members. You can manage switch configuration settings, performance, security, and collect statistics by using SNMP management applications such as CiscoWorks2000 LAN Management Suite (LMS) and HP OpenView.

  You can manage the switch 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 RMON groups.

  For more information about using SNMP, see the "SNMP Network Management Platforms" section on page 4-6.

Advantages of Using CMS and Clustering Switches

Using CMS and switch clusters can simplify and minimize your configuration and monitoring tasks. You can use Cisco switch clustering technology to manage up to 16 interconnected supported Catalyst switches through one IP address as if they were a single entity. This can conserve IP addresses if you have a limited number of them. CMS is the easiest interface to use and makes switch and switch cluster management accessible to authorized users from any PC on your network.

By using switch clusters and CMS, you can

- Manage and monitor interconnected Catalyst switches (refer to the release notes for a list of supported switches), regardless of their geographic proximity and interconnection media, including Ethernet, Fast Ethernet, Fast EtherChannel, Cisco GigaStack Gigabit Interface Converter (GBIC), Gigabit Ethernet, and Gigabit EtherChannel connections.
- Accomplish multiple configuration tasks from a single CMS window without needing to remember CLI commands to accomplish specific tasks.

- Apply actions from CMS to multiple ports and multiple switches at the same time to avoid re-entering the same commands for each individual port or switch. Here are some examples of globally setting and managing multiple ports and switches:
  - Port configuration such as speed and duplex settings
  - Port and console port security
  - NTP, STP, VLAN, and quality of service (QoS) configuration
  - Inventory and statistic reporting and link- and switch-level monitoring and troubleshooting
  - Group software upgrade
- View a topology of interconnected devices to identify existing switch clusters and eligible switches that can join a cluster. You can also use the topology to quickly identify link information between switches.
- Monitor 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 themselves.

For more information about CMS, see Chapter 2, “Getting Started with CMS.” For more information about switch clusters, see Chapter 5, “Clustering Switches.”

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 Fast Ethernet and 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 describes 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 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 network users require equal access—directly to the Fast Ethernet or Gigabit Ethernet switch ports so that they have their own Fast Ethernet or Gigabit Ethernet segment. • Use the Fast EtherChannel or Gigabit 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 such as voice and data integration 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
High demand for multimedia support	• Use CGMP and MVR to efficiently forward multicast traffic.
High demand for protecting mission-critical applications	• Use VLANs and protected ports to provide security and port isolation. • 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.
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. • Use VVIDs to provide a separate VLAN 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 2900 LRE XL switches to provide up to 15 Mb of IP connectivity over existing infrastructure (existing telephone lines).

Figure 1-1 shows three configuration examples for using the Catalyst 2900 XL and Catalyst 3500 XL switches to create the following:

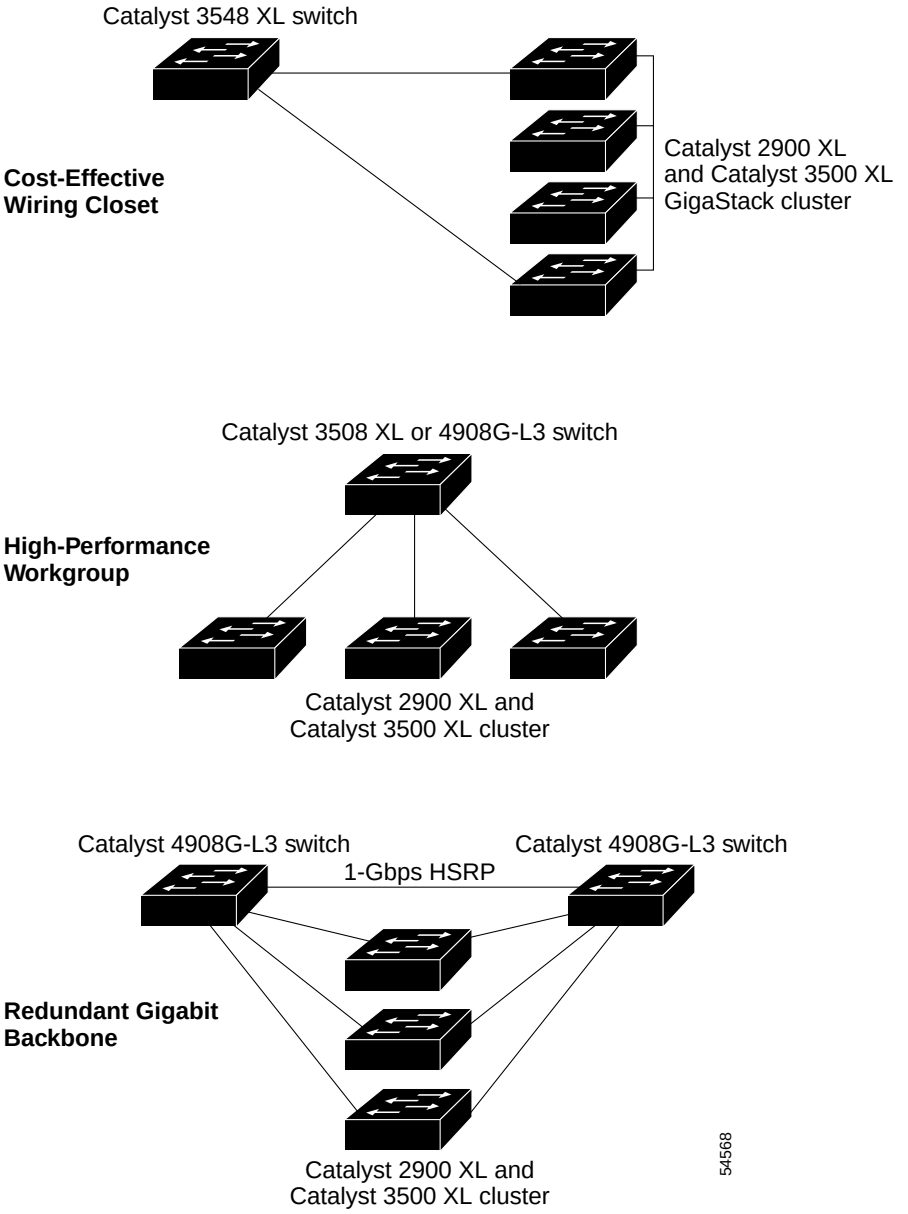
- Cost-effective wiring closet—A cost-effective way to connect many users to the wiring closet is to connect up to nine Catalyst 2900 and Catalyst 3500 XL switches through GigaStack GBIC connections. When you use a stack of Catalyst 3548 XL switches, you can connect up to 432 users. To preserve switch connectivity if one switch in the stack fails, connect the bottom switch to the top switch to create a GigaStack loopback and enable Cross-Stack UplinkFast on the cross-stack Gigabit uplinks.

  You can create backup paths by using Fast Ethernet, Gigabit, or Fast EtherChannel, or Gigabit EtherChannel links. Using Gigabit modules on two of the switches, you can have redundant uplink connections to a Gigabit backbone switch such as the Catalyst 3508G XL switch. If one of the redundant connections fails, the other can serve as a backup path. You can configure the stack members and the Catalyst 3508G XL switch as a switch cluster to manage them through a single IP address.

- High-performance workgroup—For users who require high-speed access to network resources, use Gigabit modules to connect the switches directly to a backbone switch in a star configuration. Each switch in this configuration provides users a dedicated 1-Gbps connection to network resources in the backbone. Compare this with the switches in a GigaStack configuration, where the 1-Gbps connection is shared among the switches. Using the following Gigabit modules also provides flexibility in media and distance options:
  - 1000BASE-SX GBIC: fiber connections of up to 1804 ft (550 m)
  - 1000BASE-LX/LH GBIC: fiber connections of up to 32,808 ft (10 km)
  - 1000BASE-ZX GBIC: fiber connections of up to 328,084 ft (100 km)
  - 1000BASE-T GBIC: copper connections of up to 328 ft (100 m)
  - Catalyst 2900 XL 1000BASE-T: copper connections of up to 328 ft (100 m)

- Redundant Gigabit backbone—Using HSRP, you can create backup paths between Catalyst 4908G-L3 switches. To enhance network reliability and load balancing for different VLANs and subnets, you can connect the Catalyst 2900 XL and Catalyst 3500 XL switches, again in a star configuration, to two backbone switches. If one of the backbone switches fails, the second backbone switch preserves connectivity between the switches and network resources.

Figure 1-1 Example Configurations



Small to Medium-Sized Network Configuration

Figure 1-2 shows a configuration for a network that has up to 250 users. Users in this network require e-mail, file-sharing, database, and Internet access.

You optimize network performance by placing workstations on the same logical segment as the servers they access most often. This divides the network into smaller segments (or workgroups) and reduces the amount of traffic that travels over a network backbone, thereby increasing the bandwidth available to each user and improving server response time.

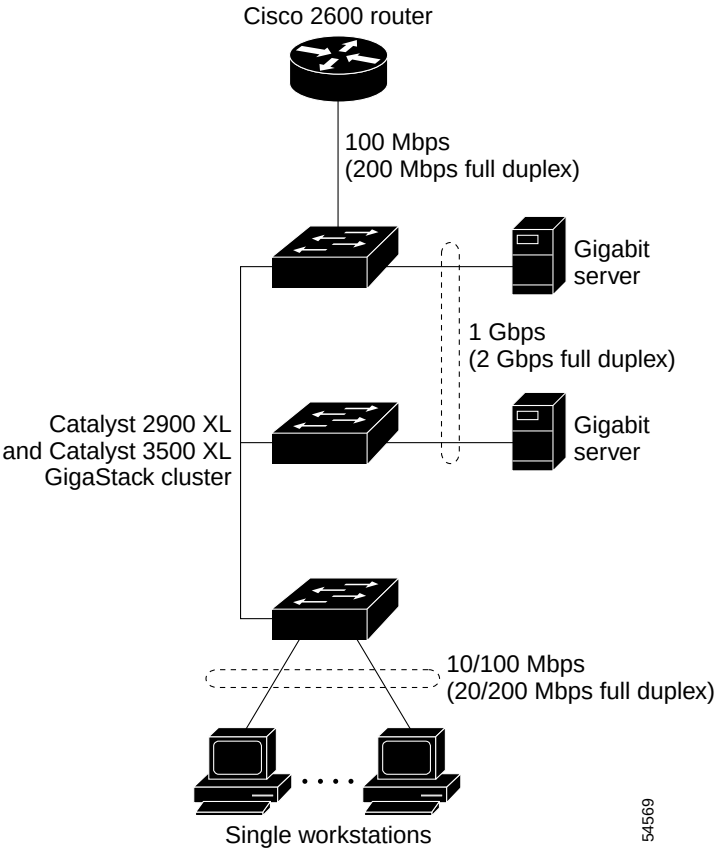
A *network backbone* is a high-bandwidth connection (such as Fast Ethernet or Gigabit Ethernet) that interconnects segments and network resources. It is required if numerous segments require access to the servers. The Catalyst 2900 XL and Catalyst 3500 XL switches in this network are connected through a GigaStack GBIC on each switch to form a 1-Gbps network backbone. This GigaStack can also be configured as a switch cluster, with primary and secondary command switches for redundant cluster management.

Workstations are connected directly to the 10/100 switch ports for their own 10- or 100-Mbps access to network resources (such as web and mail servers). When a workstation is configured for full-duplex operation, it receives up to 200 Mbps of dedicated bandwidth from the switch.

Servers are connected to the Gigabit module ports on the switches, allowing 1-Gbps throughput to users when needed. When the switch and server ports are configured for full-duplex operation, the links provide 2 Gbps of bandwidth. For networks that do not require Gigabit performance from a server, connect the server to a Fast Ethernet or Fast EtherChannel switch port.

Connecting a router to a Fast Ethernet switch port provides multiple, simultaneous access to the Internet through one line.

Figure 1-2 Small to Medium-Sized Network Configuration



Collapsed Backbone and Switch Cluster Configuration

Figure 1-3 shows a configuration for a network of approximately 500 employees. This network uses a collapsed backbone and switch clusters. A collapsed backbone has high-bandwidth uplinks from all segments and subnetworks to a single device, such as a Gigabit switch, which serves as a single point for monitoring and controlling the network. You can use a Catalyst 4908G-L3 switch, as shown, or a Catalyst 3508G XL switch to create a Gigabit backbone. A Catalyst 4908G-L3 backbone switch provides the benefits of inter-VLAN routing and allows the router to focus on WAN access.

The workgroups are created by clustering all the Catalyst switches except the Catalyst 4908G-L3 switch. Using CMS and Cisco switch clustering technology, you can group the switches into multiple clusters, as shown, or into a single cluster. You can manage a cluster through the IP address of its active and standby command switches, regardless of the geographic location of the cluster members.

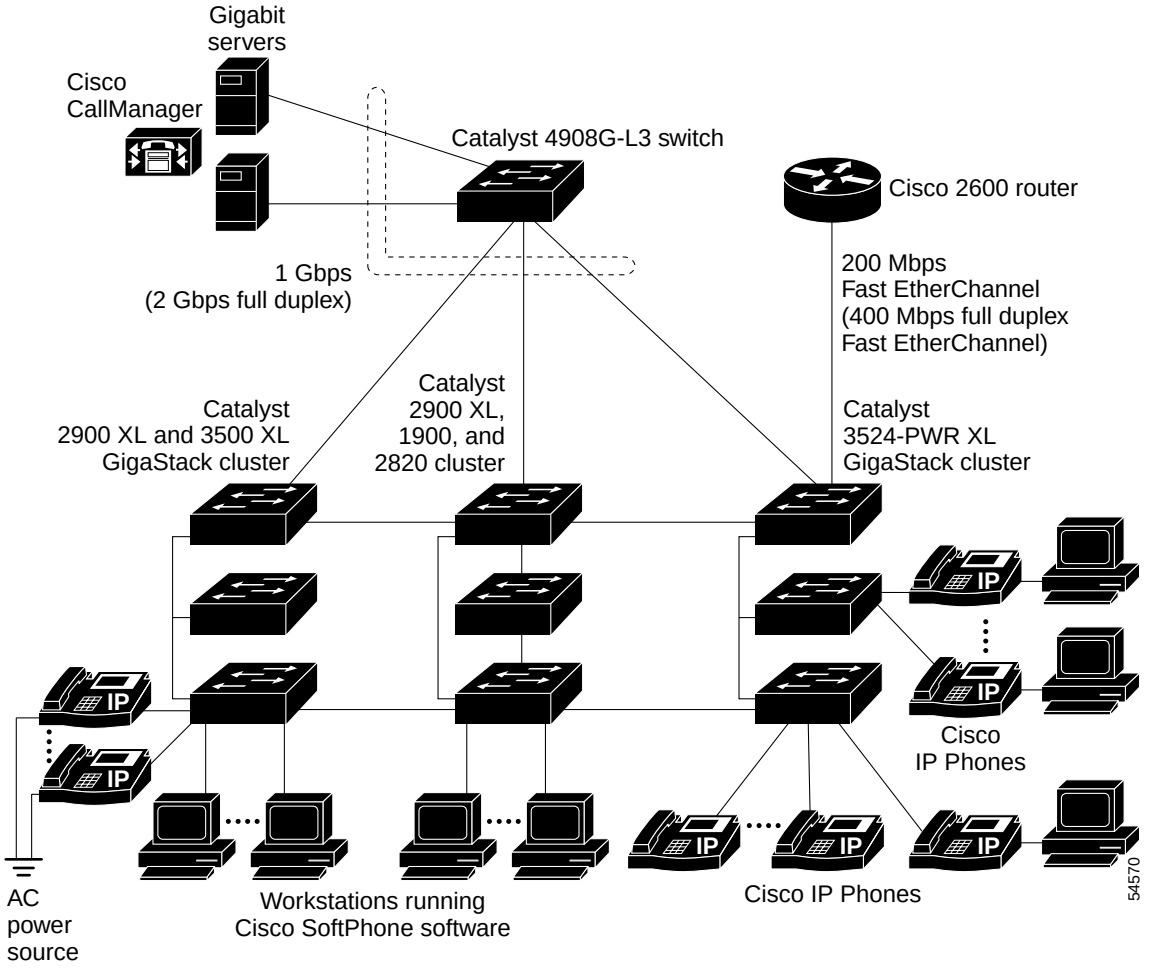
This network uses VLANs to segment the network logically into well-defined broadcast groups and for security management. Data and multimedia traffic are configured on the same VLAN. Voice traffic from the Cisco IP Phones are configured on separate VVIDs. You can have up to four VVIDs per wiring closet. 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 forwarding priority to voice traffic over data traffic.

Grouping servers in a centralized location provides benefits such as security and easier maintenance. The Gigabit connections to a server farm provide the workgroups full access to the network resources (such as a call-processing server running Cisco CallManager software, a DHCP server, or an IP/TV multicast server).

Cisco IP Phones are connected—using standard straight-through, twisted-pair cable with RJ-45 connectors—to the 10/100 inline-power ports on the Catalyst 3524-PWR XL switches and to the 10/100 ports on the Catalyst 2900 XL and Catalyst 3500 XL switches. These multiservice switch ports automatically detect if an IP phone is connected. Cisco CallManager controls call processing, routing, and IP phone features and configuration. Users with workstations running Cisco SoftPhone software can place, receive, and control calls from their PCs. Using Cisco IP Phones, Cisco CallManager software, and Cisco SoftPhone software integrates telephony and IP networks, where the IP network supports both voice and data.

Each 10/100 inline-power port on the Catalyst 3524-PWR XL switches provides –48 VDC power to the Cisco IP Phone. The IP phone can receive redundant power when it also is connected to an AC power source. IP phones not connected to the Catalyst 3524-PWR XL switches receive power from an AC power source.

Figure 1-3 Collapsed Backbone and Switch Cluster Configuration



Large Campus Configuration

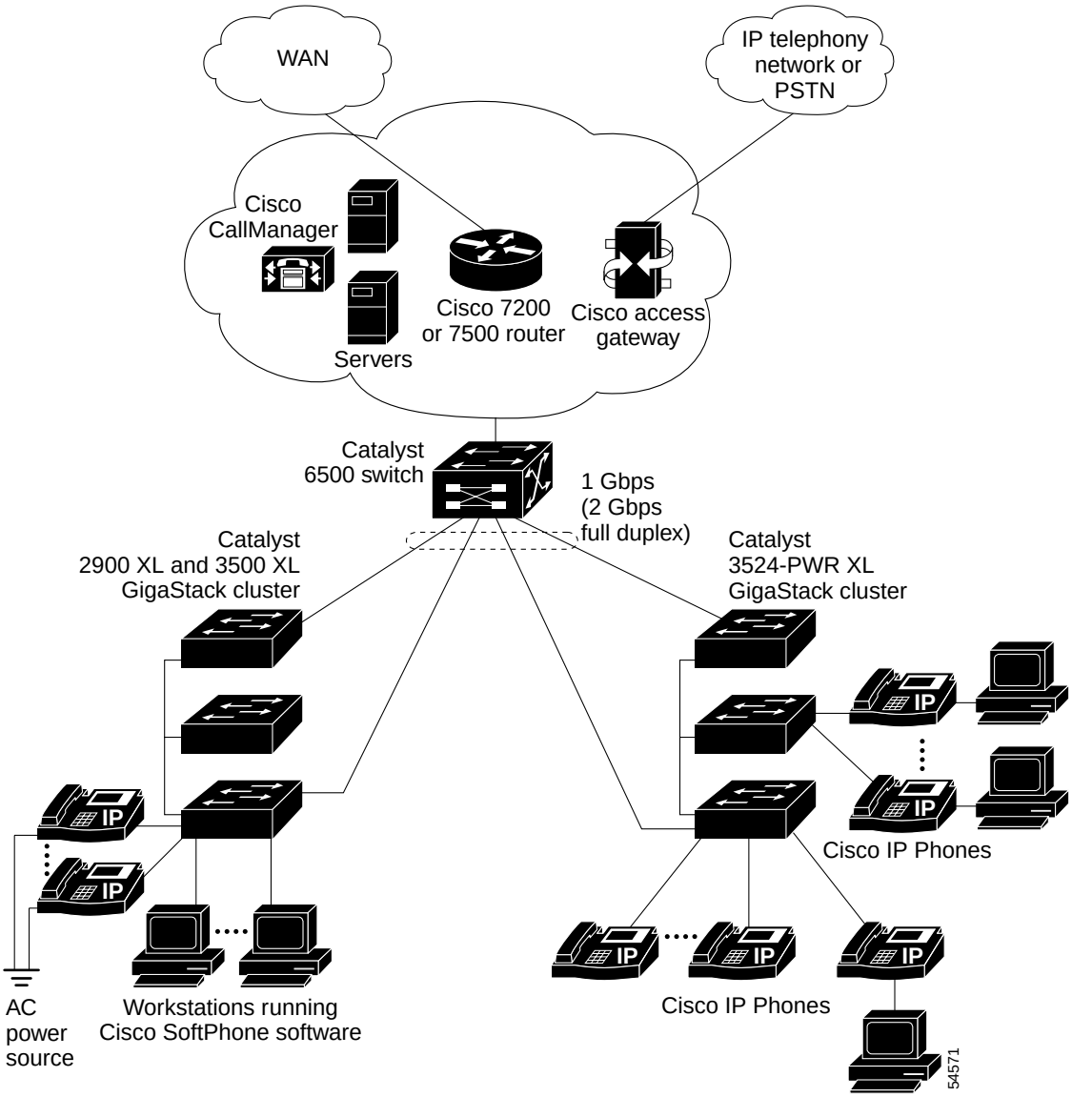
Figure 1-4 shows a configuration for a network of more than 1000 users. Because it can aggregate up to 130 Gigabit connections, a Catalyst 6500 multilayer switch is used as the backbone switch.

You can use the workgroup configurations shown in previous examples to create workgroups with Gigabit uplinks to the Catalyst 6500 switch. For example, you can use switch clusters that have a mix of Catalyst 2900 XL and Catalyst 3500 XL switches.

The Catalyst 6500 switch provides the workgroups with Gigabit access to core resources:

- Cisco 7000 series router for access to the WAN and the Internet.
- Server farm that includes a call-processing server running Cisco CallManager software. Cisco CallManager controls call processing, routing, and IP phone features and configuration.
- Cisco Access gateway (such as Cisco Access Digital Trunk Gateway or Cisco Access Analog Trunk Gateway) that connects the IP network to the PSTN or to users in an IP telephony network.

Figure 1-4 Large Campus Configuration



Hotel Network Configuration

Figure 1-5 shows the Catalyst 2900 LRE XL switches in a hotel network environment with approximately 200 rooms. This network includes a private branch exchange (PBX) switchboard, a router, and high-speed servers.

Connected to the telephone line in each hotel room is a Cisco 575 LRE CPE, which provides both telephone and Ethernet connections. A room telephone connects to the CPE phone port. The hotel customer would connect a laptop or the television set-top box to the CPE Ethernet port. The laptop and telephone, connected to the CPE, share the same telephone line.

Note All telephones not directly connected to the hotel room CPE require microfilters with a 300-Ohm termination. Microfilters improve voice call quality when voice and data equipment are using the same telephone line. They also prevent nonfiltered telephone rings and nonfiltered telephone transitions (such as on-hook to off-hook) from interrupting the Ethernet connection.

Through a patch panel, the telephone line from each room connects to a nonhomologated POTS splitter, such as the Cisco LRE 48 POTS Splitter (PS-1M-LRE-48). The splitter routes data (high-frequency) and voice (low-frequency) traffic from the telephone line to the switch and PBX. The PBX routes voice traffic to the PSTN. If a PBX is not available, a homologated POTS splitter is required to connect to the PSTN. If a connection to a phone network is not required at all, a splitter is not needed, and the switch can connect directly to the patch panel.

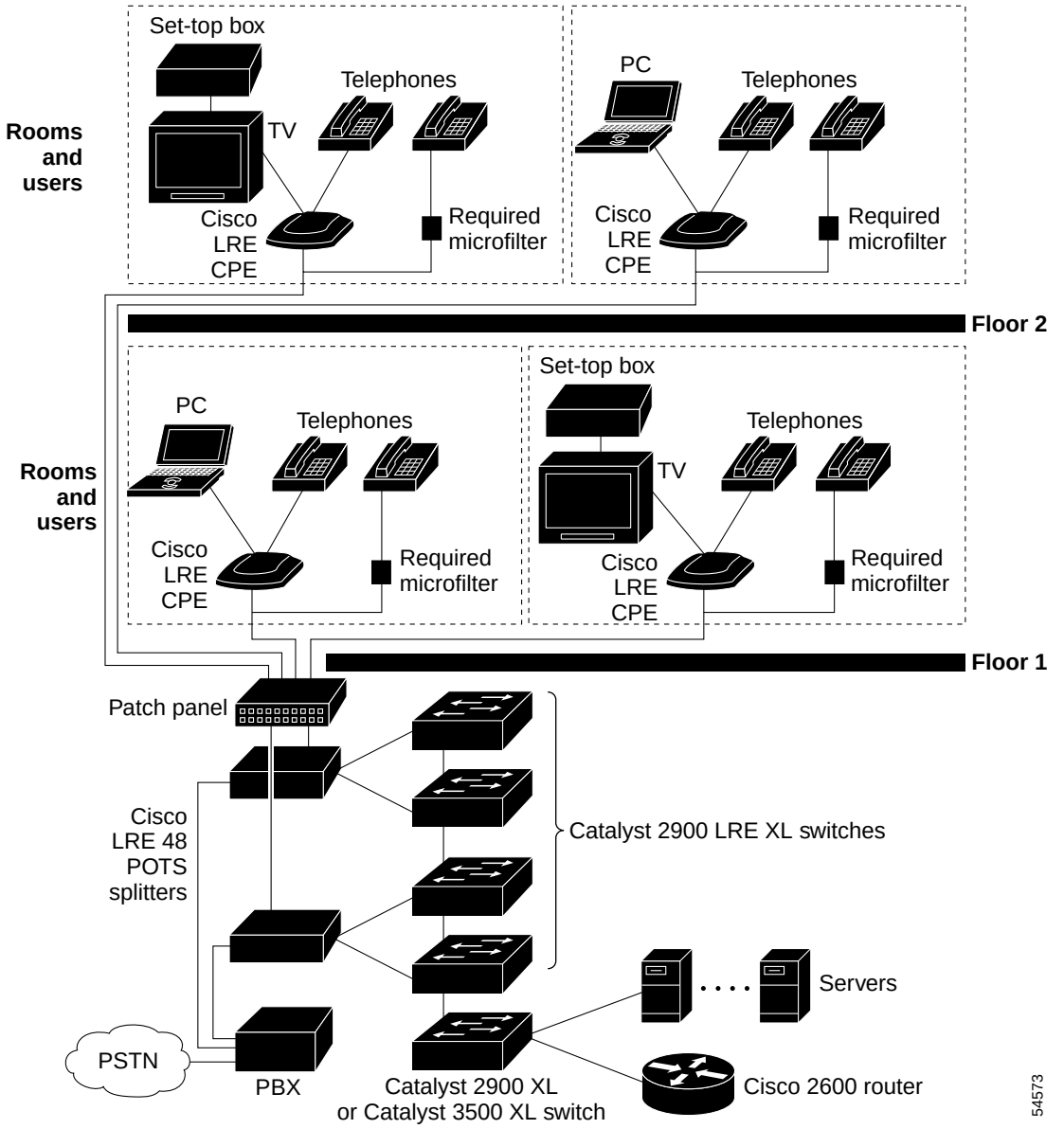
Data to and from the laptop and IP multicast traffic for the television are transferred through the LRE link, which is established between the CPE wall port and the LRE port on a Catalyst 2900 LRE XL switch. The upstream and downstream rates on the LRE link are controlled by a profile configured on each LRE port. If the Catalyst 2900 LRE XL switches were connected to the PSTN through a homologated POTS splitter, all LRE ports would use an ANSI-compliant LRE profile named PUBLIC-ANSI.

The Catalyst 2900 LRE XL switches are cascaded through the 10/100 switch ports. Each switch also has a 10/100 connection to an aggregation switch, such as a Catalyst 3524 XL switch. The aggregation switch can connect to

- Accounting, billing, and provisioning servers.
- A router that provides Internet access to the premises.

You can manage the switches through CMS as one or more switch clusters. You can also manage and monitor the individual CPEs through the Catalyst 2900 LRE XL switches to which they are connected. The LRE ports support the same software features as the 10/100 ports. For example, you can configure port-based VLANs on the LRE ports to provide individual port security and protected ports to further prevent unwanted broadcasts within the VLANs.

Figure 1-5 Hotel Network Configuration



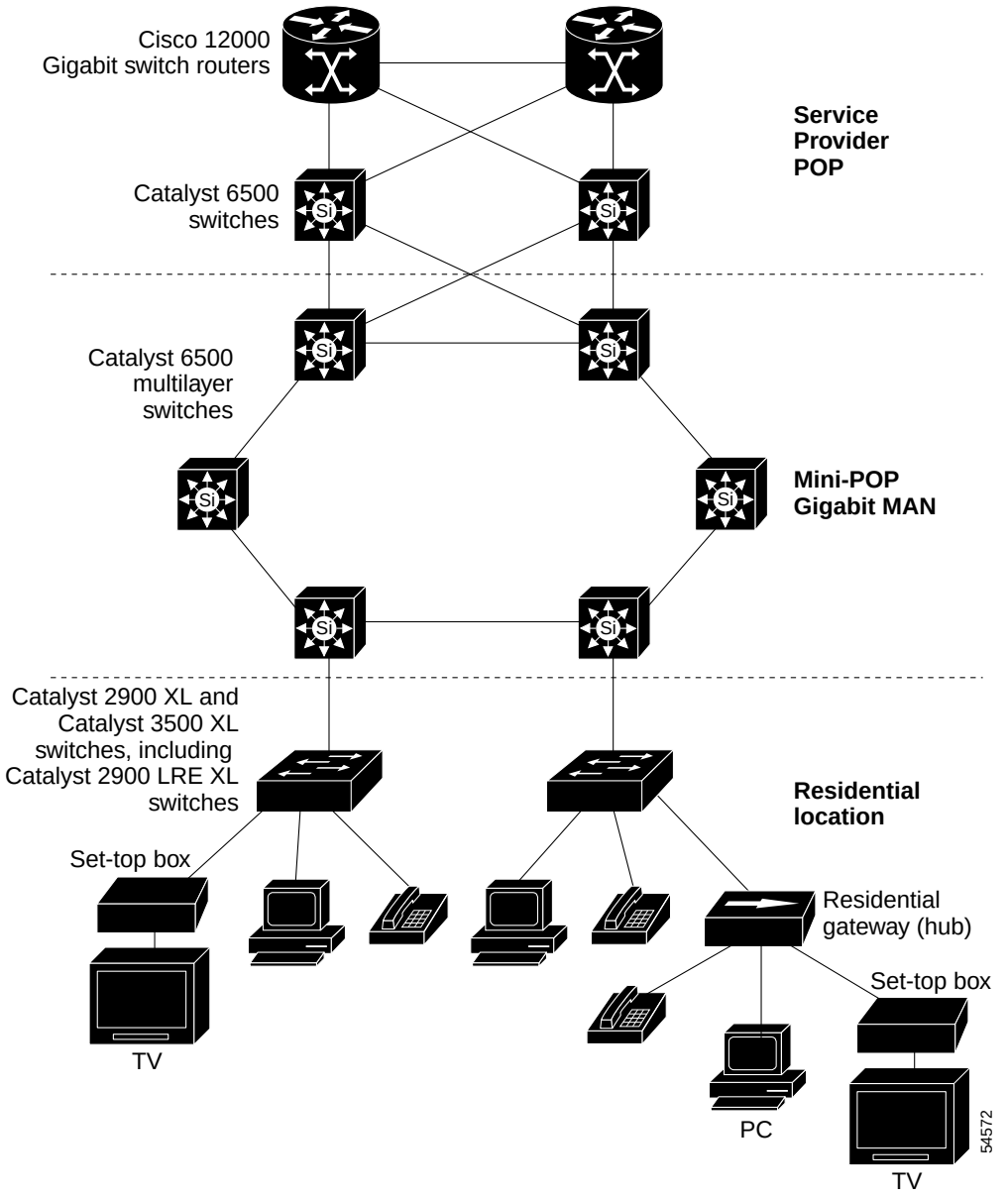
Multidwelling Configuration

A growing segment of residential and commercial customers are requiring high-speed access to Ethernet metropolitan-area networks (MANs). Figure 1-6 shows a configuration for a Gigabit Ethernet MAN ring using Catalyst 6500 switches as aggregation switches in the mini-point-of-presence (POP) location. These switches are connected through 1000BASE-X GBIC ports.

The resident switches can be Catalyst 2900 XL and Catalyst 3500 XL switches, providing customers with either Fast Ethernet or Gigabit Ethernet connections to the MAN. Catalyst 2900 LRE XL switches can also be used as residential switches for customers requiring connectivity through existing telephone lines. The Catalyst 2900 LRE XL switches can then connect to another residential switch through a 10/100 connection.

All ports on the residential switches are configured as 802.1Q trunks with the protected port and STP root guard options enabled. The protected port option provides security and isolation between ports on the switch, ensuring that subscribers cannot view packets destined for other subscribers. STP root guard prevents unauthorized devices from becoming the STP root switch. All ports have CGMP enabled for multicast traffic management. Higher VLAN and VLAN ID (4096) support is ideal for more security flexibility.

Figure 1-6 Multi-Dwelling Configuration





CHAPTER 2

Getting Started with CMS

This chapter describes the following features and interface components of the Cluster Management Suite (CMS) software:

- Visual Switch Manager (VSM) and Cluster Manager
- Cluster Builder and Cluster View
- CMS window components

This chapter also includes the following topics:

- Accessing CMS
- Saving changes on CMS
- Using different versions of CMS

For system requirements and for browser and Java plug-in configurations, refer to the release notes. For field-level descriptions of the CMS windows and for procedures for using CMS, refer to the online help.

Note This chapter describes the CMS interface used on the Catalyst 2900 XL and Catalyst 3500 XL switches. Refer to the appropriate switch documentation for descriptions of the web-based management software used on other Catalyst desktop switches, such as the Catalyst 2950, Catalyst 1900, and Catalyst 2820 switches.

Features

CMS consists of the following integrated set of Java-based applications for managing switch clusters and individual switches from a standard Web browser such as Netscape Communicator or Microsoft Internet Explorer:

- Cluster Manager and Visual Switch Manager (VSM)—Cluster Manager is the application for configuring and monitoring the switches in a specific cluster. When launched, it displays a front-panel view of all switches in the cluster.

  VSM is the application for configuring and monitoring a standalone switch or a specific switch in a cluster. It is also the application used to enable a cluster command switch. When launched, it displays a front-panel view of a specific switch.



Note You can display VSM for a specific switch from Cluster Builder or Cluster View by selecting **Device > Launch Switch Manager**. You cannot display VSM from Cluster Manager. For more information about accessing CMS, see the "Accessing CMS" section on page 2-35.

- Cluster Builder and Cluster View—Cluster Builder is the application from which you can create and modify a specific switch cluster. When launched, it displays a topology (network map) of the cluster command switch, cluster members, cluster candidates, edge devices, and the link speeds between all cluster members.

  Cluster View is the application from which you can display connected switch clusters and neighboring edge devices in your network.

  You can toggle between Cluster Builder and Cluster View by selecting **View > Toggle Views**. For more information about accessing CMS, see the "Accessing CMS" section on page 2-35.

The CMS windows use a consistent set of components (such as tabs, buttons, drop-down lists, and so on), regardless of the CMS application you use. Each CMS window also includes comprehensive online help, which provides procedures for performing tasks from the window and high-level concepts.

Cluster Manager and VSM

Cluster Manager is the CMS application for configuring the port-, switch-, and cluster-level settings of the switches in a cluster. VSM is the application for configuring switch- and port-level settings for a single switch.

To assist in your configuration and monitoring tasks, both applications provide the following features:

- A display of switch images (Figure 2-1 and Figure 2-2) for visual monitoring of the switches and switch ports. For information about using the switch images, see the "Switch Images" section on page 2-7.
- A menu bar that, except for a few options, provides the same options for managing a single switch and clustered switches. This menu bar is described in the "Menu Bars" section on page 2-14.
- A toolbar that provides buttons for displaying commonly used, switch- and cluster-level configuration windows and for displaying the legends and online help. This toolbar is described in the "Toolbar" section on page 2-17.
- A port-level pop-up menu for displaying windows specific for configuring and monitoring switch ports. This pop-up menu is described in the "Port Pop-Up Menu" section on page 2-18.
- A device-level pop-up menu for displaying the configuration and monitoring windows also available from the menu bar. This pop-up menu is described in the "Device Pop-Up Menu" section on page 2-19.

The toolbar and pop-up menus provide quick ways to access the configuration and monitoring options available from the menu bar.

Figure 2-1 Visual Switch Manager

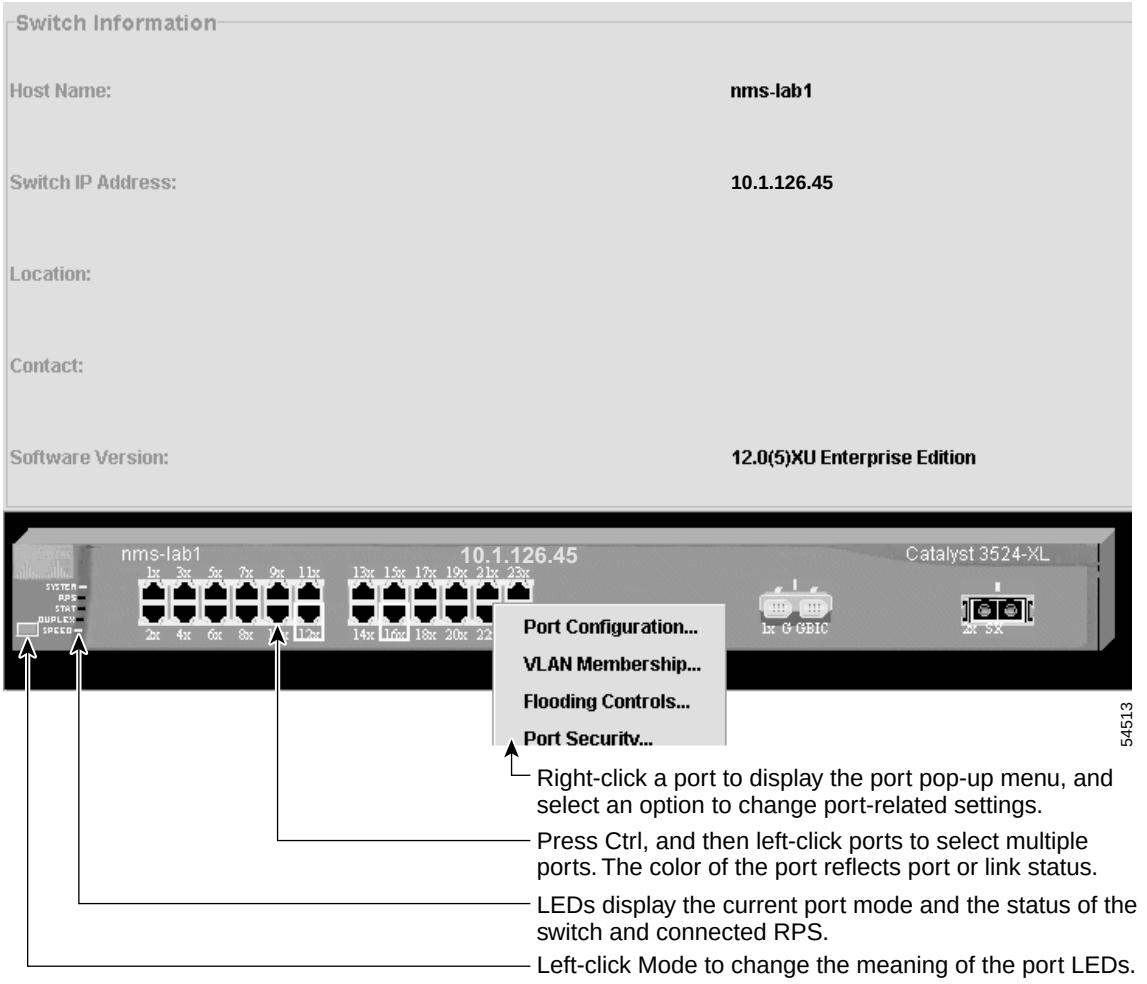
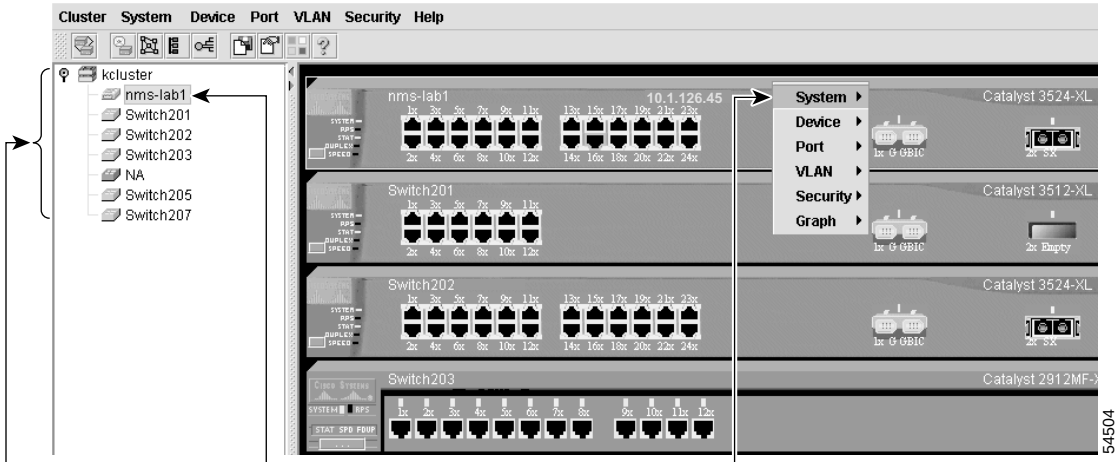


Figure 2-2 Cluster Manager



Cluster tree

Select a switch from the cluster tree. The color of the switch icon reflects switch status.

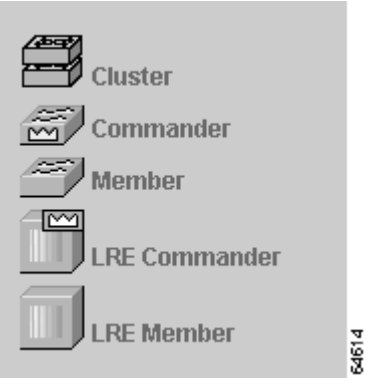
Right-click a switch to display the device pop-up menu, and select an option to change system-related settings.

Cluster Tree

The cluster tree appears in the Cluster Manager left frame (Figure 2-2). It displays a list of the switches in a specific cluster. The sequence of the cluster tree icons mirrors the sequence of the switch front-panel images. Select a cluster-tree icon to select the corresponding switch image. After you select a switch, you can configure switch-wide settings from either the Cluster Manager menu bar options or the device pop-up menu.

The cluster tree uses a subset of the same icons used in the topology displayed in Cluster View and Cluster Builder. Figure 2-3 shows the device icons as they appear in the cluster tree.

Figure 2-3 Cluster Tree Icons



The cluster tree displays the cluster name and the names and the status of cluster members (Table 2-1). For example, a yellow switch icon in the cluster tree means that particular switch is overheating or the fan is broken. Complete descriptions of the icons and icon colors are available by selecting **Help > Legend**.

Table 2-1 Cluster Tree Icon Colors

Color	Switch Status
Green	Switch is operating normally.
Yellow	A system fault exists, such as the internal fan is not operating.
Red	Switch is not powered up, has lost power, or the command switch is unable to communicate with the member switch.

Switch Images

Use the front-panel images for visual switch management from a remote station. The LEDs on these images are updated at user-configurable polling intervals, making them as useful as the LEDs on the actual switches themselves. To change the polling intervals, select **System > User Settings** from VSM or **Cluster > User Settings** from Cluster Manager.

The following sections provide complete descriptions of the Catalyst 2900 XL and Catalyst 3500 XL LED images:

- System LED
- RPS LED
- Port LEDs

Summarized descriptions of the LED images are available from the VSM and Cluster Manager menu bar by choosing **Help > Legend**.

System LED

The system LED shows whether the switch is receiving power and functioning properly. Table 2-2 lists the LED colors and their meanings.

Table 2-2 System LED

Color	System Status
Black (off)	System is not powered up.
Green	System is operating normally.
Amber	System is receiving power but is not functioning properly.

Redundant Power System LED

The Redundant Power System (RPS) LED shows the RPS status. Table 2-3 and Table 2-4 list the LED colors and their meanings.

Note The Catalyst 2912 LRE XL, Catalyst 2924 LRE XL, and Catalyst 3524-PWR XL switches use the Cisco RPS 300 (model PWR300-AC-RPS-N1). All other Catalyst 2900 XL and Catalyst 3500 XL switches use the Cisco RPS 600 (model PWR600-AC-RPS). Refer to the appropriate switch documentation for RPS descriptions specific for the switch.

Table 2-3 Cisco RPS 600 LED on the Catalyst 2900 XL and Catalyst 3500 XL Switches Except the Catalyst 2912 LRE, 2924-LRE, and 3524-PWR XL Switches

Color	RPS Status
Black (off)	RPS is off or is not installed.
Green	RPS is operational.
Blinking green	RPS and the switch AC power supply are both powered up. If the switch power supply fails, the switch powers down and after 15 seconds restarts, using power from the RPS. The switch goes through its normal boot sequence when it restarts. **Note** This is not a recommended configuration.
Amber	RPS is connected but not functioning properly. One of the power supplies in the RPS could be powered down, or a fan on the RPS could have failed.

Table 2-4 Cisco RPS 300 LED on the Catalyst 2912 LRE, 2924-LRE, and 3524-PWR XL Switches

Color	RPS Status
Black (off)	RPS is off or is not installed.
Green	RPS is connected and operational.
Blinking green	RPS is backing up another switch in the stack.
Amber	RPS is connected but not functioning. The following conditions could exist: • The RPS could be in standby mode. To put the RPS in Active mode, press the Standby/Active button on the RPS, and the LED should turn green. If it does not, one of these other two conditions could exist. • One of the RPS power supplies could be down. Contact Cisco Systems. • The RPS fan could have failed. Contact Cisco Systems.
Blinking amber	Internal power supply of the switch is down, and redundancy is lost. The switch is operating on the RPS.

Port Modes and LEDs

The port modes (Table 2-5) determine the type of information displayed through the port LEDs. When you change port modes, the meaning of the port LED colors also changes.

Note The bandwidth utilization mode (UTIL LED) is not displayed on the VSM or Cluster Manager switch images. Select **Monitoring > Bandwidth Graph** to display the total bandwidth in use by the switch. Refer to the switch hardware installation guide for information about using the UTIL LED.

To select or change a mode, click **Mode** until the desired mode LED is green.

Table 2-5 Port Modes

Mode LED	Description
STAT	Ethernet link status of the 10/100, 100BASE-FX, or 1000BASE-X switch ports, or the Ethernet link status on the remote CPE. Default mode on all Catalyst 2900 XL and Catalyst 3500 XL switches except the Catalyst 2900 LRE XL switches.
LRE (Catalyst 2900 LRE XL only)	Long-Reach Ethernet (LRE) link status of the LRE ports on the Catalyst 2900 LRE XL switches. Default mode on these switches only. **Note** When the LRE mode is active, the 10/100 switch ports on the Catalyst 2900 LRE XL continue to show Ethernet link status.
FDUP or DUPLX	Duplex setting on the ports. • Default setting is auto on all Catalyst 2900 XL and Catalyst 3500 XL switches and on the 10/100 ports on the Catalyst 2900 LRE XL switches. • Default setting is half-duplex on the LRE ports on the Catalyst 2900 LRE XL switches. **Note** On the Catalyst 2900 LRE XL switches, this LED shows the duplex mode used on the Ethernet link between the remote customer premises equipment (CPE) and Ethernet device.
SPEED or SPD	Speed setting on the ports. Default setting is auto. **Note** On the Catalyst 2900 LRE XL switches, this LED shows the link speed between the remote CPE and Ethernet device.
LINE PWR (Catalyst 3524-PWR XL only)	Inline power setting on the Catalyst 3524-PWR XL 10/100 ports. Default setting is auto.

Table 2-6, Table 2-7, and Table 2-8 explain how to interpret the port LED colors after you change the port mode.

On the modular switches, the 1 or 2 LED is green when a module is installed. Refer to the module documentation for complete information.

Table 2-6 Port LEDs on the Catalyst 2912, 2924C, 2924, 2912MF, and 2924M XL Switches

Port Mode	Port LED Color	Description
STAT	Cyan (off)	No link.
	Green	Link present.
	Blinking green	Activity on the port. Port is transmitting or receiving data.
	Amber	Link fault. Error frames can affect connectivity, and errors such as excessive collisions, CRC errors, and alignment and jabber errors are monitored for a link-fault indication. Port is not forwarding. Port was disabled by management, or by an address violation, or was blocked by Spanning Tree Protocol (STP). **Note** After a port is reconfigured, the port LED can remain amber for up to 30 seconds as STP checks the switch for possible loops.
	Brown	No link and port is administratively shut down.
FDUP	Cyan (off)	Port is operating in half-duplex mode.
	Green	Port is operating in full-duplex mode.
SPD	Cyan (off)	Port is operating at 10 Mbps.
	Green	Port is operating at 100 Mbps.

Table 2-7 LRE Port LEDs on the Catalyst 2900 LRE XL Switches[1]

Port Mode	Port LED Color	Description
LRE[2]	Cyan (off)	No LRE link present on the LRE port.
	Green	LRE link present on the LRE port. Port LED turns green in approximately 10 seconds after the LRE port detects a connection to a Cisco 575 LRE CPE.
	Amber	LRE port on the switch and WALL port on the Cisco 575 LRE CPE unable to establish the rate defined by the assigned profile. Refer to the "Troubleshooting LRE Port Configuration" section on page 9-4.
STAT	Cyan (off)	No Ethernet link present on the 10/100 switch port or on the remote CPE Ethernet port.
	Green	Ethernet link present on the 10/100 switch port or on the remote CPE Ethernet port.
	Blinking green	Activity on the 10/100 switch port or on the remote CPE Ethernet port. Port is transmitting or receiving data.
	Amber	Link fault. Error frames can affect connectivity, and errors such as excessive collisions, CRC errors, and alignment and jabber errors are monitored for a link-fault indication. 10/100 switch port or remote CPE Ethernet port is not forwarding. Port was disabled by management, by an address violation, or was blocked by STP. **Note** After a port is reconfigured, the port LED can remain amber for up to 30 seconds as STP checks the switch for possible loops.
	Brown	No link and port is administratively shut down.
DUPLX	Cyan (off)	10/100 switch port or remote CPE Ethernet port is operating in half-duplex mode.
	Green	10/100 switch port or remote CPE Ethernet port is operating in full-duplex mode.
SPEED	Cyan (off)	10/100 switch port or remote CPE Ethernet port is operating at 10 Mbps.
	Green	10/100 switch port or remote CPE Ethernet port is operating at 100 Mbps.

1. In STAT mode, the LRE ports reflect the Ethernet link between the remote CPE and Ethernet device, such as a PC. The Ethernet link default settings on the LRE ports are different than those on the 10/100 ports. See Table 2-5.
2. In LRE mode, the 10/100 port LEDs continue to reflect Ethernet link status.

Table 2-8 Port LEDs on the Catalyst 3500 XL Switches

Port Mode	Port LED Color	Description
STATUS	Cyan (off)	No link.
	Green	Link present.
	Blinking green	Activity on the port. Port is transmitting or receiving data.
	Amber	Link fault. Error frames can affect connectivity, and errors such as excessive collisions, CRC errors, and alignment and jabber errors are monitored for a link-fault indication. Port is not forwarding. Port was disabled by management, by an address violation, or was blocked by STP. **Note** After a port is reconfigured, the port LED can remain amber for up to 30 seconds as STP checks the switch for possible loops.
	Brown	No link and port is administratively shut down.
DUPLEX	Cyan (off)	Port is operating in half-duplex mode.
	Green	Port is operating in full-duplex mode.
SPEED	**10/100 Ports**	
	Cyan (off)	Port is operating at 10 Mbps.
	Green	Port is operating at 100 Mbps.
	1000BASE-X Ports	
	Cyan (off)	Port is not operating.
	Green	Port is operating at 1000 Mbps.
LINE PWR (Catalyst 3524-PWR XL only)	Cyan (off)	Inline power is off.
	Green	Inline power is on. If the Cisco IP Phone is receiving power from an AC power source, the port LED is off even if the IP phone is connected to the switch port. The LED turns green only when the switch port is providing power.

Menu Bars

The VSM menu bar provides the options for configuring and monitoring a single switch. The Cluster Manager menu bar provides the options for configuring and monitoring a switch or a switch cluster.

The menu bars (Figure 2-1 and Figure 2-2) are similar, but with the following exceptions:

- Some configuration options, such as some system and VLAN options, are arranged slightly differently in VSM and Cluster Manager.
- The option for enabling a command switch is available only from VSM.
- The option for designating a standby group of command switches is available only from Cluster Manager.
- The option for rearranging the switch images is available only from Cluster Manager.

Table 2-9 describes the VSM and Cluster Manager menu bar options and their function and shows where the two menu bars differ.

Table 2-9 VSM and Cluster Manager Menu Bars

Menu Bar Options	Task
Cluster (VSM-specific)	
Cluster Command Configuration	Enable a switch to act as the cluster command switch.
Cluster Management	Display Cluster Manager or Cluster Builder.
Cluster (Cluster Manager-specific)	
Management VLAN	Change the management VLAN for a cluster.
System Time Management	Configure the system time or configure the Network Time Protocol (NTP).
VMPS Configuration	Configure the VLAN Membership Policy Server.
Standby Command Configuration	Create an Hot Standby Router Protocol (HSRP) standby group to provide command-switch redundancy.
Device Position	Rearrange the order in which switches appear in Cluster Manager.
User Settings	Set the polling interval for Cluster Manager, Cluster Builder, and the performance graphs. Set the application to display by default.
Cluster Builder	Display Cluster Builder.
System	
Inventory	Display the device type, software version, IP address, and other information about a switch or a cluster of switches.
IP Management	Configure IP information for a switch.
Software Upgrade	Upgrade the software for the cluster or a switch.
System Time Management (VSM-specific)	Configure the system time or the NTP.
SNMP Management	Enter Simple Network Management Protocol (SNMP) community strings, and configure end stations as trap managers.
Console Baud Rate	Change the baud rate for a switch.
ARP Table	Display the device Address Resolution Protocol (ARP) table.
User Settings (VSM-specific)	Change the polling intervals for clustering and graphing, and enable the display of the splash page when VSM starts.
Save Configuration	Save the configuration.
System Reload	Reboot the software on a switch.

Table 2-9 VSM and Cluster Manager Menu Bars (continued)

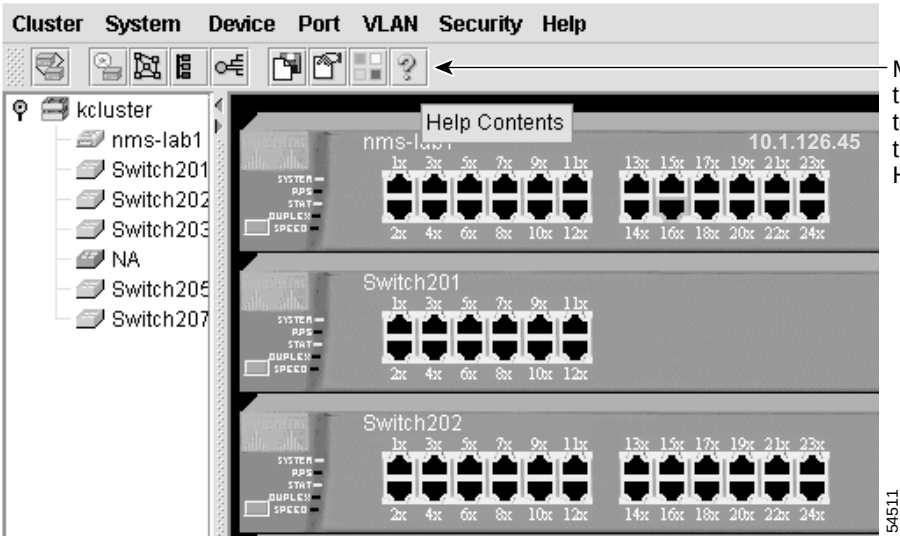
Menu Bar Options	Task
Device	
Cisco Group Management Protocol (CGMP)	Enable and disable the CGMP and the CGMP Fast Leave feature on a switch.
Spanning-Tree Protocol (STP)	Display and configure STP parameters for a switch.
LRE Profile	Display the LRE profile settings for the Catalyst 2900 LRE XL switches, and configure the speed of the LRE link.
Port	
Port Configuration	Display and configure port parameters on a switch.
Port Statistics	Display the Ethernet and LRE link statistics.
Port Search	Search for a port through its description.
Port Grouping (EtherChannel)	Group ports into logical units for high-speed links between switches.
Switch Port Analyzer (SPAN)	Enable SPAN port monitoring.
Flooding Control	Enable broadcast storm control and block unicast and multicast flooding on a per-port basis.
VLAN	
VLAN Membership	Display VLAN membership, assign ports to VLANs, and configure Inter-Switch Link (ISL) and 802.1Q trunks.
Management VLAN (VSM-specific)	Change the management VLAN on the switch.
VTP Management	Display and configure the VLAN Trunk Protocol (VTP) for interswitch VLAN membership.
VMPS Configuration (VSM-specific)	Configure the VLAN Membership Policy Server (VMPS).
Security	
Address Management	Enter dynamic, secure, and static addresses into a switch address table. You can also define the static addresses forwarding behavior.
Port Security	Enable port security on a port.
Help	
Contents	List all of the available online help topics.
Legend	Display the legend that describes the icons, labels, and links.
About	Display the version number of VSM or Cluster Manager.

Toolbar

The VSM and Cluster Manager toolbar (Figure 2-4) buttons display some switch- and cluster-level configuration windows. Hover the cursor over a button to display a pop-up description. From left to right on the toolbar, the following windows can be displayed:

- Cluster Builder (On VSM, this button is not applicable and is therefore disabled.)
- Software Upgrade window
- SNMP Management window
- VLAN Membership window
- Spanning Tree Protocol window
- Save Configuration window
- User Settings window
- Legend that describes the icons, labels, and links
- Online help table of contents

Figure 2-4 Cluster Manager Toolbar



Move the cursor over the icon to display the tool tip. For example, the **?** button displays Help Contents.

Port Pop-Up Menu

You can display all port configuration windows from the Port menu on the menu bar, or you can display a subset of the port configuration windows from the VSM and Cluster Manager port pop-up menu. The port pop-up menu provides options for displaying commonly used port configuration windows (Table 2-10). From the port pop-up menu, you can configure a single port or configure multiple ports to run with the same settings.

To display the port pop-up menu from VSM or Cluster Manager, you can either

- Click a specific port image, and right-click.
- Press the **Ctrl** key, click the port images on a single switch or on different switches, and right-click.

Table 2-10 VSM and Cluster Manager Port Pop-up Menu

Pop-up Menu Option	Task
Port Configuration	Display and configure port parameters on a switch.
VLAN Membership	Define the VLAN mode for a port or ports, and add ports to VLANs. Not available for Catalyst 1900 or Catalyst 2820 switches.
Flooding Controls	Block the normal flooding of unicast and multicast packets, and enable the switch to block packet storms. Not available for Catalyst 1900 or Catalyst 2820 switches.
Port Security	Enable port security on a port. Not available for Catalyst 1900 or Catalyst 2820 switches.
Link Graph	Right-click a port that is green to display the performance graph for the link. You can plot the link utilization percentage and the total packets, bytes, and errors recorded on the link. This feature is not available on Catalyst 1900 and Catalyst 2820 switches. For more information about link graphs, refer to the online help. **Note** This feature is only available when selecting an individual port.

Device Pop-Up Menu

With the exception of the Cluster menu bar options, the VSM and Cluster Manager device pop-up menu displays all of the configuration and monitoring windows (Table 2-11) available from the VSM and Cluster Manager menu bar.

To display the device pop-up menu from VSM, click the switch image, and right-click.

To display the device pop-up menu from Cluster Manager, you can either

- Click a specific switch icon from the Cluster Tree, and right-click.
- Press the **Ctrl** key, click the switch icons from the Cluster Tree, and right-click.

Table 2-11 VSM and Cluster Manager Device Pop-up Menu

Pop-up Menu Options	Task
System	
Inventory	Display the device type, software version, IP address, and other information about a switch or cluster of switches.
IP Management	Configure IP information for a switch.
Software Upgrade	Upgrade the software for a cluster or a switch.
SNMP Management	Enter SNMP community strings, and configure end stations as trap managers.
Console Baud Rate	Change the baud rate for one or more switches.
ARP Table	Manage the Address Resolution Protocol (ARP) table.
Save Configuration	Save the configuration on one or all of the cluster switches.
System Reload	Reboot the software on a switch or a cluster.
Device	
Cisco Group Management Protocol (CGMP)	Enable and disable CGMP and the CGMP Fast Leave feature on a switch.
Spanning Tree Protocol (STP)	Change STP parameters to prevent network loops.
LRE Profile	Display the LRE profile parameters for the Catalyst 2912 LRE and Catalyst 2924 LRE XL switches, and configure the speed of the LRE link between an LRE port and a remote CPE.

Table 2-11 VSM and Cluster Manager Device Pop-up Menu (continued)

Pop-up Menu Options	Task
Port	
Port Configuration	Display and configure port parameters on a switch.
Port Statistics	Display the Ethernet and LRE link statistics.
Port Search	Search for a port through its description.
Port Grouping (EC)	Group ports into logical units for high-speed links between switches.
Switch Port Analyzer (SPAN)	Enable SPAN port monitoring.
Flooding Control	Enable broadcast storm control, and block unicast and multicast flooding on a per-port basis.
VLAN	
VLAN Membership	Display VLAN membership, assign ports to VLANs, and configure ISL and IEEE 802.1Q trunks.
VTP Management	Display and configure the VLAN Trunk Protocol (VTP) for interswitch VLAN membership.
Security	
Address Management	Enter dynamic, secure, and static addresses into a switch address table, and define the forwarding behavior of static addresses.
Port Security	Enable port security on a port.
Monitoring	
Bandwidth Graph	Display a graph that plots the total bandwidth in use by the switch. This feature is not available on the Catalyst 1900 and Catalyst 2820 switches. For more information about bandwidth graphs, refer to the online help.

Cluster View and Cluster Builder

Cluster View (Figure 2-5) and Cluster Builder (Figure 2-6) are the CMS applications for displaying, creating, and modifying switch clusters.

To assist in your cluster configuration and monitoring tasks, both applications provide the following features:

- Cluster View displays a high-level topology where clusters are collapsed and represented as double-switch icons with links to candidate switches, other switch clusters, and edge devices.

  Cluster Builder displays the topology of a specific switch cluster, where switches and cluster- and command-capable devices connected to the command switch display as cluster members or candidates.

  The components used in a topology are described in the "Topology" section on page 2-24.

- A menu bar that provides the options for creating, modifying, monitoring, and displaying switch clusters. This menu bar is further described in the "Menu Bar" section on page 2-26.

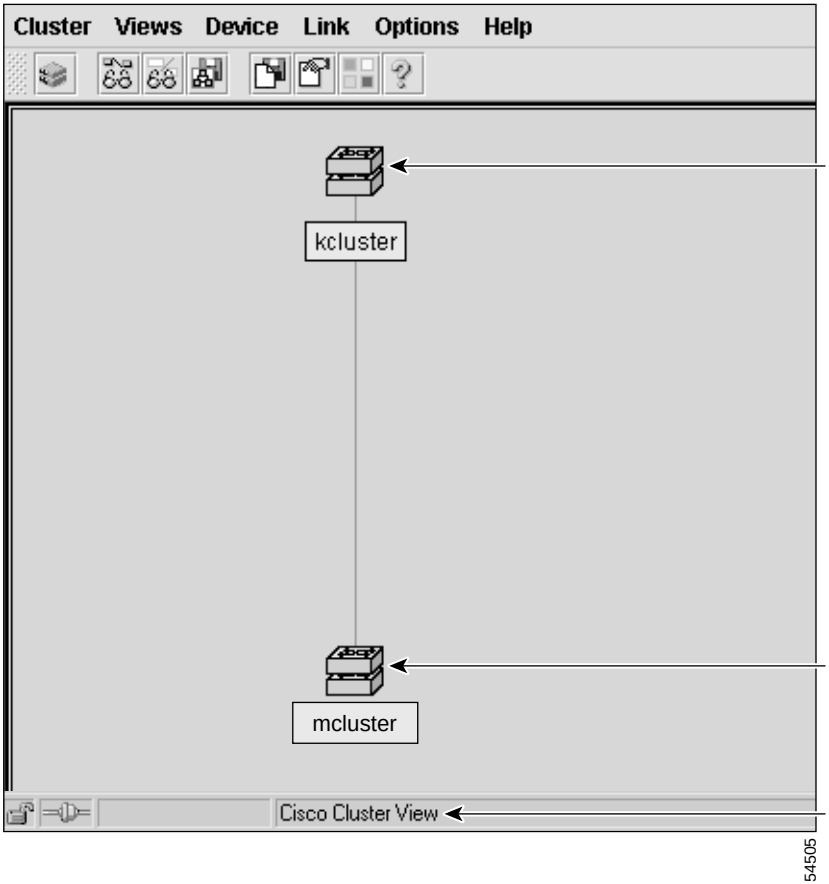
- A toolbar that provides buttons for displaying commonly used cluster configuration windows and for displaying the legends and online help. This toolbar is described in the "Toolbar" section on page 2-27.

- A device-level pop-up menu in Cluster View. This pop-up menu is described in the "Device Pop-Up Menu" section on page 2-28

- Device- and link-level pop-up menus in Cluster Builder. These pop-up menus are described in the "Candidate, Member, and Link Pop-Up Menus" section on page 2-29.

The toolbar and pop-up menus provide quick ways to access the configuration and monitoring options available from the menu bar.

Figure 2-5 Cluster View

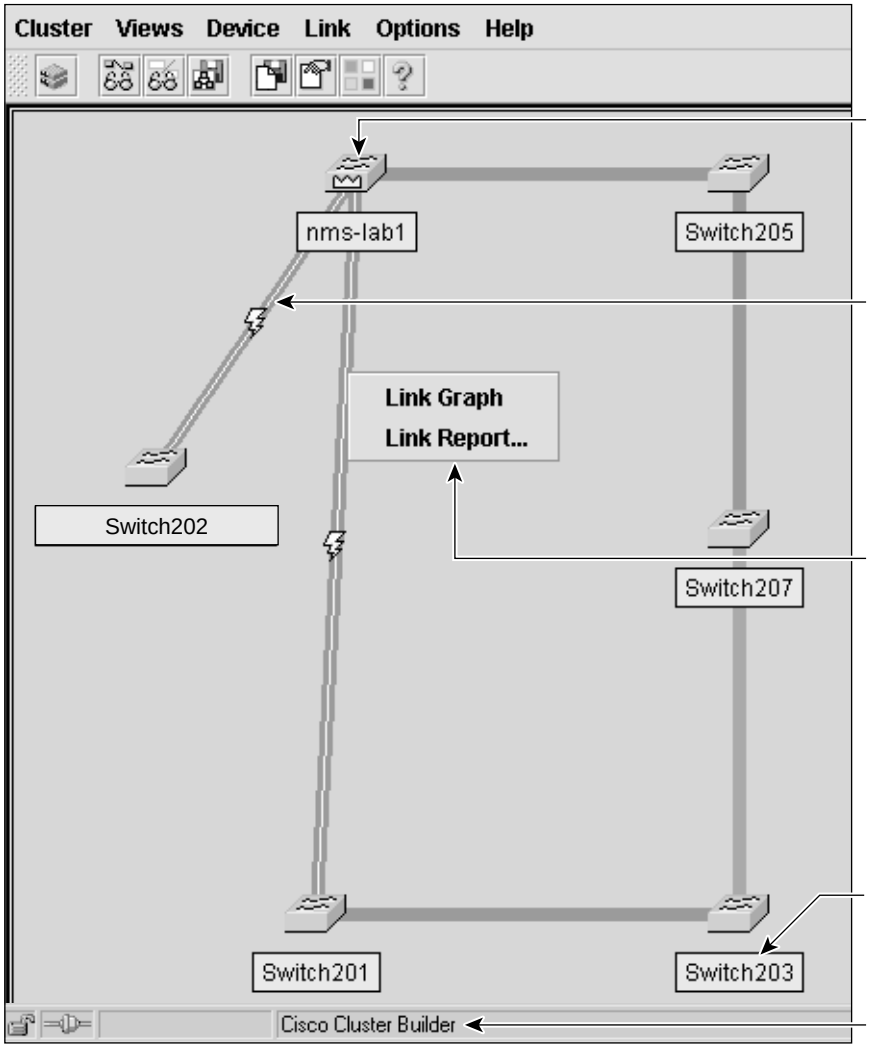


Cluster is collapsed to a double-switch icon.

Connected cluster.

Status bar shows that Cluster View is displayed.

Figure 2-6 Cluster Builder



Topology

The topology appears when you launch use Cluster View and Cluster Builder. It displays connected clusters, command switches, cluster members, candidate switches, and edge devices. From the topology, you can:

- Double-click a cluster icon (double-switch icon) to display cluster members.
- Select a command-switch icon to configure cluster-wide settings.
- Select a switch icon to configure switch-wide settings.

The topology in Cluster View (Figure 2-5) and Cluster Builder (Figure 2-6) uses the same icons used in the Cluster Manager cluster tree (Figure 2-2). It also uses an icon unique to the topology. This icon is the unknown device icon. Figure 2-7 shows the device icons as they appear in the topology. Table 2-12 describes the meanings of the icon colors.

Figure 2-7 Cluster View and Cluster Builder Device Icons



Table 2-12 Icon Colors

Icon Color	Color Meaning
Green	Device is up.
Red	Device is down.
Yellow	Fault indication.

The topology includes *device labels*, which are the switch cluster names, cluster member names, and MAC addresses (Figure 2-6). Table 2-13 describes the meanings of the label colors. You can toggle device labels by selecting **View** > **Toggle Labels**.

Table 2-13 Device Label Colors

Label Color	Color Meaning
Green	A cluster member, either a member switch or the command switch.
Cyan	A cluster candidate that is fully qualified to become a cluster member. Add these candidates with Cluster Builder.
White	A standby command switch.
Yellow	An unknown edge device that cannot become a member.

The link icons in the topology describe the link type and status between two devices. Figure 2-8 shows the device icons as they appear in the topology. Table 2-14 describes the meanings of the link colors. When you point your cursor at a link and right-click, you can display additional link information from the link pop-up menu (Figure 2-6). Complete descriptions of the icons and icon colors are available from **Help** > **Legend**.

Figure 2-8 Cluster View and Cluster Builder Link Icons

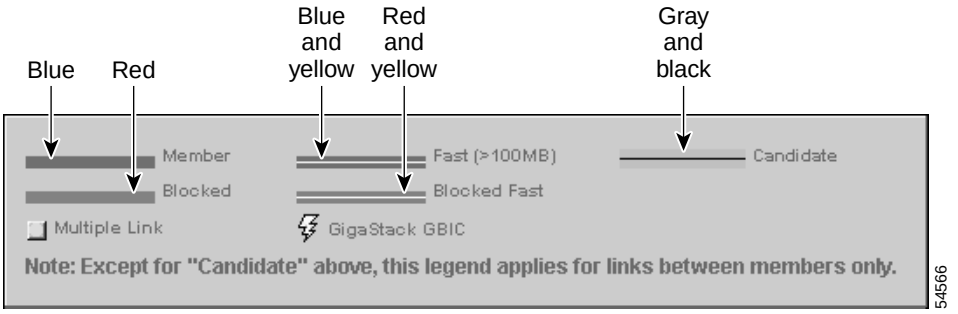


Table 2-14 Link Colors

Link Color	Color Meaning
Blue	Active link
Red	Blocked link

Menu Bar

The Cluster View and Cluster Builder menu bar provides the options for configuring and monitoring a switch cluster. Table 2-15 describes the Cluster View and Cluster Builder menu bar options and their function.

Table 2-15 Cluster View and Cluster Builder Menu

Menu Bar Options	Task
Cluster	
Add to cluster	Add candidates to cluster.
Remove from cluster	Remove members from cluster.
User Settings	Change the default settings for the number of hops to discover and the polling interval for Cluster Builder and the link graphs.
Goto Cluster Manager	Start Cluster Manager.
Views	
Toggle Views	Toggle between Cluster Builder and Cluster View.
Toggle Labels	Toggle between switch names and IP or MAC addresses and connected port numbers.
Device	
Launch Switch Manager	Start Switch Manager for a selected switch.
Bandwidth Graph	Display a graph showing the current bandwidth in use by a selected switch. Not supported on Catalyst 1900 and Catalyst 2820 switches.
Show/Hide Candidates	Expand or collapse image of all candidates connected to a cluster member.
Host Name Configuration	Change the host name for a selected device.
Link	
Link Graph	Display a graph showing the bandwidth being used for the selected link.
Link Report	Display the Link Report for two connected devices. If one device is an unknown device, candidate switch, or Catalyst 1900 or Catalyst 2820 switch, only the cluster member side of the link is displayed.

Table 2-15 Cluster View and Cluster Builder Menu (continued)

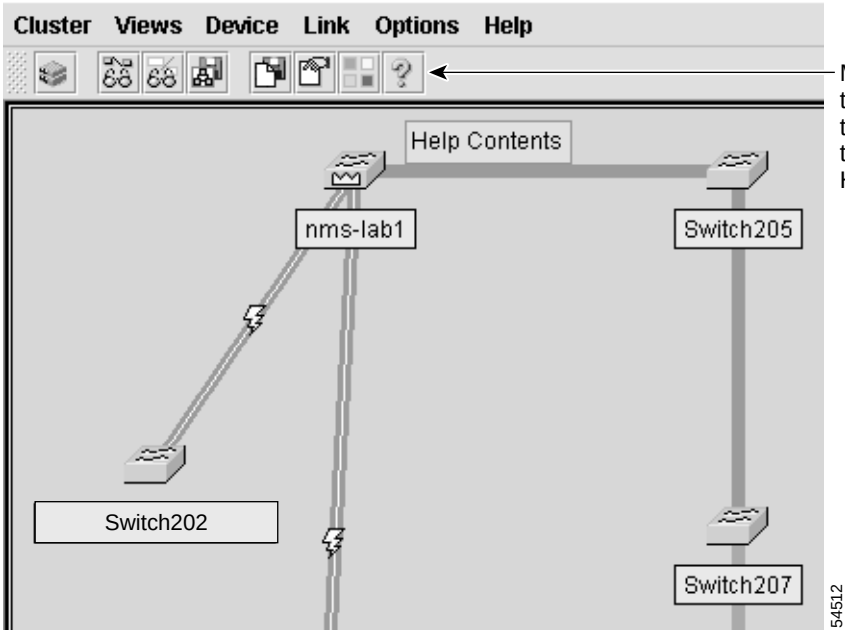
Menu Bar Options	Task
Options	
Save Layout	Save the current arrangement in the topology.
Save Configuration	Save the current configuration of cluster members to Flash memory.
Help	
Contents	List all of the available online help topics.
Legend	Display descriptions of the icons used in the topology.
About	Display the version number for Cluster Builder and Cluster View.

Toolbar

The Cluster Builder and Cluster View toolbar (Figure 2-9) buttons display some cluster-level configuration windows. Hover the cursor over a button to display a pop-up description. From left to right on the toolbar, the following windows can be displayed:

- Launch Cluster Manager.
- Toggle between Cluster Builder and Cluster View—You can also use Cluster Builder and Cluster View to manage your cluster. When you are using Cluster Builder, click the double-switch icon on the toolbar (Figure 2-9) to toggle back to Cluster Manager.
- Toggle between switch names and IP or MAC addresses and connected port numbers.
- Save the arrangement of the cluster icons as you have arranged them.
- Save the current configuration for all cluster members to Flash memory.
- Set the user settings for Cluster Builder and Cluster View.
- Display the legend that describes the icons, labels, and links that are used in Cluster Builder and Cluster View.
- List the online help topics for Cluster Builder and Cluster View.

Figure 2-9 Cluster Builder and Cluster View Toolbar



Move the cursor over the icon to display the tool tip. For example, the **?** button displays Help Contents.

Device Pop-Up Menu

Table 2-16 describes the menu options available when you right-click an icon in Cluster View.

Table 2-16 Cluster View Device Menu

Menu Option	Action
Device Web Page	Displays the web management page for the device.
Disqualification Code	Describes why the switch is not a cluster member or candidate.

Candidate, Member, and Link Pop-Up Menus

Table 2-17 describes the menu options available when you right-click a candidate-switch icon in Cluster Builder.

Table 2-17 Cluster Builder Candidate Pop-up Menu

Menu Option	Action
Device Web Page	Displays the device-management page for the device.
Add to Cluster	Adds the selected candidate or candidates to the cluster.

Table 2-18 describes the menu options available when you right-click a member-switch icon in Cluster Builder. For more information about configuring cluster members, see Chapter 5, "Clustering Switches."

Table 2-18 Cluster Builder Member Pop-up Menu

Menu Option	Action
Switch Manager	Display the VSM Home page for the selected device.
Bandwidth Graph	Display a graph that plots the total bandwidth used by the switch. This feature is not available on Catalyst 1900 or Catalyst 2820 switches.
Host Name Config	Change the name of the switch. For more information, see the "Host Names" section on page 5-10.
Remove from Cluster	Remove the selected switch from the cluster.
Show or hide Candidates	Toggle between displaying candidate switches and not displaying them.
Clear State	Return switches that were down but are now up to the green (up) state. Switches that are yellow are down or were previously down. Applicable only to yellow member switches.

Table 2-19 describes the menu options available when you right-click a link in Cluster Builder. For more information about displaying link information, refer to the online help.

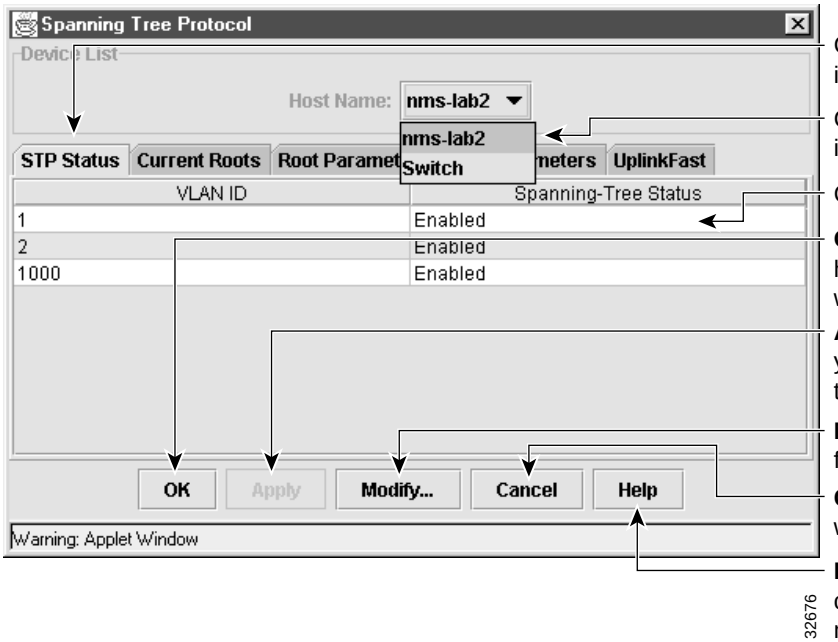
Table 2-19 Cluster Builder Link Pop-up Menu

Menu Option	Action
Link Graph	Display the performance graph for the link. One end of the link must be connected to a port on a cluster member that is a Catalyst 2900 XL or Catalyst 3500 XL switch. Links between any mix of Catalyst 1900 and Catalyst 2820 switches cannot be graphed.
Link Report	Display information about the link between two members. If one end of the link is a candidate, the report only displays information about the member switch.

CMS Window Components

CMS windows use consistent techniques to present configuration information. Figure 2-10 shows the components of a typical CMS window.

Figure 2-10 CMS Window Components



Click a tab to display more information.

Cluster members are listed in the device list.

Click in a row to select it.

OK saves the changes you have made and closes the window.

Apply saves the changes you have made and leaves the window open.

Modify displays a pop-up for the selected row.

Cancel closes the window without saving the changes.

Help displays help for the current window and the menu of Help topics.

Host Name List

The Host Name drop-down list (also referred to as the Device list) shows a list of cluster member names. To display or change the configuration of a specific switch in a cluster, select the switch name. The current configuration settings of that switch appear.

In some cases, switch-specific features (such as the LRE profiles on the Catalyst 2900 LRE XL switches) are available only when the appropriate switch is a member of the cluster. Otherwise, switch-specific features either are grayed-out or are not shown in the CMS menu bar and pop-up menus.

In other cases, depending on the menu option selected, certain cluster members names are not included in the Host Name list. For example, the VLAN Membership window would not display Catalyst 1900 and Catalyst 2820 switches, even though they are part of the cluster.

Tabs

Some CMS windows have multiple *tabs* that present different kinds of information. Tabs are arranged like folder headings across the top of the window. Click the tab to display a new screen, and click **Apply** to save information on all tabs but without closing the window.

Lists

Listed information can often be changed by selecting an item from a list. To change the information, select one or more items, and click **Modify**. Changing multiple items is limited to those items that apply to at least one of the selections. For example, when you select multiple ports, a parameter such as flow control is grayed out if the ports are not Gigabit Ethernet ports.



Tips If you try to select a port or device in Cluster Manager while another CMS window is open, the computer issues a ringing bell sound. Rearrange the windows that are displayed to find the open window, and close it to proceed.

Buttons

Table 2-20 describes the most common buttons that you use to change the information in a CMS window:

Table 2-20 Common CMS Buttons

Button	Description
OK	Save any changes made in the window, and close the window.
Apply	Save any changes made in the window, and leave the window open.
Cancel	Do not save any changes made in the window, and close the window.
Modify	Display the pop-up for changing information on the selected item or items. You usually select an item from a list or table and click **Modify**. When you close the pop-up, the original window appears.

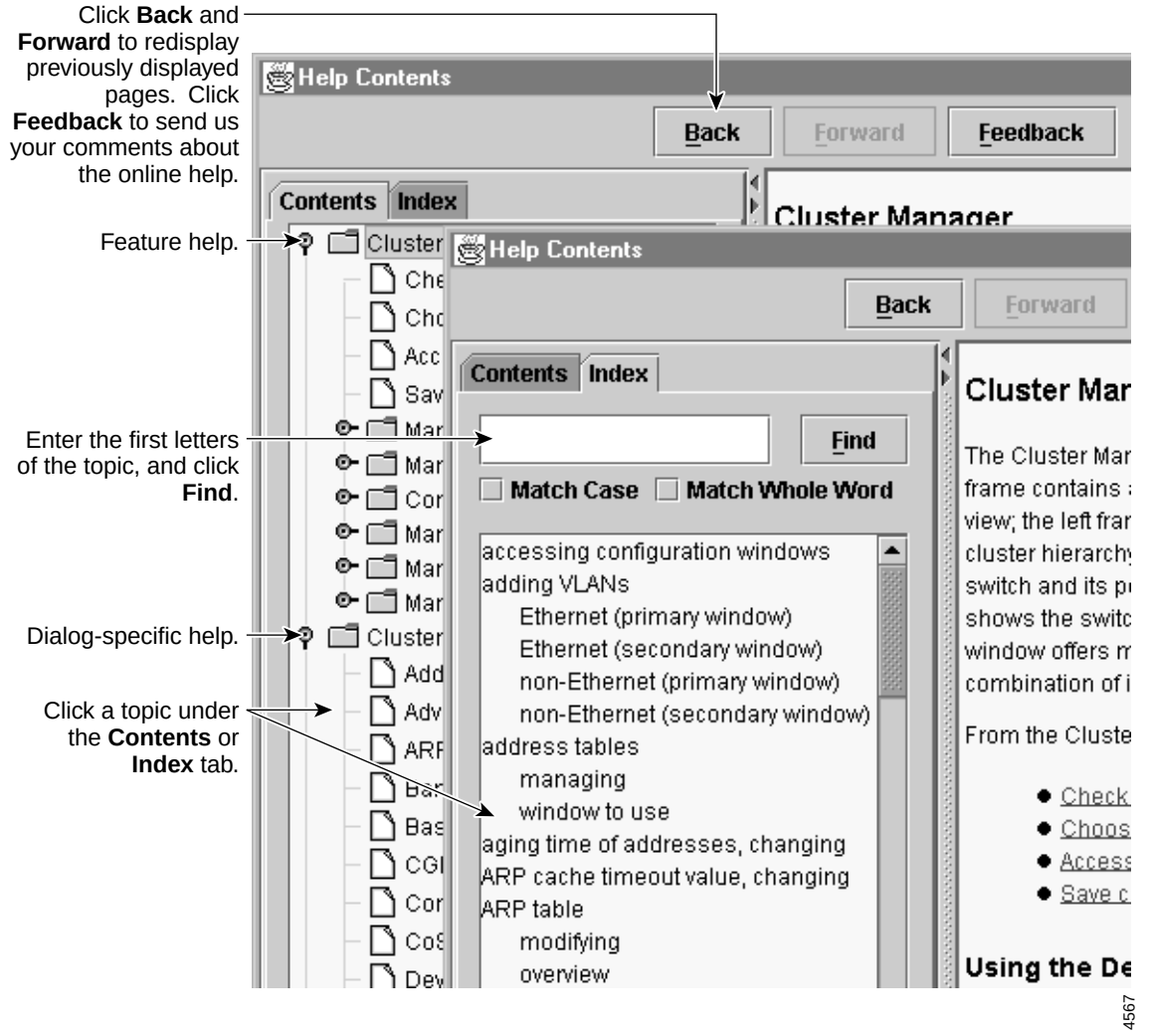
Online Help

CMS provides comprehensive online help to assist you in understanding and performing configuration and monitoring tasks from the CMS windows (Figure 2-11).

- Feature help, available from all menu bars by selecting **Help > Contents**, provides background information and concepts on the features.
- Dialog-specific help, available from the Help button on the VSM and Cluster Manager windows, provides descriptions of all window components (fields, buttons, and so on) and procedures on performing tasks from the window.
- Index of help topics.

You can send us feedback about the information provided in the online help. From the menu bar, select **Help > Contents**, and click **Feedback** to display a simple online form. After completing the form, click **Submit** to send your comments to Cisco. We appreciate and value your comments.

Figure 2-11 Help Contents



Accessing CMS

You must know the IP address and password of the specific switch or command switch to access CMS. You can assign this information to the switch in the following ways:

- Using the setup program, as described in the release notes
- Manually assigning an IP address and password, as described in the "Changing IP Information" section on page 6-2 and "Changing the Password" section on page 6-15.

  Considerations for assigning this information to a command switch and cluster members are described in the "IP Addresses" section on page 5-8 and "Passwords" section on page 5-8.

Accessing CMS also requires meeting the software requirements, including browser and Java plug-in configurations, described in the release notes.



Note Copies of the CMS pages you display are saved in your browser memory cache until you exit the browser session. A password is not required to redisplay these pages, including the Cisco Systems Access page. You can access the CLI by clicking **Web Console - HTML access to the command line interface** from a cached copy of the Cisco Systems Access page. To prevent unauthorized access to CMS and the CLI, exit your browser to end the browser session.

The following procedure assumes you have met the software requirements, (including browser and Java plug-in configurations) and have assigned IP information and a password to the switch or command switch, as described in the release notes.

To access CMS, follow these steps:

Step 1 Enter the IP address in the browser **Location** field (Netscape Communicator) or **Address** field (Microsoft Internet Explorer).

Step 2 Enter your userid and the password at the prompt.

The Cisco Systems Access page appears.

Step 3 Click **Cluster Management Suite or Visual Switch Manager**.

If you access CMS from a standalone or cluster member switch, VSM appears. If you access CMS from a command switch, Cluster Builder launches by default. You can select Cluster Manager to launch by default by selecting **Cluster > User Settings**. You can toggle between Cluster Builder and Cluster View by selecting **View > Toggle Views**.

You can display VSM for a specific cluster member from either Cluster Builder or Cluster View by selecting **Device > Launch Switch Manager**. You cannot display VSM from Cluster Manager.

For information about managing passwords in switch clusters, see the "Passwords" section on page 5-8.

CMS requires that your switch uses Hypertext Transfer Protocol (HTTP) port 80, which is the default HTTP port. If you change the HTTP port, you cannot access CMS. For more information about the HTTP port, see the "HTTP Access to CMS" section on page 4-5.

Saving Configuration Changes

The front-panel images and CMS windows always display the *running configuration* of the switch. When you make a configuration change to a switch or switch cluster, the change becomes part of the running configuration. The change *does not* automatically become part of the config.txt file in Flash memory, which is the *startup configuration* used each time the switch restarts. If you do not save your changes to Flash memory, they are lost when the switch restarts.

To save all configuration changes to Flash memory, you must select **System > Save Configuration** in the Cluster Manager menu bar or **Options > Save Configuration** in the Cluster Builder or Cluster View menu bar.



Note Catalyst 1900 and Catalyst 2820 switches automatically save configuration changes to Flash memory as they occur.



Note As you make cluster configuration changes (except for changes to the topology and in the User Settings window), make sure you periodically save the configuration. The configuration is saved on the command and member switches.

Using Different Versions of Web-Based Switch Management Software

Cluster command switches can manage a mixture of Catalyst desktop switches. However, certain models of the Catalyst desktop switches support different versions of web-based management software; thus, the interfaces can differ.

Keep in mind that when you select a switch image or switch icon and then select **Device > Launch Switch Manager** from the menu bar, a new CMS session is launched, and the web-based management software specific to that switch appears.

- The Catalyst 2900 XL, Catalyst 3500 XL, and Catalyst 2950 switches use the same version of the CMS interface.
- The Catalyst 1900 and Catalyst 2820 switches use an older interface version of VSM, which is referred to as *Switch Manager* on these switches. Other CMS features such as Cluster Manager, Cluster Builder, and Cluster View are not available on these switches.

Refer to the appropriate switch documentation for descriptions of the web-based management software used on other Catalyst desktop switches, such as the Catalyst 2950, Catalyst 1900, and Catalyst 2820 switches.

Refer to the release notes for the list of Catalyst desktop switches that are cluster-compatible and their software versions.

Where to Go Next

The rest of this guide provides descriptions of the software features and general switch administration. Table 4-2 on page 4-9 lists the defaults for all key features, gives the page number in this guide where the feature is described, and the name of the CMS window from which you can configure the feature.

Refer to the online help for CMS procedures and window descriptions. Refer to the release notes for hardware and software requirements, including required browser versions, and for procedures for installing the required Java plug-in, configuring your browser, and accessing CMS.



CHAPTER 3

Getting Started with the CLI

This chapter provides information that you should know before using the Cisco IOS command-line interface (CLI). If you have never used IOS software or if you need a refresher, take a few minutes to read this chapter before reading the rest of this guide.

- Command usage basics
- Command-line error messages
- Accessing the CLI
- Saving configuration changes

This switch software release is based on Cisco IOS Release 12.0(5). It has been enhanced to support a set of features for the Catalyst 2900 XL and Catalyst 3500 XL switches. This guide provides procedures for using only the commands that have been created or changed for these switches. The *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference* provides complete descriptions of these commands.

For information about the standard Cisco IOS Release 12.0 commands, refer to the Cisco IOS Release 12.0 documentation on Cisco.com.

Command Usage Basics

This section provides the following topics:

- Accessing command modes
- Abbreviating commands
- Using the No and Default forms of commands
- Redisplaying a command
- Getting help

Accessing Command Modes

The CLI is divided into different modes. The commands available to you at any given time depend on which mode you are in. Entering a question mark (**?**) at the system prompt provides a list of commands for each command mode.

The switch supports the following command modes:

- User EXEC
- Privileged EXEC
- VLAN database
- Global configuration
- Interface configuration
- Line configuration

When you start a session on the switch, you begin in user mode, often called user EXEC mode, which has only a limited subset of the commands. To access all commands and modes, you must first enter privileged EXEC mode. Normally, a password is required to enter privileged EXEC mode. From privileged mode, you can enter any EXEC command or enter global configuration mode. Most of the EXEC commands are one-time commands, such as **show** commands, which show the current configuration status, and **clear** commands, which clear counters or interfaces.

You can use the virtual LAN (VLAN) database and the various configuration modes to make changes to the running configuration. To access the various configuration modes, you must start at global configuration mode. From global configuration mode, you can enter interface and line configuration modes.

Each command mode supports specific Cisco IOS commands. For example, the **interface** command is used only from global configuration mode.

Table 3-1 describes how to access each mode, the prompt you see in that mode, and how to exit the mode. The examples in the table use the host name *switch*.

Table 3-1 Command Modes Summary

Modes	Access Method	Prompt	Exit Method	About This Mode[1]
User EXEC	Begin a session with your switch.	`switch>`	Enter **logout** or **quit**.	Use this mode to • Change terminal settings. • Perform basic tests. • Display system information.
Privileged EXEC	Enter the **enable** command while in user EXEC mode.	`switch#`	Enter **disable** to exit.	Use this mode to verify commands you have entered. Use a password to protect access to this mode.
VLAN database	Enter the **vlan database** command while in privileged EXEC mode.	`switch(vlan)#`	To exit to privileged EXEC mode, enter **exit**.	Use this mode to configure VLAN-specific parameters.

Table 3-1 Command Modes Summary (continued)

Modes	Access Method	Prompt	Exit Method	About This Mode[1]
Global configuration	Enter the **configure** command while in privileged EXEC mode.	`switch(config)#`	To exit to privileged EXEC mode, enter **exit** or **end**, or press **Ctrl-Z**.	Use this mode to configure parameters that apply to your switch as a whole.
Interface configuration	Enter the **interface** command (with a specific interface) while in global configuration mode.	`switch(config-if)#`	To exit to global configuration mode, enter **exit**. To exist to privileged EXEC mode, enter **Ctrl-Z or end.**	Use this mode to configure parameters for the Ethernet interfaces.
Line configuration	Specify a line with the **line vty** or **line console** command while in global configuration mode.	`switch(config-line)#`	To exit to global configuration mode, enter **exit**. To exit to privileged EXEC mode, enter **Ctrl-Z or end.**	Use this mode to configure parameters for the terminal line.

1. For any of the modes, you can see a comprehensive list of the available commands by entering a question mark (**?**) at the prompt.

Abbreviating Commands

You can abbreviate commands and keywords to the number of characters that allow a unique abbreviation. For example, you can abbreviate the **show** command to **sh** or the **show configuration** command to **show conf**.

Using the No and Default Forms of Commands

Almost every configuration command has a **no** form. In general, use the **no** form to

- Disable a feature or function.
- Reset a command to its default values.
- Reverse the action of a command. For example, the **no shutdown** command reverses the shutdown of an interface.

Use the command without the **no** form to reenable a disabled feature or to reverse the action of a **no** command.

Configuration commands can also have a default form. The default form of a command returns the command setting to its default.

Redisplaying a Command

To redisplay a command you previously entered, press the up-arrow key. You can continue to press the up-arrow key for more commands.

Getting Help

Entering a question mark (**?**) at the system prompt displays a list of commands for each command mode. You can also get a list of any command's associated keywords and arguments with the context-sensitive help feature.

The following are the commands to get help specific to a command mode, a command, a keyword, or an argument:

- **help**—Obtain a brief description of the help system in any command mode.

  ```
  switch> help
  ```

- *abbreviated-command-entry***?**—Obtain a list of commands that begin with a particular character string.

  ```
  switch> dis?
  switch> disable  disconnect
  ```

- *abbreviated-command-entry*<**Tab**>—Complete a partial command name.

Note No space before tabbing.

```
switch# sh conf<tab>
switch# sh configuration
```

- **?** — List all commands available for a particular command mode.

```
switch> ?
```

- *command* **?**—List of command keywords.

```
switch> show ?
```

- *command keyword* **?**— List of command keyword arguments.

```
switch> show udld ?
FastEthernet       FastEthernet IEEE 802.3
Null               Null interface
VLAN               Switch VLAN Virtual Interface
```

When using context-sensitive help, the space (or lack of a space) before the question mark (**?**) is significant. To obtain a list of commands that begin with a particular character sequence, enter those characters followed immediately by the question mark (**?**). Do not include a space. This form of help is called word help, because it completes a word for you.

To list keywords or arguments, enter a question mark (**?**) in place of a keyword or argument. Include a space before the **?**. This form of help is called command syntax help, because it reminds you which keywords or arguments are applicable based on the command, keywords, and arguments you already have entered.

Command-Line Error Messages

Table 3-2 lists some error messages that you might encounter while using the CLI.

Table 3-2 Common CLI Error Messages

Error Message	Meaning	How to Get Help
`% Ambiguous command: "show con"`	You did not enter enough characters for your switch to recognize the command.	Reenter the command followed by a space and a question mark (**?**). The possible keywords that you can enter with the command appear.
`% Incomplete command.`	You did not enter all of the keywords or values required by this command.	Reenter the command followed by a space and a question mark (**?**). The possible keywords that you can enter with the command appear.
`% Invalid input detected at '^' marker.`	You entered the command incorrectly. The caret (^) marks the point of the error.	Enter a question mark (**?**) to display all of the commands that are available in this command mode. The possible keywords that you can enter with the command appear.

Accessing the CLI

The following procedure assumes you have already assigned IP information and password to the switch or command switch. You can assign this information to the switch in the following ways:

- Using the setup program, as described in the release notes
- Manually assigning an IP address and password, as described in the "Changing IP Information" section on page 6-2 and "Changing the Password" section on page 6-15.

  Considerations for assigning this information to a command switch and cluster members are described in the "IP Addresses" section on page 5-8 and "Passwords" section on page 5-8.

To access the CLI, follow these steps:

Step 1 Start up the emulation software (such as ProComm, HyperTerminal, tip, or minicom) on the management station.

Step 2 If necessary, reconfigure the terminal-emulation software to match the switch console port settings (default settings are 9600 baud, no parity, 8 data bits, and 1 stop bit).

Step 3 Establish a connection with the switch by either

- Connecting the switch console port to a management station or dial-up modem. For information about connecting to the console port, refer to the switch hardware installation guide.
- Using any Telnet TCP/IP package from a remote management station. The switch must have network connectivity with the Telnet client, and the switch must have an enable secret password configured. For information about configuring the switch for Telnet access, see the "SNMP Network Management Platforms" section on page 4-6.

  The switch supports up to seven simultaneous Telnet sessions. Changes made by one Telnet user are reflected in all other Telnet sessions.

After you connect through the console port or through a Telnet session, the User EXEC prompt appears on the management station.

Accessing the CLI from a Browser

The following procedure assumes you have met the software requirements, (including browser and Java plug-in configurations) and have assigned IP information and a Telnet password to the switch or command switch, as described in the release notes.

To access the CLI from a web browser, follow these steps:

Step 1 Start one of the supported browsers.

Step 2 In the **URL** field, enter the IP address of the command switch.

Step 3 When the Cisco Systems Access page appears, click **Telnet** to start a Telnet session.

You can also access the CLI by clicking **Web Console - HTML access to the command line interface** from the Cisco Systems Access page. For information about the Cisco Systems Access page, see the "Accessing CMS" section on page 2-35 and the release notes.

Step 4 Enter the switch password.

The User EXEC prompt appears on the management station.



Note Copies of the CMS pages you display are saved in your browser memory cache until you exit the browser session. A password is not required to redisplay these pages, including the Cisco Systems Access page. You can access the CLI by clicking **Web Console - HTML access to the command line interface** from a cached copy of the Cisco Systems Access page. To prevent unauthorized access to CMS and the CLI, exit your browser to end the browser session.

Saving Configuration Changes

The **show** command always displays the *running configuration* of the switch. When you make a configuration change to a switch or switch cluster, the change becomes part of the running configuration. The change *does not* automatically become part of the config.txt file in Flash memory, which is the *startup configuration* used each time the switch restarts. If you do not save your changes to Flash memory, they are lost when the switch restarts.

To save all configuration changes to Flash memory, you must enter the **write memory** command in privileged EXEC mode.

Note The **write memory** command does not apply to the Catalyst 1900 and Catalyst 2820 switches, which automatically save configuration changes to Flash memory as they occur.

Tips As you make cluster configuration changes, make sure you periodically save the configuration. The configuration is saved on the command and member switches.

Where to Go Next

The rest of this guide provides descriptions of the software features and general switch administration. Table 4-2 on page 4-9 lists the defaults for all key features and gives the page numbers in this guide where the feature is described and CLI procedures are provided.

Refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference* for complete descriptions of the switch commands.

Refer to the Cisco IOS Release 12.0 documentation on Cisco.com for information about the standard Cisco IOS Release 12.0 commands.



General Switch Administration

This chapter provides the following switch administration topics:

- Basic IP connectivity to the switch
- Switch software releases
- Console port access
- Hypertext Transfer Protocol (HTTP) access
- Telnet access
- Simple Network Management Protocol (SNMP) network management platforms
- Default settings of key software features

Refer to the release notes for information about starting up the switch:

- Software and hardware requirements and compatibility
- Browser and Java plug-in configurations
- Setup program

Also refer to the release notes about switch upgrades.

For information about the standard Cisco IOS Release 12.0 commands, refer to the Cisco IOS Release 12.0 documentation on Cisco.com.

Basic IP Connectivity to the Switch

The switch uses IP address information to communicate with the local routers and the Internet. You need it if you plan to use the CMS to configure and manage the switch. The switch also requires a secret password. IP information is

- Switch IP address
- Subnet mask (IP netmask)
- Default gateway (router)

Once IP information is assigned, you can run the switch on its default settings or configure any settings to meet your network requirements.

The first time that you access the switch, it runs a setup program that prompts you enter this information. For information about running the setup program and assigning basic information to the switch, refer to the release notes.

Switch Software Releases

The switch software is regularly updated with new features and bug fixes, and you might want to upgrade your Catalyst 2900 XL and Catalyst 3500 XL with the latest software release. New software releases are posted on Cisco.com on the World Wide Web and are available through authorized resellers. Cisco also supplies a TFTP server that you can download from Cisco.com.

Before upgrading a switch, first find out the version of the software that the switch is running. You can do this by using the Software Upgrade window, by selecting **Help > About**, or by using the **show version** command.

Knowing the software version is also important for compatibility reasons, especially for switch clusters. Refer to the release notes for the following information:

- Compatibility requirements
- Upgrade guidelines and procedures and software reload information

Console Port Access

The switch console port provides switch access to a directly-attached terminal or PC or to a remote terminal or PC through a serial connection and a modem. For information about connecting to the switch console port, refer to the switch hardware installation guide.

Be sure that the switch console port settings match the settings of the terminal or PC. These are the default settings of the switch console port:

- Baud rate default is 9600.
- Data bits default is 8.

Note If the data bits option is set to 8, set the parity option to None.

- Stop bits default is 1.
- Parity settings default is None.

Make sure that you save any changes you make to the switch console port settings to Flash memory. For information about saving changes from CMS, see the "Saving Configuration Changes" section on page 2-37. For information about saving changes from the CLI, see the "Saving Configuration Changes" section on page 3-10.

Telnet Access to the CLI

The following procedure assumes you have assigned IP information and a Telnet password to the switch or command switch, as described in the release notes. Information about accessing the CLI through a Telnet session is provided in the "Accessing the CLI" section on page 3-8.

To configure the switch for Telnet access, follow these steps:

	Command	Purpose
Step 1		Attach a PC or workstation with emulation software to the switch console port. The default data characteristics of the switch console port are 9600, 8, 1, no parity. When the command line appears, go to Step 2.
Step 2	**enable**	Enter privileged EXEC mode.
Step 3	**config terminal**	Enter global configuration mode.
Step 4	**line vty 0 15**	Enter the interface configuration mode for the Telnet interface. There are 16 possible sessions on a command-capable switch. The 0 and 15 mean that you are configuring all 16 possible Telnet sessions.
Step 5	**password** <*password*>	Enter a enable secret password.
Step 6	**end**	Return to privileged EXEC mode so that you can verify the entry.
Step 7	**show running-config**	Display the running configuration. The password is listed under the command **line vty 0 15**
Step 8	**copy running-config startup-config**	(Optional) Save the running configuration to the startup configuration.

HTTP Access to CMS

CMS uses Hypertext Transfer Protocol (HTTP), which is an in-band form of communication with the switch through any one of its Ethernet ports and that allows switch management from a standard web browser. CMS requires that your switch uses HTTP port 80, which is the default HTTP port.



Note If you change the HTTP port, you cannot use CMS.

Do not disable or otherwise misconfigure the port through which your management station is communicating with the switch. You might want to write down the port number to which you are connected. Changes to the switch IP information should be done with care.

Refer to the following topics in the release notes for information about accessing CMS:

- System requirements
- Running the setup program, which includes assigning a privilege-level 15 password for accessing CMS
- Installing the required Java plug-in
- Configuring your web browser
- Displaying the Cisco Systems Access page

You can also refer to the "Accessing CMS" section on page 2-35.

For information about connecting to a switch port, refer to the switch hardware installation guide.

SNMP Network Management Platforms

You can manage switches by using an Simple Network Management Protocol (SNMP)-compatible management station running such platforms as HP OpenView or SunNet Manager. CiscoWorks2000 and CiscoView 5.0 are network-management applications you can use to configure, monitor, and troubleshoot Catalyst 2900 XL and Catalyst 3500 XL switches.

The switch supports a comprehensive set of Management Information Base (MIB) extensions and MIB II, the IEEE 802.1D bridge MIB, and four Remote Monitoring (RMON) groups, which this IOS software release supports. You can configure these groups by using an SNMP application or by using the CLI. The four supported groups are alarms, events, history, and statistics.

This section describes how to access MIB objects to configure and manage your switch. It provides the following information:

- Using File Transfer Protocol (FTP) to access the MIB files
- Using SNMP to access the MIB variables

In a cluster configuration, the command switch manages communication between the SNMP management station and all switches in the cluster. For information about managing cluster switches through SNMP, see the "Using SNMP to Manage Switch Clusters" section on page 5-22.

When configuring your switch by using SNMP, note that certain combinations of port features create configuration conflicts. For more information, see the "Avoiding Configuration Conflicts" section on page 9-2.

Using FTP to Access the MIB Files

You can obtain each MIB file with the following procedure:

Step 1 Use FTP to access the server **ftp.cisco.com**.

Step 2 Log in with the username *anonymous*.

Step 3 Enter your e-mail username when prompted for the password.

Step 4 At the `ftp>` prompt, change directories to /pub/mibs/supportlists.

Step 5 Change directories to one of the following:

- **wsc2900xl** for a list of Catalyst 2900 XL MIBs
- **wsc3500xl** for a list of Catalyst 3500 XL MIBs

Step 6 Use the **get** *MIB_filename* command to obtain a copy of the MIB file.

You can also access this server from your browser by entering the following URL in the **Location** field of your Netscape browser (the **Address** field in Internet Explorer):

`ftp://ftp.cisco.com`

Use the mouse to navigate to the folders listed above.

Using SNMP to Access MIB Variables

The switch MIB variables are accessible through SNMP, an application-layer protocol facilitating the exchange of management information between network devices. The SNMP system consists of three parts:

- The SNMP manager, which resides on the network management system (NMS)
- The SNMP agent, which resides on the switch
- The MIBs that reside on the switch but that can be compiled with your network management software

An example of an NMS is the CiscoWorks network management software. CiscoWorks2000 software uses the switch MIB variables to set device variables and to poll devices on the network for specific information. The results of a poll can be displayed as a graph and analyzed to troubleshoot internetworking problems, increase network performance, verify the configuration of devices, monitor traffic loads, and more.

As shown in Figure 4-1, the SNMP agent gathers data from the MIB, which is the repository for information about device parameters and network data. The agent can send traps, or notification of certain events, to the SNMP manager, which receives and processes the traps. Traps are messages alerting the SNMP manager to a condition on the network such as improper user authentication, restarts, link status (up or down), and so forth. In addition, the SNMP agent responds to MIB-related queries sent by the SNMP manager in *get-request*, *get-next-request*, and *set-request* format.

The SNMP manager uses information in the MIB to perform the operations described in Table 4-1.

Figure 4-1 SNMP Network

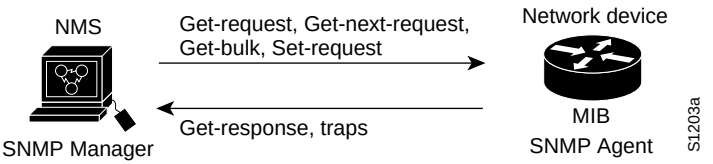


Table 4-1 SNMP Operations

Operation	Description
get-request	Retrieves a value from a specific variable.
get-next-request	Retrieves a value from a variable within a table.[1]
get-response	Replies to a get-request, get-next-request, and set-request sent by an NMS.
set-request	Stores a value in a specific variable.
trap	An unsolicited message sent by an SNMP agent to an SNMP manager indicating that some event has occurred.

1. With this operation, an SNMP manager does not need to know the exact variable name. A sequential search is performed to find the needed variable from within a table.

Default Settings

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. For information about assigning basic IP information to the switch, see the "Basic IP Connectivity to the Switch" section on page 4-2 and the release notes.

If you have specific network needs, you can configure the switch through its various management interfaces. Table 4-2 lists the key software features, their defaults, their page numbers in this guide, and where you can configure them from the command-line interface (CLI) and Cluster Management Suite (CMS).

Table 4-2 Default Settings and Where To Change Them

Feature	Default Setting	Concepts and CLI Procedures	CMS Option
Cluster Management			
Enabling a command switch	None	"Designating and Enabling a Command Switch" section on page 5-14. No CLI procedure provided.	VSM **Cluster > Cluster Command Configuration**
Creating a cluster	None	"Creating a Switch Cluster" section on page 5-13. No CLI procedure provided.	Cluster Builder
Adding and removing cluster members	None	"Adding and Removing Cluster Members" section on page 5-14. No CLI procedure provided.	Cluster Builder **Cluster > Add to Cluster** and **Cluster > Remove from Cluster**
Creating a standby command switch group	None	"Designating and Enabling Standby Command Switches" section on page 5-17. No CLI procedure provided.	Cluster Manager: **Cluster > Standby Command Configuration**

Table 4-2 Default Settings and Where To Change Them (continued)

Feature	Default Setting	Concepts and CLI Procedures	CMS Option
Upgrading cluster software	Enabled	"Switch Software Releases" section on page 4-2. Release notes on Cisco.com	Cluster Manager **System > Software Upgrade**
Configuring SNMP community strings and trap managers	None	"SNMP Community Strings" section on page 5-10 and "Configuring SNMP" section on page 6-18.	Cluster Manager **System > SNMP Management**
Device Management			
Switch IP address, subnet mask, and default gateway	0.0.0.0	"Changing IP Information" section on page 6-2. Documentation set for Cisco IOS Release 12.0 on Cisco.com.	Cluster Manager **System > IP Management**
Dynamic Host Configuration Protocol (DHCP)	DHCP client is enabled	"Using DHCP-Based Autoconfiguration" section on page 6-4. Documentation set for Cisco IOS Release 12.0 on Cisco.com.	–
Management VLAN	VLAN 1	"Management VLANs" section on page 8-4.	Cluster Manager **Cluster > Management VLAN**
Domain name	None	"Configuring the Domain Name and the DNS" section on page 6-8. Documentation set for Cisco IOS Release 12.0 on Cisco.com.	Cluster Manager **System > IP Management**
Cisco Discovery Protocol (CDP)	Enabled	"Configuring CDP" section on page 6-22. Documentation set for Cisco IOS Release 12.0 on Cisco.com.	–

Table 4-2 Default Settings and Where To Change Them (continued)

Feature	Default Setting	Concepts and CLI Procedures	CMS Option
Address Resolution Protocol (ARP)	Enabled	"Managing the ARP Table" section on page 6-45. Documentation set for Cisco IOS Release 12.0 on Cisco.com.	Cluster Manager **System > ARP Table**
System Time Management	None	"Setting the System Date and Time" section on page 6-17. Documentation set for Cisco IOS Release 12.0 on Cisco.com.	Cluster Manager **Cluster > System Time Management**
Static address assignment	None assigned	"Adding Static Addresses" section on page 6-59. Documentation set for Cisco IOS Release 12.0 on Cisco.com.	Cluster Manager **Security > Address Management**
Dynamic address management	Enabled	"Managing the MAC Address Tables" section on page 6-56. Documentation set for Cisco IOS Release 12.0 on Cisco.com.	Cluster Manager **Security > Address Management**
Voice configuration	–	"Configuring Voice Ports" section on page 7-17.	–
VLAN membership	Static-access ports in VLAN 1	"Assigning VLAN Port Membership Modes" section on page 8-7.	Cluster Manager **VLAN > VLAN Membership**
VMPS Configuration	–	"How the VMPS Works" section on page 8-52.	Cluster Manager **Cluster > VMPS Configuration**
VTP Management	VTP server mode	"Configuring VTP" section on page 8-20.	Cluster Manager **VLAN > VTP Management**

Table 4-2 Default Settings and Where To Change Them (continued)

Feature	Default Setting	Concepts and CLI Procedures	CMS Option
Performance			
Configuring a port	None	Chapter 7, "Configuring the Switch Ports."	Cluster Manager **Port > Port Configuration** and **Device > LRE Profile** (for LRE ports only)
Duplex mode	• Auto on all 10/100 ports • Half duplex on all LRE ports	"Changing the Port Speed and Duplex Mode" section on page 7-2.	Cluster Manager **Port > Port Configuration**
Speed on 10/100 ports	Auto	"Changing the Port Speed and Duplex Mode" section on page 7-2	Cluster Manager **Port > Port Configuration**
Gigabit Ethernet flow control	• Any on all Gigabit ports • Disabled on LRE ports in half-duplex mode; enabled on LRE ports in full-duplex mode **Note** This option is configurable only on the Gigabit ports.	"Configuring Flow Control on Gigabit Ethernet Ports" section on page 7-3.	Cluster Manager **Port > Port Configuration**
LRE link speed and LRE port profiles	LRE-10	"Configuring the LRE Ports" section on page 7-22.	Cluster Manager **Device > LRE Profile Configuration**
Inline power	Auto	"Configuring Inline Power on the Catalyst 3524-PWR Ports" section on page 7-21	–

Table 4-2 Default Settings and Where To Change Them (continued)

Feature	Default Setting	Concepts and CLI Procedures	CMS Option
Flooding Control			
Storm control	Disabled	"Configuring Flooding Controls" section on page 7-4.	Cluster Manager **Port > Flooding Control**
Flooding unknown unicast and multicast packets	Enabled	"Blocking Flooded Traffic on a Port" section on page 7-6.	Cluster Manager **Port > Flooding Control**
Cisco Group Management Protocol (CGMP)	Enabled	"Controlling IP Multicast Packets through CGMP" section on page 6-46.	Cluster Manager **Device > Cisco Group Management Protocol (CGMP)**
Multicast VLAN Registration (MVR)	Disabled	"Configuring MVR" section on page 6-49.	–
Network Port	Disabled	"Enabling a Network Port" section on page 7-7.	–
Network Redundancy			
Hot Standby Router Protocol	Disabled	"Designating and Enabling Standby Command Switches" section on page 5-17.	–
Spanning Tree Protocol	Enabled	"Configuring STP" section on page 6-24.	Cluster Manager **Device > Spanning Tree Protocol (STP)**
Unidirectional link detection	Disabled	"Configuring UniDirectional Link Detection" section on page 7-9.	–
Port grouping	None assigned	"Creating EtherChannel Port Groups" section on page 7-10.	Cluster Manager **Port > Port Grouping (EC)**

Table 4-2 Default Settings and Where To Change Them (continued)

Feature	Default Setting	Concepts and CLI Procedures	CMS Option
Diagnostics			
Displaying graphs and statistics	Enabled	"Displaying an Inventory of the Clustered Switches" section on page 5-19 and "Displaying Link Information" section on page 5-20.	Cluster Manager **Port > Port Statistics** and **Port > Port Configuration > Runtime Status** Cluster Builder **Link > Link Graph** and **Link > Link Report**
Switch Port Analyzer (SPAN) port monitoring	Disabled	"Enabling SPAN" section on page 7-16.	Cluster Manager **Port > Switch Port Analyzer (SPAN)**
Console, buffer, and file logging	Disabled	– Documentation set for Cisco IOS Release 12.0 on Cisco.com.	–
Remote monitoring (RMON)	Disabled	"SNMP Network Management Platforms" section on page 4-6. Documentation set for Cisco IOS Release 12.0 on Cisco.com.	–
Security			
Password	None	"Passwords" section on page 5-8 and "Changing the Password" section on page 6-15.	–
Addressing security	Disabled	"Managing the MAC Address Tables" section on page 6-56.	Cluster Manager **Security > Address Management**
Trap manager	0.0.0.0	"Adding Trap Managers" section on page 6-19.	Cluster Manager **System > SNMP Management**

Table 4-2 Default Settings and Where To Change Them (continued)

Feature	Default Setting	Concepts and CLI Procedures	CMS Option
Community strings	public	"SNMP Community Strings" section on page 5-10 and "Entering Community Strings" section on page 6-19. Documentation set for Cisco IOS Release 12.0 on Cisco.com.	Cluster Manager **System > SNMP Configuration**
Port security	Disabled	"Enabling Port Security" section on page 7-14.	Cluster Manager **Security > Port Security**
Terminal Access Controller Access Control System Plus (TACACS+)	Disabled	"Configuring TACACS+" section on page 6-61.	–
Protected port	Disabled	"Configuring Protected Ports" section on page 7-13.	–



Clustering Switches

This chapter provides the following topics to help you get started with switch clustering:

- Switch cluster overview
- Planning a switch cluster
- Creating a switch cluster
- Verifying a switch cluster
- Using the command-line interface (CLI) to manage switch clusters
- Using Simple Network Management Protocol (SNMP) to manage switch clusters

Configuring switch clusters is more easily done from the Cluster Management Suite (CMS) web-based interface than through the CLI. Therefore, information in this chapter focuses on using CMS. See Chapter 2, "Getting Started with CMS," for additional information about switch clusters and the clustering options. For complete procedures on using CMS to configure switch clusters, refer to the online help.

For the cluster commands, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

Note Refer to the release notes for the list of Catalyst switches enabled for switch clustering, including which ones can be command switches and which ones can only be member switches, and for the the required software versions and browser and Java plug-in configurations.

Understanding Switch Clusters

A switch cluster is a group of connected Catalyst desktop switches that are managed as a single entity. The switches can be in the same location, or they can be distributed across a contiguous Layer 2 network. All communication with cluster switches is through one IP address.

In a switch cluster, 1 switch must be designated as the *command switch* and up to 15 switches can be *member switches*. The command switch is the single point of access used to configure, manage, and monitor the member switches. It identifies and controls all member switches in a cluster, regardless of where they are located and how they are connected. You can designate one or more switches as *standby command switches* to avoid losing contact with cluster members if the command switch fails.

The following sections list the requirements for the following cluster members:

- Command switch
- Standby command switches
- Candidate and member switches



Note Refer to the release notes for the list of Catalyst switches enabled for switch clustering, including which ones can be command switches and which ones can only be member switches, and the required software versions.

Command Switch Characteristics

The command switch must meet the following requirements:

- It is running Cisco IOS Release 12.0(5)XP or later.
- It has an IP address.
- It has Cisco Discovery Protocol (CDP) version 2 enabled (the default).
- It is not a command or member switch of another cluster.
- It belongs to the same management VLAN as the cluster member switches.
- No access lists have been defined for the switch because access lists can restrict access to a switch. Access lists are not usually used in configuring the Catalyst 2900 XL and Catalyst 3500 XL switches, except for the access class 199 that is created when a device is configured as the command switch.

Standby Command Switch Characteristics

You can assign one or more switches to a standby group of command switches. There is no limit to the number of switches you assign to a standby group. To be eligible for a standby group, a switch must meet the following requirements:

- It is running Cisco IOS Release 12.0(5)XP or later.
- It has its own IP address.
- It has CDP version 2 enabled.
- It is not a command or member switch of another cluster.
- It is in the same management VLAN as the active command switch.
- It is a member of the cluster.

For redundancy, we also recommend that each standby command switch is cabled so that connectivity to cluster members is maintained.

Candidate and Cluster Member Characteristics

Candidate switches are cluster-capable switches that have not yet been added to a cluster. Member switches are switches that have actually been added to a switch cluster. A candidate or member switch can have its own IP address, but it is not required. It can also have its own enable or enable secret password.



Note Before adding a candidate switch to the cluster, you must know its enable or enable secret password.

To join a cluster, a switch must meet the following requirements:

- It is running cluster-capable software.
- It has CDP version 2 enabled.
- It is connected to a command switch through ports that belong to the same management VLAN (see the "Management VLAN" section on page 5-11).
- It is not an active member or the command switch of another cluster.

Planning a Switch Cluster

Anticipating conflicts and compatibility issues is a high priority when you manage several switches through a cluster. This section describes the following considerations, requirements, and caveats that you should understand before you create the cluster.

Refer to the release notes for software compatibility considerations and requirements on cluster-capable switches.

Automatic Discovery of Cluster Candidates

The switch uses Cisco Discovery Protocol (CDP) to discover and display candidate switches that can be added to a cluster. By using CDP, a switch can automatically discover switches in star or cascaded topologies that are up to three cluster-enabled devices away from the edge of the cluster. You can configure the command switch to discover switches up to seven cluster-enabled devices away. The default is three hops. To set the number of hops the command switch searches for candidate and member switches, or to disable the automatic display of suggested candidates, select **Cluster** > **User Settings**.



Note Do not disable CDP. CDP must be enabled for the switch to discover and display the switch cluster and connected switch clusters, cluster candidates, and neighboring edge devices.

When an edge device that does not support CDP is connected to the command switch, CDP can still discover the candidate switches that are attached to it. When a switch that does support CDP but does not support clustering is connected to the command switch, the cluster is unable to discover candidates that are attached to that switch. For example, Cluster Builder cannot create a cluster that includes candidates that are connected to a Catalyst 5000 series or Catalyst 6000 switch connected to the command switch. For more information about CDP, see the "Configuring CDP" section on page 6-22.

Standby Command Switches

Because a command switch manages the forwarding of all communication and configuration information to all the cluster members, we strongly recommend that you configure a standby command switch to take over if the command switch fails. We also recommend redundant cabling from the standby command switch to the switch cluster.

IOS Release 12.0(5)XU and higher supports a version of the Hot Standby Router Protocol (HSRP) so that you can configure a *standby group* of command switches. A standby group is a group of switches that meet the requirements described in the "Standby Command Switch Characteristics" section on page 5-3.

Note Catalyst 2900 XL and Catalyst 3500 XL switches running releases earlier than IOS Release 12.0(5)XU can belong to clusters supported by standby command switches, but they cannot belong to a standby group.

The standby group of command switches are ranked according to a set of user-defined priorities. Switches are ranked first by the number of links they have and second by the switch speed. If switches have the same number of links and speed, they are listed alphabetically. The member switch with the highest priority in the group is the *standby command switch*. The standby group is *bound* to the switch cluster so that the standby command switch becomes active if the primary command switch fails.

You assign a unique virtual IP address to the standby group. The primary command switch receives member traffic destined for the virtual IP address. To manage the standby group, you must access the primary command switch through the virtual IP address, not through the command-switch IP address. If HSRP is enabled and you use the command-switch IP address, you will be prompted a second time for a password when you move between Cluster Builder and VSM.

Figure 5-1 shows a group of switches with a standby command switch.

Figure 5-1 A Cluster with a Standby Command Switch

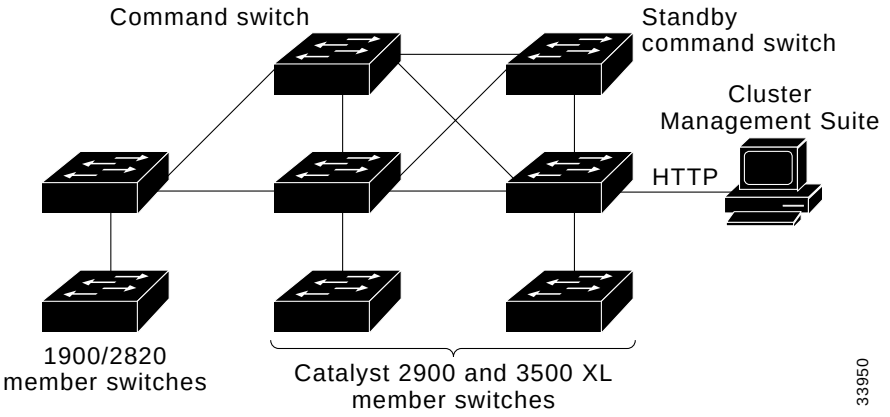
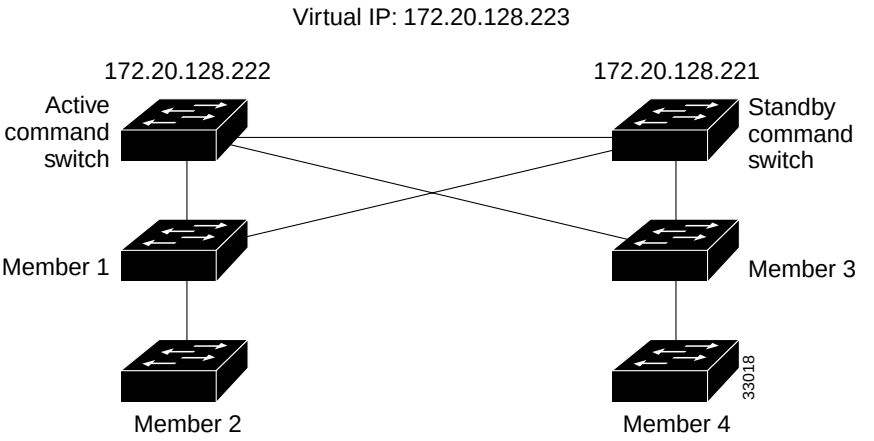


Figure 5-2 shows a network cabled to allow the standby switch to maintain management contact with the member switches if the cluster command switch fails. Spanning Tree Protocol (STP) prevents the loops in such a configuration from reducing performance.

Figure 5-2 Redundant Cabling to Support HSRP



To ensure that the standby command switch can take over the cluster if the primary command switch fails, the primary command switch continually forwards cluster configuration information to the standby command switch.

Note The command switch forwards cluster configuration information to the standby switch but not device-configuration information. The standby command switch is informed of new cluster members but not the configuration of any given switch.

If the primary command switch fails, the standby command switch assumes ownership of the virtual IP address and MAC address and begins acting as the command switch. The remaining switches in the standby group compare their assigned priorities to determine the new standby command switch.

When the primary command switch becomes active again, the command switch resumes its role as the active command switch. An automatic recovery procedure adds cluster members that were added to the cluster while the primary command switch was down.

To configure an HSRP standby command group, see the "Designating and Enabling Standby Command Switches" section on page 5-17.

IP Addresses

Clustering switches conserves IP addresses if you have a limited number of them. If you plan to create switch clusters, you must assign IP information to a command switch. Through the command-switch IP address, you can manage and monitor up to 16 switches.

When a switch joins a cluster, it is managed and communicates with other member switches through the command-switch IP address. You can assign an IP address to the candidate or member switch, but it is not necessary. When a member switch has its own IP address, it remains manageable if it leaves the cluster and becomes a standalone switch.

Caution Changing the command-switch IP address ends your CMS session. Restart your CMS session by entering the new IP address in the browser **Location** field (Netscape Communicator) or **Address** field (Microsoft Internet Explorer), as described in the release notes.

You can assign IP information by using the setup program (refer to the release notes) or by manually assigning it (see the "Changing IP Information" section on page 6-2).

Passwords

If you plan to create switch clusters, you should assign an enable secret password to the command switch. You can assign a privilege level (1 to 15) to the password, where level 15, the default, provides the highest level of security. An enable secret password with privilege level 15 is required to access to the switch or switch cluster through CMS and TACACS+ authentication. You can assign this password by using the setup program (refer to the release notes) or by manually assigning it (see the "Changing the Password" section on page 6-15).

It is not necessary to assign passwords to an individual switch if it will be a cluster member. If a candidate switch has a password, you must enter that password to add the switch to the cluster. When the switch joins the cluster, it inherits the command-switch password and retains it when it leaves the cluster. If no command-switch password is configured, the member switch inherits a null password.

If you change the member-switch password, it is not manageable by the command switch until you change the member-switch password to match the command-switch password or until you reboot the member switch.

Note Copies of the CMS pages you display are saved in your browser memory cache until you exit the browser session. A password is not required to redisplay these pages, including the Cisco Systems Access page. You can access the CLI by clicking **Web Console - HTML access to the command line interface** from a cached copy of the Cisco Systems Access page. To prevent unauthorized access to CMS and the CLI, exit your browser to end the browser session.

If a Catalyst 1900 or Catalyst 2820 switch joins the cluster, its passwords and privilege levels are altered. Keep in mind the following caveats if your cluster has Catalyst 1900 and Catalyst 2820 member switches:

- Password length
  - If the command-switch enable password is longer than eight characters, the member-switch enable password is truncated to eight characters.
  - If the command-switch enable password is between one and eight characters inclusive, the member-switch enable password is the same as the command switch password. (Though the password length for Catalyst 1900 and Catalyst 2820 switches is from four to eight characters, the length is only checked when the password is configured from the menu console or with the CLI.)
  - Both the command switch and member switch support up to 25 characters (52 characters encrypted) in the enable secret password.
- Privilege level

  The command switch supports up to 15 privilege levels. Catalyst 1900 and Catalyst 2820 member switches support only levels 1 and 15.
  - Command-switch privilege levels 1 to 14 map to level 1 on the member switch.
  - Command-switch privilege level 15 maps to level 15 on the member switch.

Host Names

You do not need to assign a host name to either a command switch or an eligible cluster member. However, a host name assigned to the command switch can help to more easily identify the switch cluster. The default host name for any Catalyst 2900 XL and Catalyst 3500 XL switch is *Switch*.

If a switch joins a cluster and it does not have a host name, the command switch appends a unique member number to its own host name and assigns it sequentially as each switch joins the cluster. The number indicates the member number of the switch. For example, a command switch named *eng-cluster* could name cluster member number 5, *eng-cluster-5*.

If a switch has a host name, it retains that name when it joins a cluster. It retains that host name even after it leaves the cluster.

If a switch received its host name from the command switch, was removed from the cluster, and was then was added to a new cluster, its old host name (such as *eng-cluster-5*) is overwritten with the host name of the command switch in the new cluster.

SNMP Community Strings

The Cluster Management software appends the member switch number (*@esN*, where *N* is the switch number) to the first configured RO and RW community strings on the command switch and propagates them to the member switch:

- *commander-readonly-community-string@esN*
- *commander-readwrite-community-string@esN*

If the command switch has multiple read-only or read-write community strings, only the first read-only and read-write strings are propagated to the member switch.

The Catalyst 2900 XL and Catalyst 3500 XL switches support an unlimited number of community strings and string lengths.

The Catalyst 1900 and Catalyst 2820 switches support up to four read-only and four read-write community strings; each string contains up to 32 characters. When these switches join the cluster, the first read-only and read-write community string on the command switch is propagated and overwrites the fourth read-only and read-write community string on the member switches. To support the

32-character string-length limitation on the Catalyst 1900 and Catalyst 2820 switches, the command-switch community strings are truncated to 27 characters when propagating them to these switches, and the *@esN* (where *N* refers to the member switch number and can be up to two digits) is appended to them.

For more information about configuring community strings through Cluster Manager, see the "Configuring SNMP" section on page 6-18. For more information about using SNMP to manage clusters, see the "Using SNMP to Manage Switch Clusters" section on page 5-22.

Management VLAN

Communication with the switch management interfaces is through the switch IP address. The IP address is associated with the management VLAN, which by default is VLAN 1. To manage switches in a cluster, the port connections among the command, member, and candidate switches must be connected through ports that belong to the management VLAN.

Any VLAN can serve as the management VLAN as long as there are links between the command switch and the member switches for both the old and the new management VLAN. When you change the management VLAN on an existing cluster, the command switch synchronizes activities with member switches to ensure that no loss of management connectivity occurs.

Note Activity synchronization is only valid for IOS Release 12.0(5)XU and higher. Previous releases of the software require that switches be upgraded one at a time.

If your cluster includes members that are running a software release earlier than Cisco IOS Release 12.0(5)XP, you cannot change the management VLAN of the cluster. If your cluster includes member switches that are running Cisco IOS Release 12.0(5)XP, those members need to have the VLAN changed before using the Management VLAN window.

Caution You can change the management VLAN through a console connection without interrupting the console connection. However, changing the management VLAN ends your CMS session. Restart your CMS session by entering the new IP address in the browser **Location** field (Netscape Communicator) or **Address** field (Microsoft Internet Explorer), as described in the release notes.

To change the management VLAN on an existing cluster, see the "Changing the Management VLAN for a New Switch" section on page 8-5.

If you add a new switch to an existing cluster and the cluster is using a management VLAN other than the default VLAN 1, the command switch automatically senses that the new switch has a different management VLAN and has not been configured. The command switch issues commands to change the management VLAN on the new switch to match the one in use by the cluster. This automatic change of the VLAN only occurs for new, out-of-box switches that do not have a config.text file and for which there have been no changes to the running configuration.

Network Port

A network port cannot link cluster members. For more information about the network port, see the "Enabling a Network Port" section on page 7-7.

NAT Commands

When a cluster is created, Network Address Translation (NAT) commands are added to the configuration file of the command switch. Do not remove these commands.

LRE Profiles

A configuration conflict occurs if a switch cluster has LRE switches using both private and public profiles. If one LRE switch in a cluster is assigned a public profile, all LRE switches in that cluster must have that same public profile. Before you add an LRE switch to a cluster, make sure that you assign it the same public profile used by other LRE switches in the cluster.

A cluster can have a mix of LRE switches using different private profiles.

For more information about LRE port profiles, see the "Configuring the LRE Ports" section on page 7-22.

Availability of Switch-Specific Features in Switch Clusters

When a switch has features specific to it and the switch is part of a switch cluster, the CMS menu bars display the configuration options of those features. For example, Device > LRE Profile appears in the Cluster Manager menu bar when at least one Catalyst 2900 LRE XL switch is in the cluster. However, these options are only available when the appropriate switch is selected from the Host Name drop-down list.

Creating a Switch Cluster

You create a cluster by performing these tasks:

1. Cabling together switches running clustering software
2. Assigning basic information to one switch (the command switch)
3. Starting VSM to designate and enable a command switch
4. Starting Cluster Builder to add candidate and standby command switches to the cluster

After the cluster is formed, you can access all switches in the cluster by entering the IP address of the command switch into the browser **Location** field (Netscape Communicator) or **Address** field (Microsoft Internet Explorer).

This section provides procedures for enabling a command switch and building a cluster. For procedures on connecting switches together, refer to the switch hardware installation guide. For procedures on assigning basic information to the command switch, refer to the release notes.

Designating and Enabling a Command Switch

Before you enable a switch as a command switch, refer to the release notes for command-switch requirements. To enable a command switch, display VSM, select **Cluster > Cluster Command Configuration**, and in the Command Switch Status field, select **Enable**. You can use up to 31 characters to name your cluster.

After enabling a command switch, select **Cluster > Cluster Builder** to begin building your cluster.

Adding and Removing Cluster Members

Each time you launch CMS, it displays the Suggested Candidates window (Figure 5-3) and prompts you to create a cluster by adding qualified candidates. This window lists the cluster candidates discovered by the switch. The Suggested Candidate window lists each candidate switch with its device type, MAC address, and the switch through which it is connected to the cluster. By default, the suggested candidates are highlighted in the Suggested Candidates window, but you can select 1 or more switches as long as the number of switches selected does not exceed 16. This window does not appear after the number of switches in the cluster reaches the maximum of 16. Only candidates that you accept are added to the cluster.

When you add new cluster-eligible switches to the network, CMS discovers those new switches and the next time you launch Cluster Builder, it prompts you with an updated Suggested Candidates window.

Note The Suggested Candidates window displays prequalified candidates whether or not they are in the same management VLAN as the command switch. If you enter the password for a candidate in a different management VLAN than the cluster and click **OK**, this switch is not added to the cluster. It appears as a candidate switch in Cluster Builder. For information about how to change the management VLAN, see the "Management VLAN" section on page 5-11.

From the Cluster Builder topology, you can also add a candidate switch to a cluster. Display Cluster Builder, right-click the candidate icon, and from the pop-up menu, select **Add to Cluster** (Figure 5-4). Cluster members have green labels, and candidates have blue labels. You can add a switch to a cluster if the cluster has no more than 16 members; otherwise, you must remove a member before adding a new one. The Add to Cluster option is disabled when the number of cluster members reaches 16.

To add several switches to a cluster, press **Ctrl**, and left-click the candidates you want to add. If any of the candidates cannot be added, Cluster Builder displays a message that states which candidates were not added and why.

Figure 5-3 Suggested Candidate Window

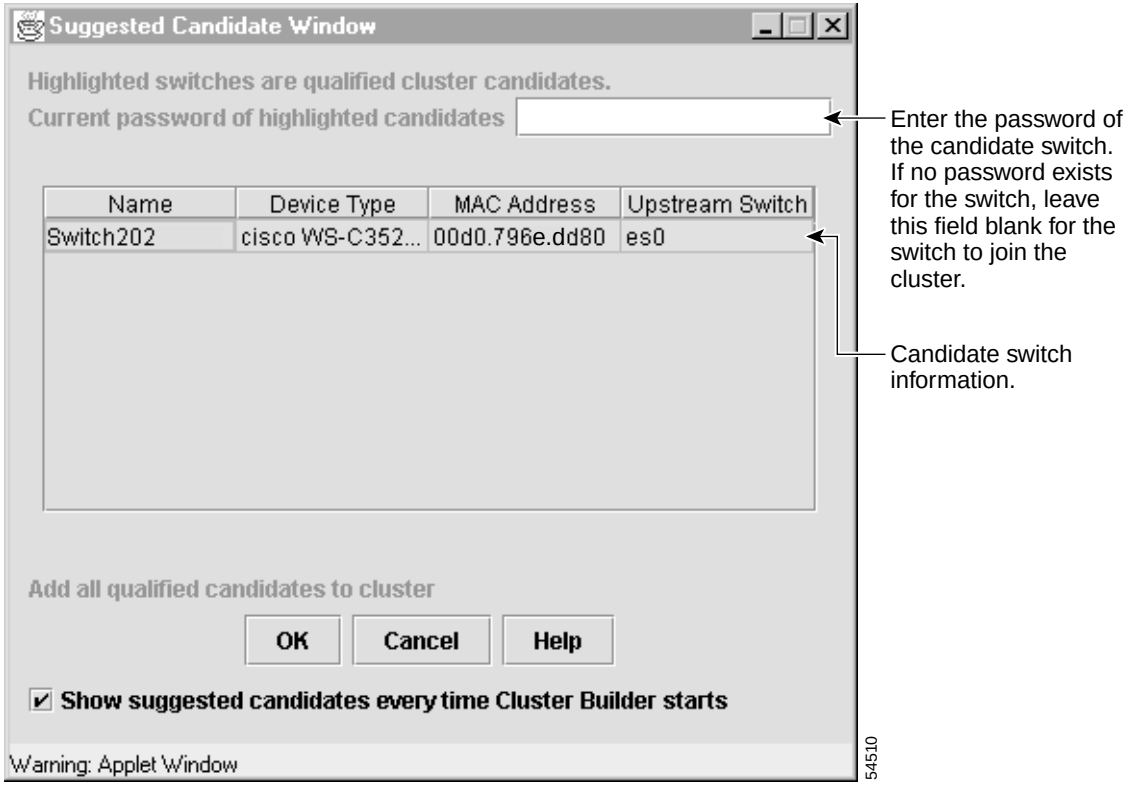
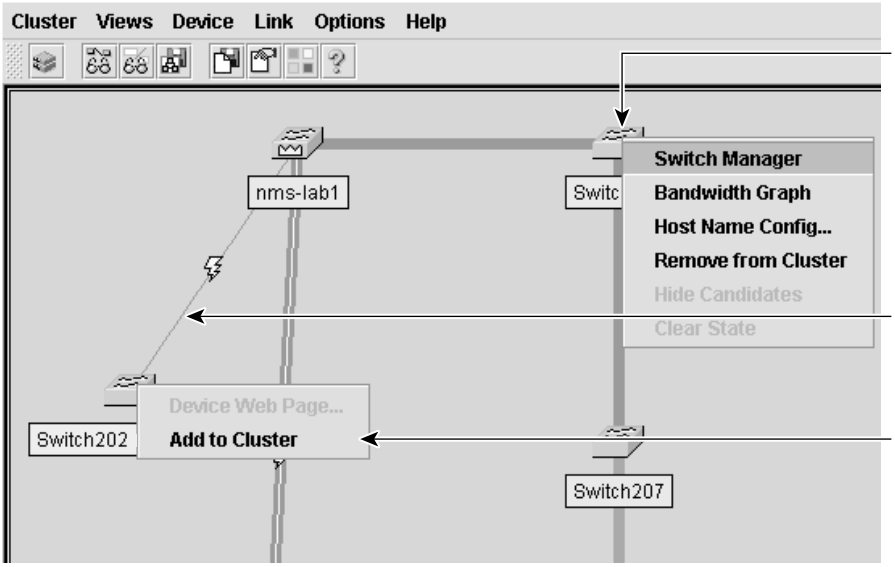


Figure 5-4 Cluster Builder



Right-click a member switch to display the device pop-up menu, and select an option to display the Switch Manager, display switch information, or remove the switch from the cluster.

Thin line indicates a connection to a candidate switch.

Right-click a candidate switch to display the device pop-up menu, and select **Add to Cluster** to add the switch to a cluster.

If a password has been configured on the candidate switch, you are prompted to enter it and your username. You can add multiple candidates at the same time if they have the same password. If you enter a password that does not match the password defined for the candidate or if you enter a password for a candidate that does not have a password, the candidate is not added to the cluster. In all cases, once a candidate switch joins a cluster, it inherits the command-switch password.

To remove a member switch, right-click it, and from the pop-up menu, select **Remove from Cluster**. The switch retains its configured password when it leaves the cluster. For more information about setting passwords, see the "Passwords" section on page 5-8.

If the candidate is in a different management VLAN than the command switch, a message states that this candidate is unreachable, and you will not be able to add it to the cluster. For more information about management VLAN considerations, see the "Management VLAN" section on page 5-11.

For information about how to remove Catalyst 1900 or Catalyst 2820 member switches, refer to the *Catalyst 1900 Series Installation and Configuration Guide* or the *Catalyst 2820 Series Installation and Configuration Guide*.

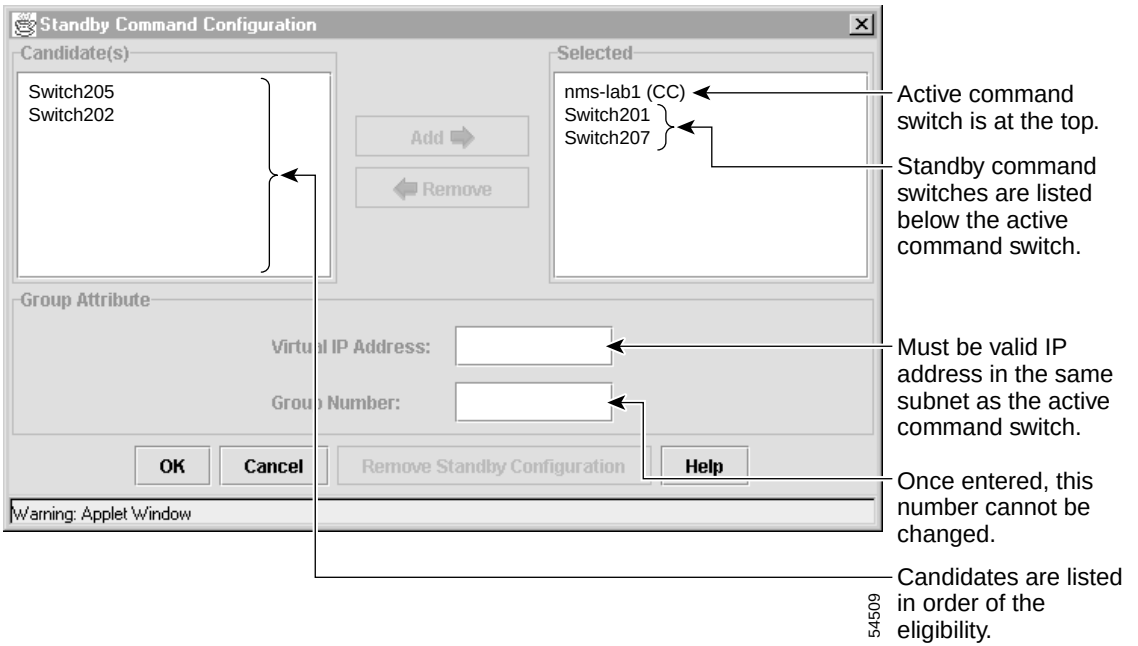
Designating and Enabling Standby Command Switches

To create a standby group, display Cluster Manager, and select **Cluster > Standby Command Configuration** to display the Standby Command Configuration window (Figure 5-5).

Eligible switches are listed in the Candidates list according to an eligibility ranking. Candidate switches are ranked first by the number of links they have and second by the switch speed. If the switches have the same number of links and speed, they are listed alphabetically.

In the Selected list, the active command switch has the highest priority and is always at the top of the list. The standby switch with the next highest priority becomes the standby command switch. The standby command switch is listed after the active command switch, followed by the other standby switches according to their priority. The last switch has the lowest priority. If the primary command switch fails, the standby command switch becomes the primary command switch. The standby switch with the next highest priority then becomes the standby command switch.

Figure 5-5 Standby Command Configuration



The following abbreviations are appended to the switch host names in the Selected list to show their status in the standby group:

- AC—Active command switch
- SC—Standby command switch
- PC—Member of the standby group but not the standby command switch
- CC—Command switch when HSRP is disabled

The virtual IP address must be in the same subnet as the IP addresses of the switches, and the group number must be unique within the IP subnet. It can be from 0 to 255, and the default is 0.

The Standby Command Configuration window uses the default values for the **preempt** and **name** commands that you have set by using the CLI. If you use this window to create the HSRP group, all switches in the group have the **preempt** command enabled, and the name for the group is *clustername_standby.*

Verifying a Switch Cluster

You can display the switch cluster you have built by

- Displaying an inventory of the switches in the cluster.
- Displaying the topology of the switch cluster and viewing link information.

You can also display port and switch statistics from **Port > Port Statistics** and **Port > Port Configuration > Runtime Status**.

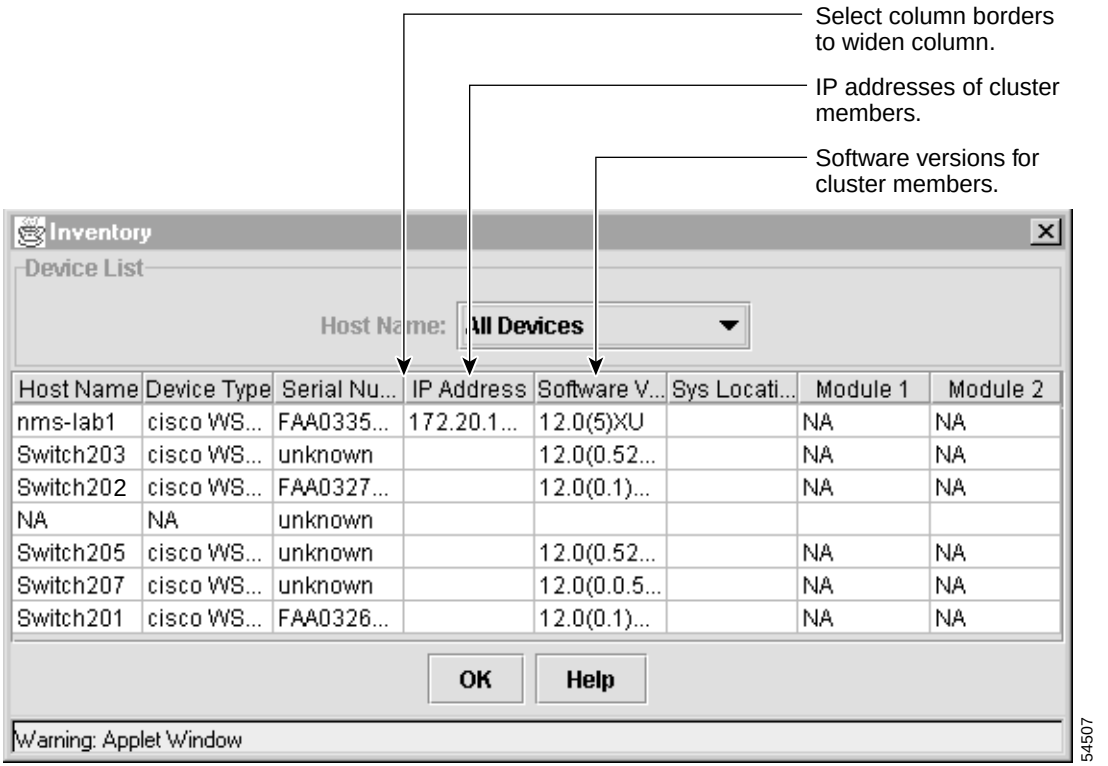
For information about troubleshooting switch clusters, see Chapter 9, "Troubleshooting."

Displaying an Inventory of the Clustered Switches

To display an inventory of the switch cluster, display VSM or Cluster Manager, and select **System > Inventory** to display the Inventory window (Figure 5-6). To display this information for a single switch, select the switch image, right-click it, and select **System > Inventory**.

The inventory summary of the cluster members includes information such as switch model numbers, serial numbers, software versions, IP information, location, and any installed modules.

Figure 5-6 Inventory



Displaying Link Information

You can see how the cluster members are interconnected from Cluster Builder. It shows how the switches are connected and the type of connection between each device. To display a legend describing the icons, links, and colors used in Cluster Builder, select **Help > Legend**. To display port-connection information such as port numbers for each end of the link, select **Views > Toggle Labels**.

Using the CLI to Manage Switch Clusters

You can configure member switches from the CLI by first logging in to the command switch. Enter the **rcommand** user EXEC command and the member switch number to start a Telnet session (through a console or Telnet connection) and to access the member switch CLI. After this, the command mode changes and IOS commands operate as usual. Enter the **exit** privileged EXEC command on the member switch to return to the command-switch CLI. For more information about the rcommand command, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

The following example shows how to log into member-switch 3 from the command-switch CLI:

```
switch# rcommand 3
```

If you do not know the member-switch number, enter the **show cluster members** user EXEC command on the command switch.

For Catalyst 2900 XL and Catalyst 3500 XL switches, the Telnet session accesses the member-switch CLI at the same privilege level as on the command switch. The IOS commands then operate as usual. For instructions on configuring the Catalyst 2900 XL or Catalyst 3500 XL switch for a Telnet session, see the "Accessing the CLI" section on page 3-8.

For Catalyst 1900 and Catalyst 2820 switches running standard edition software, the Telnet session accesses the management console (a menu-driven interface) if the command switch is at privilege level 15. If the command switch is at privilege level 14, you are prompted for the password before being able to access the menu console.

Command-switch privilege levels map to the Catalyst 1900 and Catalyst 2820 member switches running standard and Enterprise Edition Software as follows:

- If the command-switch privilege level is 1 to 14, the member switch is accessed at privilege level 1.
- If the command-switch privilege level is 15, the member switch is accessed at privilege level 15.



Note The Catalyst 1900 and Catalyst 2820 CLI is available only on switches running Enterprise Edition Software.

Using SNMP to Manage Switch Clusters

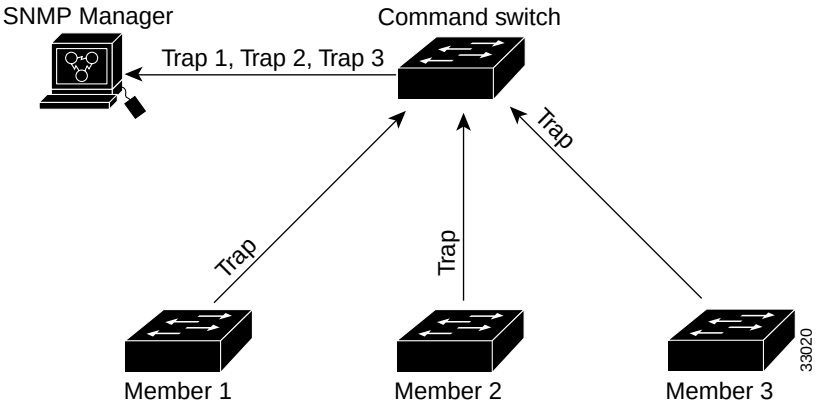
You must enable SNMP for the Cluster Management reporting and graphing features to function properly. When you first power on the switch, SNMP is enabled if you enter the IP information by using the setup program and accept its proposed configuration. If you did not use the setup program to enter the IP information and SNMP was not enabled, you can enable it on the SNMP Configuration page described in the "Configuring SNMP" section on page 6-18. On Catalyst 1900 and Catalyst 2820 switches, SNMP is enabled by default.

When you create a cluster, the command switch manages the exchange of messages between member switches and an SNMP application. The Cluster Management software appends the member switch number (*@esN*, where *N* is the switch number) to the first configured RW and RO community strings on the command switch and propagates them to the member switch. The command switch uses this community string to control the forwarding of gets, sets, and get-next messages between the SNMP management station and the member switches.

Note When a standby group is configured, the command switch can change without your knowledge. Use the first read-write and read-only community strings to communicate with the command switch if there is a standby group configured for the cluster.

If the member switch does not have an IP address, the command switch passes traps from the member switch to the management station, as shown in Figure 5-7. If a member switch has its own IP address and community strings, they can be used in addition to the access provided by the command switch. For more information, see the "SNMP Community Strings" section on page 5-10 and the "Configuring SNMP" section on page 6-18.

Figure 5-7 SNMP Management for a Cluster





Configuring the System

This chapter provides information about changing switch-wide configuration settings. It includes command-line interface (CLI) procedures for using commands that have been specifically created or changed for the Catalyst 2900 XL or Catalyst 3500 XL switches. For complete syntax and usage information for the commands used in this chapter, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

This chapter does not repeat the concepts and CLI procedures provided in the standard Cisco IOS Release 12.0 documentation. For switch features that use standard Cisco IOS Release 12.0 commands, refer to the Cisco IOS Release 12.0 documentation on Cisco.com for additional information and CLI procedures.

For information about configuring these settings from Cluster Management Suite (CMS), refer to the online help.

Note Some features can be implemented only by using the CLI.

Changing IP Information

You can assign and change the IP information of your switch in the following ways:

- Using the setup program, as described in the release notes
- Manually assigning an IP address, as described in this section
- Using Dynamic Host Configuration Protocol (DHCP)-based autoconfiguration, as described in this section

Caution Changing the switch IP address ends any CMS, Telnet, or Simple Network Management Protocol (SNMP) session. To restart your CMS session, enter the new IP address in the browser **Location** field (Netscape Communicator) or **Address** field (Internet Explorer). To restart your CLI session through Telnet, follow the steps described in the "Accessing the CLI" section on page 3-8.

Note If you enabled the DHCP feature, the switch assumes you are using an external server for IP address allocation. While this feature is enabled, any values you manually enter (from the CMS or from the **ip address** command) are ignored.

Manually Assigning and Removing Switch IP Information

You can manually assign an IP address, mask, and default gateway to the switch. The mask identifies the bits that denote the network number in the IP address. When you use the mask to subnet a network, the mask is then referred to as a subnet mask. The broadcast address is reserved for sending messages to all hosts. The CPU sends traffic to an unknown IP address through the default gateway.

Beginning in privileged EXEC mode, follow these steps to enter the IP information:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface vlan 1**	Enter interface configuration mode, and enter the VLAN to which the IP information is assigned. VLAN 1 is the default management VLAN, but you can configure any VLAN from IDs 1 to 1001.
Step 3	**ip address** *ip_address subnet_mask*	Enter the IP address and subnet mask.
Step 4	**exit**	Return to global configuration mode.
Step 5	**ip default-gateway** *ip_address*	Enter the IP address of the default router.
Step 6	**end**	Return to privileged EXEC mode.
Step 7	**show running-config**	Verify that the information was entered correctly by displaying the running configuration. If the information is incorrect, repeat the procedure.

Use the following procedure to remove the IP information from a switch.

Note Using the **no ip address** command in configuration mode disables the IP protocol stack as well as removes the IP information. Cluster members without IP addresses rely on the IP protocol stack being enabled.

Beginning in privileged EXEC mode, follow these steps to remove an IP address:

	Command	Purpose
Step 1	**clear ip address vlan 1** *ip_address subnet_mask*	Remove the IP address and subnet mask.
Step 2	**end**	Return to privileged EXEC mode.
Step 3	**show running-config**	Verify that the information was removed by displaying the running configuration.

Using DHCP-Based Autoconfiguration

The Dynamic Host Configuration Protocol (DHCP) provides configuration information to Internet hosts and internetworking devices. With DHCP-based autoconfiguration, your switch (DHCP client) can be automatically configured during bootup with IP address information and a configuration file that it receives during DHCP-based autoconfiguration.

Note DHCP replaces the Bootstrap Protocol (BOOTP) feature autoconfiguration to ensure retrieval of configuration files by unicast TFTP messages. BOOTP is available in earlier software releases for this switch.

Understanding DHCP-Based Autoconfiguration

The DHCP provides configuration information to internet hosts and internetworking devices. This protocol consists of two components: one for delivering configuration parameters from a DHCP server to a device and one for allocating network addresses to devices. DHCP is built on a client-server model, where designated DHCP servers allocate network addresses and deliver configuration parameters to dynamically configured devices.

With DHCP-based autoconfiguration, your switch (DHCP client) can be automatically configured at startup with IP address information and a configuration file that it receives during DHCP-based autoconfiguration. No DHCP client-side configuration is required on your switch.

However, you need to configure the DHCP server for various lease options. You might also need to configure a TFTP server, a Domain Name System (DNS) server, and possibly a relay device if the servers are on a different LAN than your switch. A relay device forwards broadcast traffic between two directly connected LANs. A router does not forward broadcast packets, but it forwards packets based on the destination IP address in the received packet. DHCP-based autoconfiguration replaces the BOOTP client functionality on your switch.

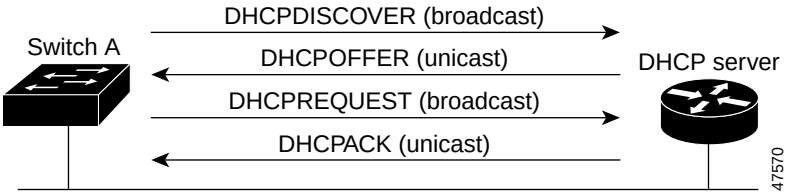
DHCP Client Request Process

When you boot your switch, the DHCP client can be invoked and automatically request configuration information from a DHCP server under the following conditions:

- The configuration file is not present on the switch.
- The configuration file is present, but the IP address is not specified in it.
- The configuration file is present, the IP address is not specified in it, and the **service config** global configuration command is included. This command enables the autoloading of a configuration file from a network server.

Figure 6-1 shows the sequence of messages that are exchanged between the DHCP client and the DHCP server.

Figure 6-1 DHCP Request for IP Information from a DHCP Server



The client, Switch A, broadcasts a DHCPDISCOVER message to locate a DHCP server. The DHCP server offers configuration parameters (such as an IP address, subnet mask, gateway IP address, DNS IP address, a lease for the IP address, and so forth) to the client in a DHCPOFFER unicast message.

In a DHCPREQUEST broadcast message, the client returns a request for the offered configuration information to the DHCP server. The request is broadcast so that all other DHCP servers that received the DHCPDISCOVER broadcast message from the client can reclaim the IP addresses that they offered to the client.

The DHCP server confirms that the IP address has been allocated to the client by returning a DHCPACK unicast message to the client. With this message, the client and server are bound, and the client uses configuration information received from the server. The amount of information the switch receives depends on how you configure the DHCP server. For more information, see the "Configuring the DHCP Server" section on page 6-6.

If the configuration parameters sent to the client in the DHCPOFFER unicast message by the DHCP server are invalid (a configuration error exists), the client returns a DHCPDECLINE broadcast message to the DHCP server.

The DHCP server sends the client a DHCPNAK denial broadcast message, which means the offered configuration parameters have not been assigned, an error has occurred during the negotiation of the parameters, or the client has been slow in responding to the DHCPOFFER message (the DHCP server assigned the parameters to another client) of the DHCP server.

A DHCP client might receive offers from multiple DHCP or BOOTP servers and can accept any one of the offers; however, the client usually accepts the first offer it receives. The offer from the DHCP server is not a guarantee that the IP address will be allocated to the client; however, the server usually reserves the address until the client has had a chance to formally request the address. If the switch accepts replies from a BOOTP server and configures itself, the switch will broadcast, instead of unicast, TFTP requests to obtain the switch configuration file.

Configuring the DHCP Server

You should configure the DHCP servers with reserved leases that are bound to each switch by the switch hardware address. If the DHCP server does not support reserved leases, the switch can obtain different IP addresses and configuration files at different boot instances. You should configure the DHCP server with the following lease options:

- IP address of the client (required)
- Subnet mask of the client (required)
- DNS server IP address (required)
- Router IP address (default gateway address to be used by the switch) (required)
- TFTP server name (required)
- Boot filename (the name of the configuration file that the client needs) (recommended)
- Host name (optional)

If you do not configure the DHCP server with the lease options described earlier, then it replies to client requests with only those parameters that have available values. If the IP address and subnet mask are not in the reply, the switch is not configured. If the DNS server IP address, router IP address, or TFTP server name are not found, the switch might broadcast TFTP requests. Unavailability of other lease options does not affect autoconfiguration.



Note If the configuration file on the switch does not contain the IP address, the switch obtains its address, mask, gateway IP address, and host name from DHCP. If the **service config** global configuration command is specified in the configuration file, the switch receives the configuration file through TFTP requests. If the **service config** global configuration command and the IP address are both present in the configuration file, DHCP is not used, and the switch obtains the default configuration file by broadcasting TFTP requests.

The DHCP server can be on the same or a different LAN as the switch. If it is on a different LAN, the switch must be able to access it through a relay device. The DHCP server can be running on a UNIX or Linux operating system; however, the Windows NT operating system is not supported in this release.

For more information, see the "Configuring the Relay Device" section on page 6-9. You must also set up the TFTP server with the switch configuration files; for more information, see the next section.

For CLI procedures, refer to the Cisco IOS Release 12.0 documentation on Cisco.com for additional information and CLI procedures.

Configuring the TFTP Server

The TFTP server must contain one or more configuration files in its base directory. The files can include the following:

- The configuration file named in the DHCP reply (the actual switch configuration file)
- The network-confg or the cisconet.cfg file (known as the default configuration files)
- The router-confg or the ciscortr.cfg file (These files contain commands common to all switches. Normally, if the DHCP and TFTP servers are properly configured, these files are not accessed.)

You must specify the TFTP server name in the DHCP server lease database. You must also specify the TFTP server name-to-IP-address mapping in the DNS server database.

The TFTP server can be on the same or a different LAN as the switch. If it is on a different LAN, the switch must be able to access it through a relay device or a router. For more information, see the "Configuring the Relay Device" section on page 6-9.

If the configuration filename is provided in the DHCP server reply, the configuration files for a switch can be spread over multiple TFTP servers. However, if the configuration filename is not provided, then the configuration files must reside on a single TFTP server.

For CLI procedures, refer to the Cisco IOS Release 12.0 documentation on Cisco.com for additional information and CLI procedures.

Configuring the Domain Name and the DNS

Each unique IP address can have a host name associated with it. The IOS software maintains a cache of host name-to-address mappings for use by the EXEC mode **connect**, **telnet**, and **ping** commands, and related Telnet support operations. This cache speeds the process of converting names to addresses.

IP defines a hierarchical naming scheme that allows a device to be identified by its location or domain. Domain names are pieced together with periods (.) as the delimiting characters. For example, Cisco Systems is a commercial organization that IP identifies by a *com* domain name, so its domain name is *cisco.com*. A specific device in this domain, the File Transfer Protocol (FTP) system for example, is identified as *ftp.cisco.com*.

To keep track of domain names, IP has defined the concept of a Domain Name Server (DNS), which holds a cache (or database) of names mapped to IP addresses. To map domain names to IP addresses, you must first identify the host names and then specify a name server and enable the DNS, the Internet's global naming scheme that uniquely identifies network devices.

You can specify a default domain name that the software uses to complete domain name requests. You can specify either a single domain name or a list of domain names. When you specify a domain name, any IP host name without a domain name will have that domain name appended to it before being added to the host table.

If your network devices require connectivity with devices in networks for which you do not control name assignment, you can assign device names that uniquely identify your devices within the entire internetwork. The Internet's global naming scheme, the DNS, accomplishes this task. This service is enabled by default.

The switch uses the DNS server to resolve the TFTP server name to a TFTP server IP address. You must configure the TFTP server name-to-IP address map on the DNS server. The TFTP server contains the configuration files for the switch.

You must configure the IP addresses of the DNS servers in the lease database of the DHCP server from where the DHCP replies will retrieve them. You can enter up to two DNS server IP addresses in the lease database.

The DNS server can be on the same or a different LAN as the switch. If it is on a different LAN, the switch must be able to access it through a relay device or router. For more information, see the "Configuring the Relay Device" section on page 6-9.

For CLI procedures, refer to the Cisco IOS Release 12.0 documentation on Cisco.com for additional information and CLI procedures.

Configuring the Relay Device

You need to use a relay device if the DHCP, DNS, or TFTP servers are on a different LAN than the switch. You must configure this relay device to forward received broadcast packets on an interface to the destination host. This configuration ensures that broadcasts from the DHCP client can reach the DHCP, DNS, and TFTP servers and that broadcasts from the servers can reach the DHCP client.

If the relay device is a Cisco router, you enable IP routing (**ip routing** global configuration command) and configure it with helper addresses by using the **ip helper-address** interface configuration command.

For example, in Figure 6-2, you configure the router interfaces as follows:

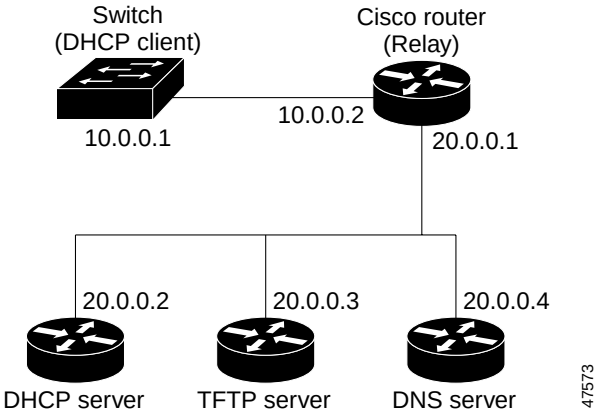
On interface 10.0.0.2:

```
router(config-if)# ip helper-address 20.0.0.2
router(config-if)# ip helper-address 20.0.0.3
router(config-if)# ip helper-address 20.0.0.4
```

On interface 20.0.0.1

```
router(config-if)# ip helper-address 10.0.0.1
```

Figure 6-2 Relay Device Used in Autoconfiguration



For CLI procedures, refer to the Cisco IOS Release 12.0 documentation on Cisco.com for additional information and CLI procedures.

Obtaining Configuration Files

Depending on the availability of the IP address and the configuration filename in the DHCP reserved lease, the switch obtains its configuration information in the following ways:

- The IP address and the configuration filename is reserved for the switch and provided in the DHCP reply (one-file read method).

  The switch receives its IP address, subnet mask, and configuration filename from the DHCP server. It also receives a DNS server IP address and a TFTP server name. The switch sends a DNS request to the DNS server, specifying the TFTP server name, to obtain the TFTP server address. Then the switch sends a unicast message to the TFTP server to retrieve the named configuration file from the base directory of the server, and upon receipt, completes its boot-up process.

- Only the configuration filename is reserved for the switch. The IP address is dynamically allocated to the switch by the DHCP server (one-file read method).

  The switch follows the same configuration process described above.

- Only the IP address is reserved for the switch and provided in the DHCP reply. The configuration filename is not provided (two-file read method).

  The switch receives its IP address and subnet mask from the DHCP server. It also receives a DNS server IP address and a TFTP server name. The switch sends a DNS request to the DNS server, specifying the TFTP server name, to obtain the TFTP server address.

  The switch sends a unicast message to the TFTP server to retrieve the network-confg or cisconet.cfg default configuration file. (If the network-confg file cannot be read, the switch reads the cisconet.cfg file.)

  The default configuration file contains the host names-to-IP-address mapping for the switch. The switch fills its host table with the information in the file and obtains its host name. If the host name is not found in the file, the switch uses the host name in the DHCP reply. If the host name is not specified in the DHCP reply, the switch uses the default "Switch" as its host name.

  After obtaining its host name from the default configuration file or the DHCP reply, the switch reads the configuration file that has the same name as its host name (*hostname*-confg or *hostname*.cfg, depending on whether network-confg or cisconet.cfg was read earlier) from the TFTP server. If the cisconet.cfg file is read, the filename of the host is truncated to eight characters.

  If the switch cannot read the network-confg, cisconet.cfg, or the host-name file, it reads the router-confg file. If the switch cannot read the router-confg file, it reads the ciscortr.cfg file.



Note The switch broadcasts TFTP server requests if the TFTP server name is not obtained from the DHCP replies, if all attempts to read the configuration file through unicast transmissions fail, or if the TFTP server name cannot be resolved to an IP address.

Example Configuration

Figure 6-3 shows a sample network for retrieving IP information using DHCP-based autoconfiguration.

Figure 6-3 DHCP-Based Autoconfiguration Network Example

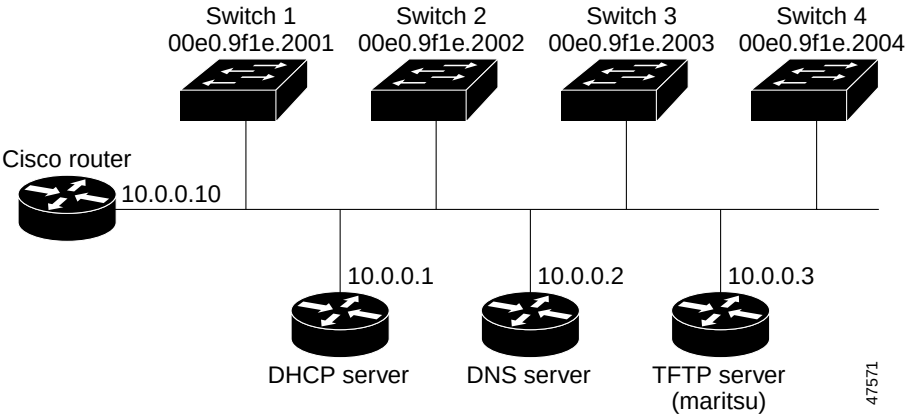


Table 6-1 shows the configuration of the reserved leases on the DHCP server.

Table 6-1 DHCP Server Configuration

	Switch-1	Switch-2	Switch-3	Switch-4
Binding key (hardware address)	00e0.9f1e.2001	00e0.9f1e.2002	00e0.9f1e.2003	00e0.9f1e.2004
IP address	10.0.0.21	10.0.0.22	10.0.0.23	10.0.0.24
Subnet mask	255.255.255.0	255.255.255.0	255.255.255.0	255.255.255.0
Router address	10.0.0.10	10.0.0.10	10.0.0.10	10.0.0.10
DNS server address	10.0.0.2	10.0.0.2	10.0.0.2	10.0.0.2
TFTP server name	*maritsu* or *10.0.0.3*	*maritsu* or *10.0.0.3*	*maritsu* or *10.0.0.3*	*maritsu* or *10.0.0.3*
Boot filename (configuration file) (optional)	switch1-confg	switch2-confg	switch3-confg	switch4-confg
Host name (optional)	switch1	switch2	switch3	switch4

DNS Server Configuration

The DNS server maps the TFTP server name *maritsu* to IP address 10.0.0.3.

TFTP Server Configuration (on UNIX)

The TFTP server base directory is set to /tftpserver/work/. This directory contains the network-confg file used in the two-file read method. This file contains the host name to be assigned to the switch based on its IP address. The base directory also contains a configuration file for each switch (switch1-confg, switch2-confg, and so forth) as shown in this display:

```
prompt> cd /tftpserver/work/
prompt> ls
network-confg
switch1-confg
switch2-confg
switch3-confg
switch4-confg
prompt> cat network-confg
ip host switch1 10.0.0.21
ip host switch2 10.0.0.22
ip host switch3 10.0.0.23
ip host switch4 10.0.0.24
```

DHCP Client Configuration

No configuration file is present on Switch 1 through Switch 4.

Configuration Explanation

In Figure 6-3, Switch 1 reads its configuration file as follows:

- It obtains its IP address 10.0.0.21 from the DHCP server.
- If no configuration filename is given in the DHCP server reply, Switch 1 reads the network-confg file from the base directory of the TFTP server.
- It adds the contents of the network-confg file to its host table.
- It reads its host table by indexing its IP address 10.0.0.21 to its host name (switch1).
- It reads the configuration file that corresponds to its host name; for example, it reads switch1-confg from the TFTP server.

Switches 2 through 4 retrieve their configuration files and IP addresses in the same way.

Changing the Password

You can assign the password of your switch in the following ways:

- Using the setup program, as described in the release notes
- Manually assigning a password, as described in this section

Note You can change a password only by using the CLI. Your connection with the switch ends when you change the enable secret password. You will then need to reopen the session with the new password. If you have forgotten your password, see the "Recovering from a Lost or Forgotten Password" section on page 9-22.

Because many privileged EXEC commands are used to set operating parameters, you should password-protect these commands to prevent unauthorized use. Catalyst 2900 XL and Catalyst 3500 XL switches have two commands for setting passwords:

- **enable secret** *password* (a very secure, encrypted password)
- **enable password** *password* (a less secure, unencrypted password)

You must enter one of these passwords to gain access to privileged EXEC mode. We recommend that you use the enable secret password.

Note When set, the enable secret password takes precedence, and the enable password serves no purpose.

If you enter the **enable secret** command, the text is encrypted before it is written to the config.text file, and it is unreadable. If you enter the **enable password** command, the text is written as entered to the config.text file where you can read it.

You can also specify up to 15 privilege levels and define passwords for them by using the **enable password** [**level** *level*] {*password*} or the **enable secret** [**level** *level*] {*password*} command. Level 1 is EXEC-mode user privileges. If you do not specify a level, the privilege level defaults to 15 (privileged EXEC-mode privileges).

You can specify a level, set a password, and give the password only to users who need to have access at this level. Use the **privilege level** global configuration command to specify commands accessible at various levels.

Note You need an enable secret password with a privilege level 15 to access CMS. You must also use this password if you configure the Terminal Access Controller Access Control System Plus (TACACS+) protocol from the CLI so that all your HTTP connections are authenticated through the TACACS+ server. The Telnet password must be an enable secret password.

For information about managing passwords in switch clusters, see the "Passwords" section on page 5-8.

Both types of passwords can contain from 1 to 25 uppercase and lowercase alphanumeric characters, and both can start with a number. Spaces are also valid password characters; for example, *two words* is a valid password. Leading spaces are ignored; trailing spaces are recognized. The password is case sensitive.

To remove a password, use the **no** version of the commands: **no enable secret** or **no enable password**. If you lose or forget your enable password, see the "Recovering from a Lost or Forgotten Password" section on page 9-22.

For CLI procedures, refer to the Cisco IOS Release 12.0 documentation on Cisco.com for additional information and CLI procedures.

Setting the System Date and Time

You can change the date and a 24-hour clock time setting on the switch. If you are entering the time for an American time zone, enter the three-letter abbreviation for the time zone, such as PST for Pacific standard time. If you are identifying the time zone by referring to Greenwich mean time, enter UTC (universal coordinated time). You then must enter a negative or positive number as an offset to indicate the number of time zones between the switch and Greenwich, England. Enter a negative number if the switch is west of Greenwich, England, and east of the international date line. For example, California is eight time zones west of Greenwich, so you would enter –8. Enter a positive number if the switch is east of Greenwich. You can also enter negative and positive numbers for minutes.

Configuring Daylight Saving Time

You can configure the switch to change to daylight saving time on a particular day every year, on a day that you enter, or not at all.

For CLI procedures, refer to the Cisco IOS Release 12.0 documentation on Cisco.com for additional information and CLI procedures.

Configuring the Network Time Protocol

In complex networks, it is often prudent to distribute time information from a central server. The Network Time Protocol (NTP) can distribute time information by responding to requests from clients or by broadcasting time information.

For CLI procedures, refer to the Cisco IOS Release 12.0 documentation on Cisco.com for additional information and CLI procedures.

Configuring the Switch as an NTP Client

You configure the switch as an NTP client by entering the IP addresses of up to ten NTP servers and specifying which server should be used first. You can also enter an authentication key to be used as a password when requests for time information are sent to the server.

Enabling NTP Authentication

To ensure the validity of information received from NTP servers, you can authenticate NTP messages with public-key encryption. This procedure must be coordinated with the administrator of the NTP servers: the information you enter will be matched by the servers to authenticate it.

Configuring the Switch for NTP Broadcast-Client Mode

You can configure the switch to receive NTP broadcast messages if there is an NTP broadcast server, such as a router, broadcasting time information on the network. You can also enter a value to account for any round-trip delay between the client and the NTP broadcast server.

Configuring SNMP

If your switch is part of a cluster, the clustering software can change Simple Network Management Protocol (SNMP) parameters (such as host names) when the cluster is created. If you are configuring a cluster for SNMP, see the "SNMP Community Strings" section on page 5-10.

Disabling and Enabling SNMP

SNMP is enabled by default and must be enabled for Cluster Management features to work properly.

SNMP is always enabled for Catalyst 1900 and Catalyst 2820 switches.

For CLI procedures, refer to the Cisco IOS Release 12.0 documentation on Cisco.com for additional information and CLI procedures.

Entering Community Strings

Community strings serve as passwords for SNMP messages, permitting access to the agent on the switch. If you are entering community strings for a cluster member, see the "SNMP Community Strings" section on page 5-10. You can enter community strings with the following characteristics:

Read-only (RO)—Requests accompanied by the string can display MIB-object information.

Read-write (RW)—Requests accompanied by the string can display MIB-object information and set MIB objects.

For CLI procedures, refer to the Cisco IOS Release 12.0 documentation on Cisco.com for additional information and CLI procedures.

Adding Trap Managers

A trap manager is a management station that receives and processes traps. When you configure a trap manager, the community strings for each member switch must be unique. If a member switch has an assigned IP address, the management station accesses the switch by using that IP address.

By default, no trap manager is defined, and no traps are issued. Table 6-2 describes the Catalyst 2900 XL and Catalyst 3500 XL switch traps. You can enable any or all of these traps and configure a trap manager on these switches to receive them.

Table 6-2 Catalyst 2900 XL and Catalyst 3500 XL Switch Traps

Config	Generate traps whenever the switch configuration changes.
SNMP	Generate the supported SNMP traps.
TTY	Generate traps when the switch starts a management console CLI session.
VLAN membership	Generate a trap for each VLAN Membership Policy Server (VMPS) change.
VTP	Generate a trap for each VLAN Trunk Protocol (VTP) change.
C2900/C3500	Generate the switch-specific traps. These traps are in the private enterprise-specific Management Information Base (MIB).

Catalyst 1900 and Catalyst 2820 switches support up to four trap managers. When you configure community strings for these switches, limit the string length to 32 characters. When configuring traps on these switches, you cannot configure individual trap managers to receive specific traps.

Table 6-3 describes the Catalyst 1900 and Catalyst 2820 switch traps. You can enable any or all of these traps, but these traps are received by all configured trap managers.

Table 6-3 Catalyst 1900 and Catalyst 2820 Switch Traps

Trap Type	Description
Address-violation	Generates a trap when the address violation threshold is exceeded.
Authentication	Generates a trap when an SNMP request is not accompanied by a valid community string.
BSC	Generates a trap when the broadcast threshold is exceeded.
Link-up-down	Generates a link-down trap when a port is suspended or disabled for any of these reasons: • Secure address violation (address mismatch or duplication) • Network connection error (loss of linkbeat or jabber error) • User disabling the port Generates a link-up trap when a port is enabled for any of these reasons: • Presence of linkbeat • Management intervention • Recovery from an address violation or any other error • STP action
VTP	Generates a trap when VTP changes occur.

Beginning in privileged EXEC mode, follow these steps to add a trap manager and a community string:

	Command	Purpose
Step 1	**config terminal**	Enter global configuration mode.
Step 2	**snmp-server host 172.2.128.263 traps1 snmp vlan-membership**	Enter the trap manager IP address, the community string, and the traps to generate.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show running-config**	Verify that the information was entered correctly by displaying the running configuration.

Configuring CDP

Use the Cisco IOS CLI and Cisco Discovery Protocol (CDP) to enable CDP for the switch, set global CDP parameters, and display information about neighboring Cisco devices.

CDP enables the Cluster Management Suite to display a graphical view of the network. For example, the switch uses CDP to find cluster candidates and to maintain information about cluster members and other devices up to three cluster-enabled devices away from the command switch.

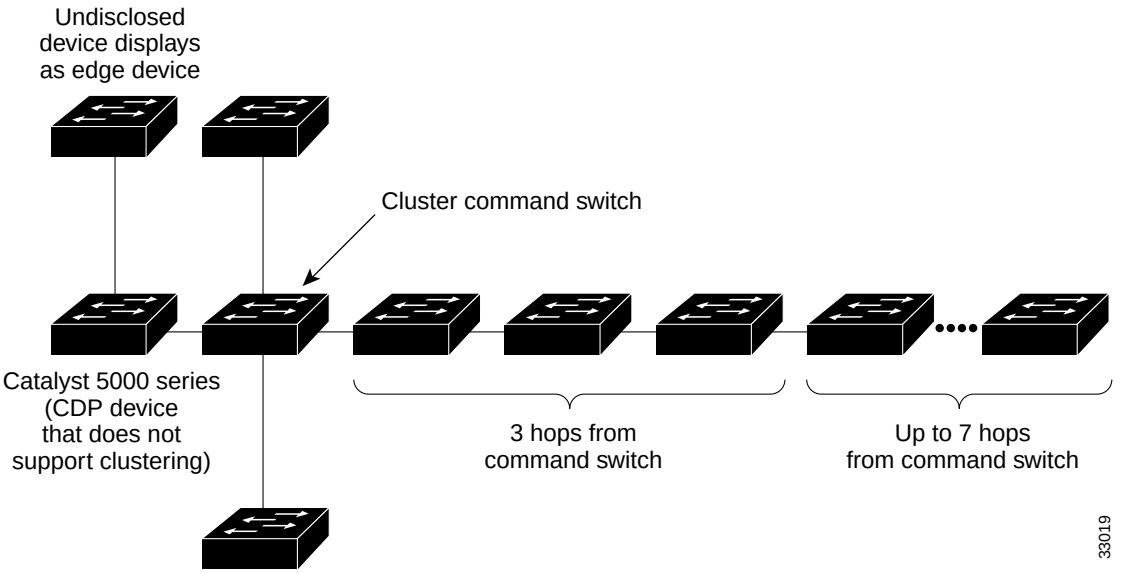
If necessary, you can configure CDP to discover switches running the Cluster Management Suite up to seven devices away from the command switch. Devices that do not run clustering software display as edge devices, and CDP cannot discover any device connected to them.

Note Creating and maintaining switch clusters is based on the regular exchange of CDP messages. Disabling CDP can interrupt cluster discovery. For more information about the role that CDP plays in clustering, see the "Automatic Discovery of Cluster Candidates" section on page 5-4.

Configuring CDP for Extended Discovery

You can change the default configuration of CDP on the command switch to continue discovering devices up to seven *hops* away. Figure 6-4 shows a command switch that can discover candidates and cluster members up to seven devices away from it. Figure 6-4 also shows the command switch connected to a Catalyst 5000 series switch. Although the Catalyst 5000 supports CDP, it does not support clustering, and the command switch cannot learn about connected candidate switches connected to it, even if they are running CMS.

Figure 6-4 Discovering Cluster Candidates through CDP



Beginning in privileged EXEC mode, follow these steps to configure the number of hops that CDP uses to discover candidate switches and cluster members.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**cluster discovery hop-count** *number*	Enter the number of hops that you want CDP to search for cluster candidates and cluster members.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show running-config**	Verify the change by displaying the running configuration file. The hop count is displayed in the file.

Configuring STP

Spanning Tree Protocol (STP) provides path redundancy while preventing undesirable loops in the network. Only one active path can exist between any two stations. STP calculates the best loop-free path throughout the network.

Supported STP Instances

You create an STP instance when you assign an interface to a VLAN. The STP instance is removed when the last interface is moved to another VLAN. You can configure switch and port parameters before an STP instance is created. These parameters are applied when the STP instance is created. You can change all VLANs on a switch by using the **stp-list** parameter when you enter STP commands through the CLI. For more information, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

All Catalyst 3500 XL switches and most Catalyst 2900 XL switches support 250 VLANs. The Catalyst 2912 XL, Catalyst 2924 XL, and Catalyst 2924C XL support only 64 VLANs. For more information about VLANs, see Chapter 8, "Configuring VLANs."

Each VLAN is a separate STP instance. If you have already used up all available STP instances on a switch, adding another VLAN anywhere in the VLAN Trunk Protocol (VTP) domain creates a VLAN that is not running STP on that switch. For example, if 250 VLANs are defined in the VTP domain, you can enable STP on those 250 VLANs. The remaining VLANs must operate with STP disabled.

You can disable STP on one of the VLANs where it is running, and then enable it on the VLAN where you want it to run. Use the **no spanning-tree vlan** *vlan-id* global configuration command to disable STP on a specific VLAN, and use the **spanning-tree vlan** *vlan-id* global configuration command to enable STP on the desired VLAN.

Caution Switches that are not running spanning tree still forward Bridge Protocol Data Units (BPDUs) that they receive so that the other switches on the VLAN that have a running STP instance can break loops. Therefore, spanning tree must be running on enough switches so that it can break all the loops in the network. For example, at least one switch on each loop in the VLAN must be running spanning tree. It is not absolutely necessary to run spanning tree on all

switches in the VLAN; however, if you are running STP only on a minimal set of switches, an incautious change to the network that introduces another loop into the VLAN can result in a broadcast storm.

Note If you have the default allowed list on the trunk ports of that switch, the new VLAN is carried on all trunk ports. Depending on the topology of the network, this could create a loop in the new VLAN that will not be broken, particularly if there are several adjacent switches that all have run out of STP instances. You can prevent this by setting allowed lists on the trunk ports of switches that have used up their allocation of STP instances. Setting up allowed lists is not necessary in many cases and makes it more labor-intensive to add another VLAN to the network.

Using STP to Support Redundant Connectivity

You can create a redundant backbone with STP by connecting two of the switch ports to another device or to two different devices. STP automatically disables one port but enables it if the other port is lost. If one link is high-speed and the other low-speed, the low-speed link is originally disabled. If the two link speeds are the same, the port priority and the port ID are added together, and STP disables the link with the lowest value.

You can also create redundant links between switches by using EtherChannel port groups. For more information about creating port groups, see the "Creating EtherChannel Port Groups" section on page 7-10.

Disabling STP

STP is enabled by default. Disable STP only if you are sure there are no loops in the network topology.

Caution When STP is disabled and loops are present in the topology, excessive traffic and indefinite packet duplication can severely reduce network performance.

Beginning in privileged EXEC mode, follow these steps to disable STP:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**no spanning-tree vlan** *stp-list*	Disable STP on a VLAN.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show spanning-tree**	Verify your entry.

Accelerating Aging to Retain Connectivity

The default for aging dynamic addresses is 5 minutes. However, a reconfiguration of the spanning tree can cause many station locations to change. Because these stations could be unreachable for 5 minutes or more during a reconfiguration, the address-aging time is accelerated so that station addresses can be dropped from the address table and then relearned. The accelerated aging is the same as the forward-delay parameter value when STP reconfigures.

Because each VLAN is a separate instance of STP, the switch accelerates aging on a per-VLAN basis. A reconfiguration of STP on one VLAN can cause the dynamic addresses learned on that VLAN to be subject to accelerated aging. Dynamic addresses on other VLANs can be unaffected and remain subject to the aging interval entered for the switch.

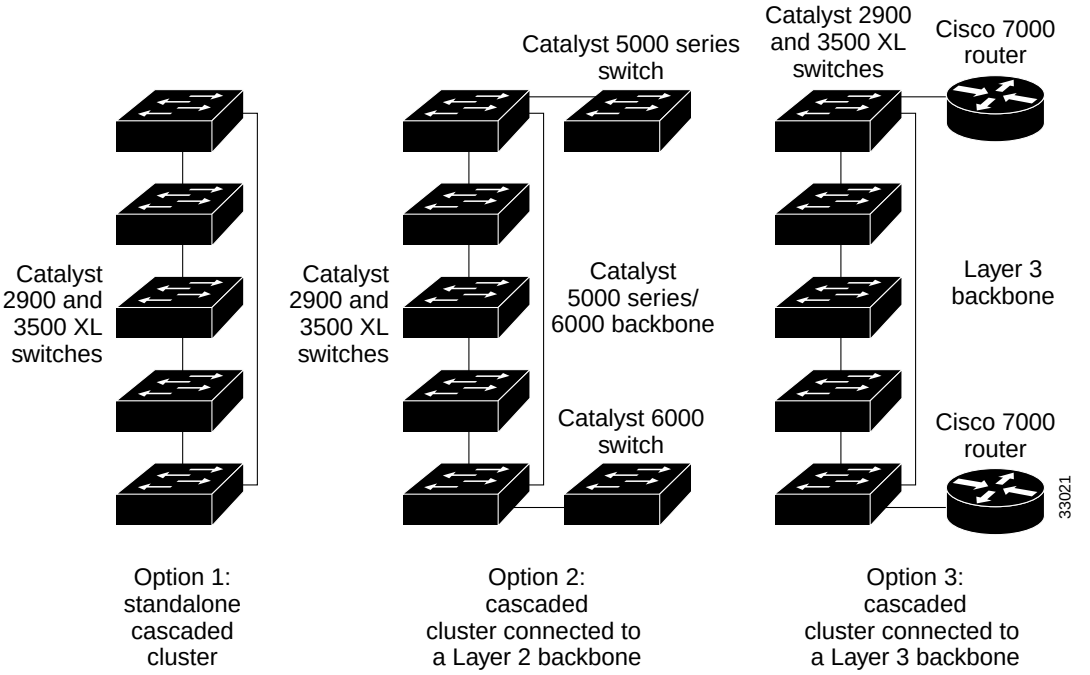
Configuring STP and UplinkFast in a Cascaded Cluster

STP uses default values that can be reduced when configuring Catalyst 2900 XL and Catalyst 3500 XL switches in cascaded configurations. If an STP root switch is part of a cluster that is one switch from a cascaded stack, you can customize STP to reconverge more quickly after a switch failure. Figure 6-5 shows modular Catalyst 2900 XL and Catalyst 3500 XL switches in three cascaded clusters that use the GigaStack GBIC. Table 6-4 shows the default STP settings and those that are acceptable for these configurations.

Table 6-4 Default and Acceptable STP Parameter Settings (in Seconds)

STP Parameter	STP Default (IEEE)	Acceptable for Option 1	Acceptable for Option 2	Acceptable for Option 3
Hello Time	2	1	1	1
Max Age	20	6	10	6
Forwarding delay	15	4	7	4

Figure 6-5 Gigabit Ethernet Clusters



Enabling UplinkFast on all cluster switches can further reduce the time it takes cluster switches to begin forwarding after a new root switch is selected.

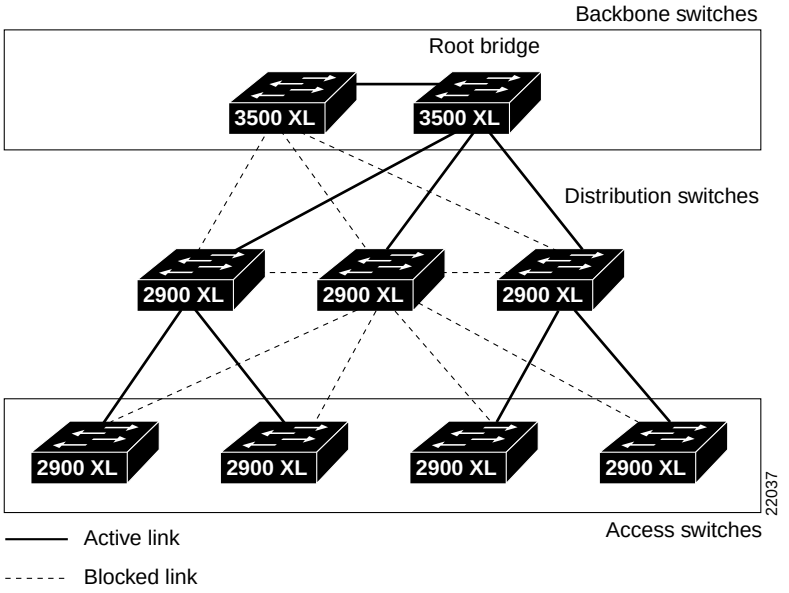
Configuring Redundant Links By Using STP UplinkFast

Switches in hierarchical networks can be grouped into backbone switches, distribution switches, and access switches. Figure 6-6 shows a complex network where distribution switches and access switches each have at least one redundant link that STP blocks to prevent loops.

If a switch looses connectivity, the switch begins using the alternate paths as soon as STP selects a new root port. When STP reconfigures the new root port, other ports flood the network with multicast packets, one for each address that was learned on the port. You can limit these bursts of multicast traffic by reducing the max-update-rate parameter. The default for this parameter is 150 packets per second. However, if you enter zero, station-learning frames are not generated, so the STP topology converges more slowly after a loss of connectivity.

STP UplinkFast is a Cisco enhancement that accelerates the choice of a new root port when a link or switch fails or when STP reconfigures itself. The root port transitions to the forwarding state immediately without going through the listening and learning states, as it would with normal STP procedures. UplinkFast is most useful in edge or access switches and might not be appropriate for backbone devices.

Figure 6-6 Switches in a Hierarchical Network



Enabling STP UplinkFast

When you enable UplinkFast, it is enabled for the entire switch and cannot be enabled for individual VLANs.

Beginning in privileged EXEC mode, follow these steps to configure UplinkFast:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**spanning-tree uplinkfast max-update-rate** *pkts-per-second*	Enable UplinkFast on the switch. The range is from 0 to 1000 packets per second. The default is 150. If you set the rate to 0, station-learning frames are not generated, so the STP topology converges more slowly after a loss of connectivity.
Step 3	**exit**	Return to privileged EXEC mode.
Step 4	**show spanning-tree**	Verify your entries.

When UplinkFast is enabled, the bridge priority of all VLANs is set to 49152, and the path cost of all ports and VLAN trunks is increased by 3000. This change reduces the chance that the switch will become the root switch. When UplinkFast is disabled, the bridge priorities of all VLANs and path costs of all ports are set to default values.

Configuring Cross-Stack UplinkFast

Cross-stack UplinkFast (CSUF) provides a fast spanning-tree transition (fast convergence in less than 2 seconds under normal network conditions) across a stack of switches that use the GigaStack GBICs connected in a shared cascaded configuration (multidrop backbone). During the fast transition, an alternate redundant link on the stack of switches is placed into the forwarding state without causing temporary spanning-tree loops or loss of connectivity to the backbone. With this feature, you can have a redundant and resilient network in some configurations.

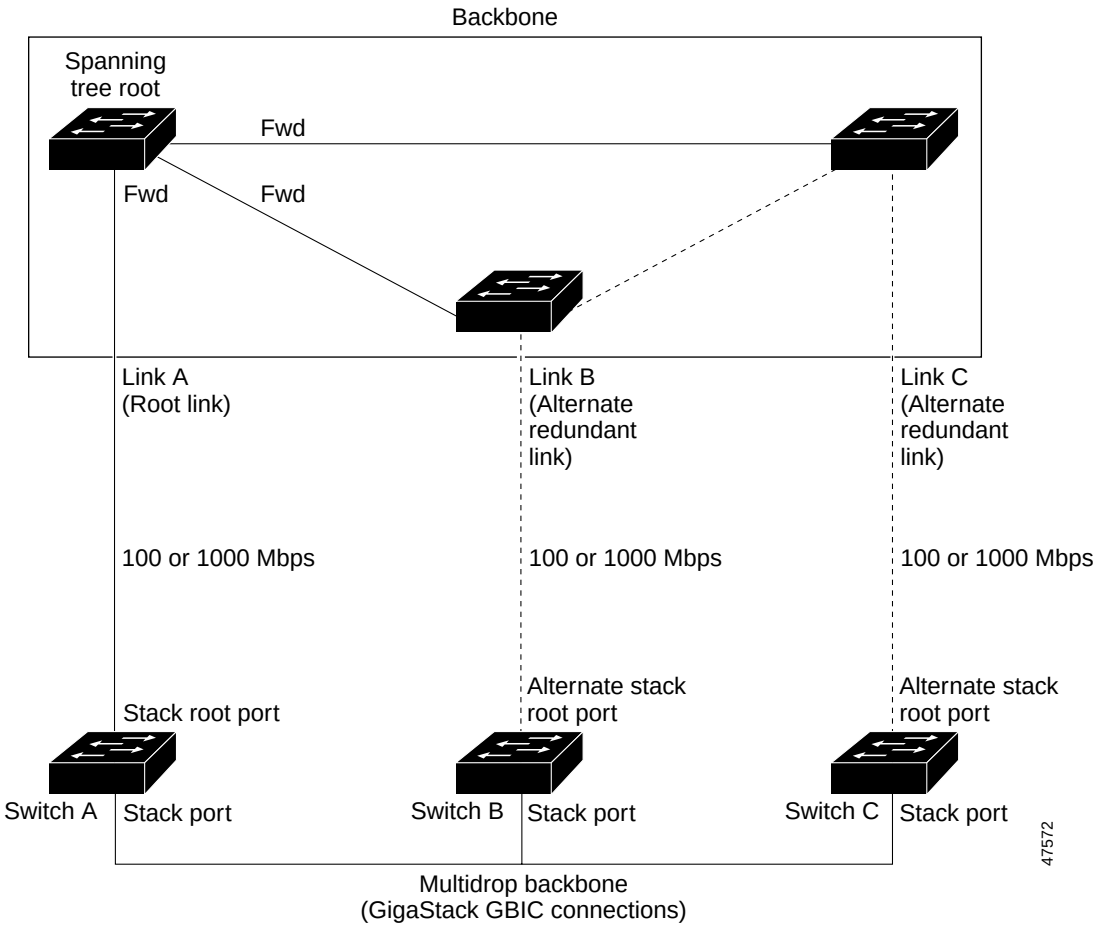
CSUF might not provide a fast transition all the time; in these cases, the normal STP transition occurs, which completes in 30 to 40 seconds. For more information, see the "Events that Cause Fast Convergence" section on page 6-33.

How CSUF Works

CSUF ensures that one link in the stack is elected as the path to the root. As shown in Figure 6-7, Switches A, B, and C are cascaded through the Gigastack GBIC to form a multidrop backbone, which communicates control and data traffic across the switches at the access layer. The switches in the stack use their stack ports to communicate with each other and to connect to the stack backbone; stack ports are always in the STP forwarding state. The stack root port on Switch A provides the path to the root of the spanning tree; the alternate stack root ports on Switches B and C can provide an alternate path to the spanning-tree root if the current stack root switch fails or its link to the spanning-tree root fails.

Link A, the root link, is in the STP forwarding state; Links B and C are alternate redundant links that are in the STP blocking state. If Switch A fails, if its stack root port fails, or if Link A fails, CSUF selects either the Switch B or Switch C alternate stack root port and puts it into the forwarding state in less than 1 second.

Figure 6-7 Cross-Stack UplinkFast Topology



CSUF implements the Stack Membership Discovery Protocol and the Fast Uplink Transition Protocol. Using the Stack Membership Discovery Protocol, all stack switches build a neighbor list of stack members through the receipt of discovery hello packets. When certain link loss or STP events occur (described in the "Events that Cause Fast Convergence" section on page 6-33), the Fast Uplink Transition Protocol uses the neighbor list to send fast-transition requests on the stack port to stack members.

The switch sending the fast-transition request needs to do a fast transition to the forwarding state of a port that it has chosen as the root port, and it must obtain an acknowledgement from each stack switch before performing the fast transition.

Each switch in the stack determines if the sending switch is a better choice than itself to be the stack root of this STP instance by comparing STP root, cost, and bridge ID. If the sending switch is the best choice as the stack root, the switch in the stack returns an acknowledgement; otherwise, it does not respond to the sending switch (drops the packet) and prevents the sending switch from receiving acknowledgements from all stack switches.

When acknowledgements are received from all stack switches, the Fast Uplink Transition Protocol on the sending switch immediately transitions its alternate stack root port to the forwarding state. If acknowledgements from all stack switches are not obtained by the sending switch, the normal STP transitions (blocking, listening, learning, forwarding) take place, and the spanning-tree topology converges at its normal rate (2 * forward-delay time + max-age time).

The Fast Uplink Transition Protocol is implemented on a per-VLAN basis and affects only one STP instance at a time.

Events that Cause Fast Convergence

Depending on the network event or failure, fast convergence provided by CSUF might or might not occur.

Fast convergence (within 2 seconds under normal network conditions) occurs under these circumstances:

- The stack root port link goes down.

  If two switches in the stack have alternate paths to the root, only one of the switches performs the fast transition.
- The failed link, which connected the stack root to the STP root, comes back up.
- A network reconfiguration causes a new stack root switch to be selected.

- A network reconfiguration causes a new port on the current stack root switch to be chosen as the stack root port.

Note The fast transition might not occur if multiple events occur simultaneously. For example, if a stack member switch is powered down, and at the same time, a link connecting the stack root to the STP root comes back up, the normal STP convergence occurs.

Normal STP convergence (30 to 40 seconds) occurs under these conditions:

- The stack root switch is powered down or the software failed.
- The stack root switch, which was powered down or failed, is powered up.
- A new switch, which might become the stack root, is added to the stack.
- A switch other than the stack root is powered down or failed.
- A link fails between stack ports on the multidrop backbone.

Note The fast transition of CSUF depends on the amount of network traffic and how you connect the GigaStack GBICs across the stack switches. Because the Fast Uplink Transition Protocol only waits 2 seconds to receive acknowledgements from all stack switches, heavy network traffic might prevent the fast transition from occurring within this time frame. Instead of a fast transition, the normal STP convergence then occurs.

Limitations

The following limitations apply to CSUF:

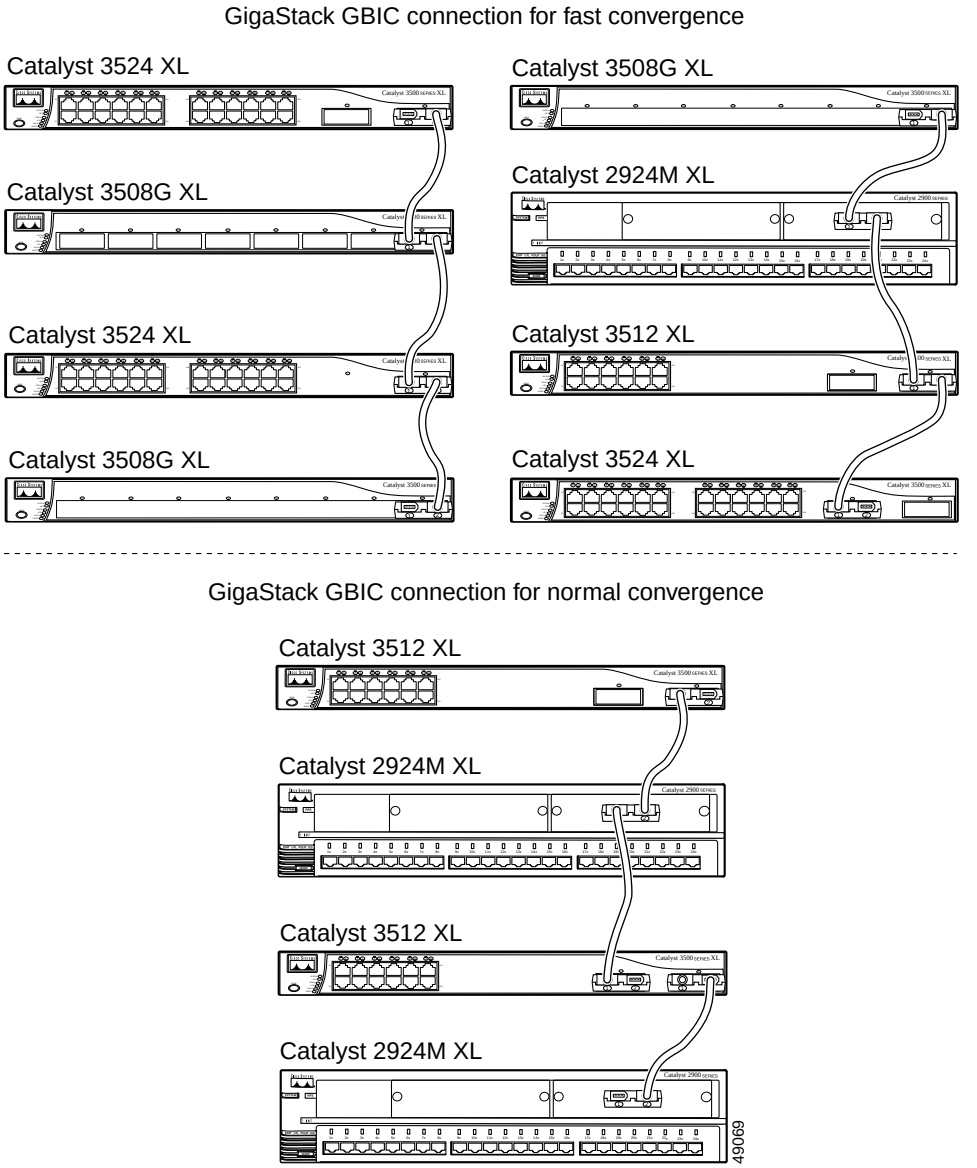
- CSUF uses the Gigastack GBIC and runs on all Catalyst 3500 XL switches but only on modular Catalyst 2900 XL switches.
- Up to nine stack switches can be connected through their stack ports to the multidrop backbone. Only one stack port per switch is supported.
- Each stack switch can be connected to the STP backbone through one uplink.
- Up to 64 VLANs are supported.

Connecting the Stack Ports

A fast transition occurs across the stack of switches if the multidrop backbone connections are a continuous link from one GigaStack GBIC to another as shown in Figure 6-8. In addition, follow these guidelines:

- Do not connect alternate stack root ports to stack ports.
- Only one stack port is supported per switch.
- All stack ports on the stack of switches must be connected to the multidrop backbone.
- You can connect the open ports on the top and bottom GigaStack GBICs within the same stack to form a redundant link.

Figure 6-8 GigaStack GBIC Connections and STP Convergence



Configuring Cross-Stack UplinkFast

Before enabling CSUF, make sure your stack switches are properly connected. For more information, see the "Connecting the Stack Ports" section on page 6-35.

Beginning in privileged EXEC mode, follow these steps to enable CSUF:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**spanning-tree uplinkfast** [**max-update-rate** *pkts-per-second*]	Enable UplinkFast on the switch. (Optional) For **max-update-rate** *pkts-per-second*, specify the number of packets per second at which update packets are sent. The range is 0 to 65535; the default is 150 packets per second.
Step 1	**interface** *interface-id*	Enter interface configuration mode, and specify the GBIC interface on which to enable CSUF.
Step 2	**spanning-tree stack-port**	Enable CSUF on only one stack-port GBIC interface. The stack port connects to GigaStack GBIC multidrop backbone. If you try to enable CSUF on a Fast Ethernet or a copper-based Gigabit Ethernet port, you receive an error message. If CSUF is already enabled on an interface and you try to enable it on another interface, you receive an error message. You must disable CSUF on the first interface before enabling it on a new interface. Use this command only on access switches.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show spanning-tree**	Verify your entries.
Step 5	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To disable CSUF on an interface, use the **no spanning-tree stack-port** interface configuration command. To disable UplinkFast on the switch, use the **no spanning-tree uplinkfast** global configuration command.

Changing the STP Parameters for a VLAN

The root switch for each VLAN is the switch with the highest priority and transmits topology frames to other switches in the spanning tree. You can change the root parameters for the VLANs on a selected switch. The following options define how your switch responds when STP reconfigures itself.

Protocol	Implementation of STP to use: IBM or IEEE. The default is IEEE.
Priority	Value (0 to 65535) used to identify the root switch. The switch with the **lowest value** has the highest priority and is selected as the root.
Max age	Number of seconds (6 to 200) a switch waits without receiving STP configuration messages before attempting a reconfiguration. This parameter takes effect when a switch is operating as the root switch. Switches not acting as the root use the root-switch Max age parameter.
Hello Time	Number of seconds (1 to 10) between the transmission of hello messages, which indicate that the switch is active. Switches not acting as a root switch use the root-switch Hello-time value.
Forward Delay	Number of seconds (4 to 200) a port waits before changing from its STP learning and listening states to the forwarding state. This wait is necessary so that other switches on the network ensure that no loop is formed before they allow the port to forward packets.

Changing the STP Implementation

Beginning in privileged EXEC mode, follow these steps to change the STP implementation. The *stp-list* is the list of VLANs to which the STP command applies.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**spanning-tree** [**vlan** *stp-list*] **protocol** {**ieee** | **ibm**}	Specify the STP implementation to be used for a spanning-tree instance.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show spanning-tree**	Verify your entry.

Changing the Switch Priority

Beginning in privileged EXEC mode, follow these steps to change the switch priority and affect which switch is the root switch. The *stp-list* is the list of VLANs to which the STP command applies.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**spanning-tree** [**vlan** *stp-list*] **priority** *bridge-priority*	Configure the switch priority for the specified spanning-tree instance. Enter a number from 0 to 65535; the lower the number, the more likely the switch will be chosen as the root switch.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show spanning-tree**	Verify your entry.

Changing the BPDU Message Interval

Beginning in privileged EXEC mode, follow these steps to change the BPDU message interval (max age time). The *stp-list* is the list of VLANs to which the STP command applies.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**spanning-tree** [**vlan** *stp-list*] **max-age** *seconds*	Specify the interval between messages the spanning tree receives from the root switch. The maximum age is the number of seconds a switch waits without receiving STP configuration messages before attempting a reconfiguration. Enter a number from 6 to 200.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show spanning-tree**	Verify your entry.

Changing the Hello BPDU Interval

Beginning in privileged EXEC mode, follow these steps to change the hello BPDU interval (hello time). The *stp-list* is the list of VLANs to which the STP command applies.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**spanning-tree** [**vlan** *stp-list*] **hello-time** *seconds*	Specify the interval between hello BPDUs. Hello messages indicate that the switch is active. Enter a number from 1 to 10.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show spanning-tree**	Verify your entry.

Changing the Forwarding Delay Time

Beginning in privileged EXEC mode, follow these steps to change the forwarding delay time. The *stp-list* is the list of VLANs to which the STP command applies.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**spanning-tree** [**vlan** *stp-list*] **forward-time** *seconds*	Specify the forwarding time for the specified spanning-tree instance. The forward delay is the number of seconds a port waits before changing from its STP learning and listening states to the forwarding state. Enter a number from 4 to 200. The default for IEEE is 15 seconds; the default for IBM is 4 seconds.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show spanning-tree**	Verify your entry.

STP Port States

When a port is not forwarding due to STP, it can be in one of these states:

- Blocking—Port is not participating in the frame-forwarding process and is not learning new addresses.
- Listening—Port is not participating in the frame-forwarding process, but is progressing towards a forwarding state. The port is not learning addresses.
- Learning—Port is not forwarding frames but is learning addresses.
- Forwarding—Port is forwarding frames and learning addresses.
- Disabled—Port has been removed from STP operation.
- Down—Port has no physical link.
- Broken—One end of the link is configured as an access port, and the other end is configured as an 802.1Q trunk port, or both ends of the link are configured as 802.1Q trunk ports but have different native VLAN IDs.

Enabling the Port Fast Feature

The Port Fast feature brings a port directly from a blocking state into a forwarding state. This feature is useful when a connected server or workstation times out because its port is going through the normal cycle of STP status changes. A port with Port Fast enabled only goes through the normal cycle of STP status changes when the switch is restarted.

Caution Enabling this feature on a port connected to a switch or hub could prevent STP from detecting and disabling loops in your network, and this could cause broadcast storms and address-learning problems.

You can modify the following Port Fast parameters:

- Port Fast—Enable to bring the port more quickly to an STP forwarding state.
- Path Cost —A lower path cost represents higher-speed transmission. This can affect which port remains enabled in the event of a loop.

  Enter a number from 1 to 65535. The default is 100 for 10 Mbps, 19 for 100 Mbps, 14 for 155 Mbps (ATM), 4 for 1 Gbps, 2 for 10 Gbps, and 1 for interfaces with speeds greater than 10 Gbps.
- Priority —Number used to set the priority for a port. A higher number has higher priority. Enter a number from 0 to 65535.

Enabling this feature on a port connected to a switch or hub could prevent STP from detecting and disabling loops in your network. Beginning in privileged EXEC mode, follow these steps to enable the Port Fast feature:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to be configured.
Step 3	**spanning-tree portfast**	Enable the Port Fast feature for the port.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show running-config**	Verify your entry.

Changing the Path Cost

Beginning in privileged EXEC mode, follow these steps to change the path cost for STP calculations. The STP command applies to the *stp-list*.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to be configured.
Step 3	**spanning-tree** [**vlan** *stp-list*] **cost** *cost*	Configure the path cost for the specified spanning-tree instance. Enter a number from 1 to 65535.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show running-config**	Verify your entry.

Changing the Port Priority

Beginning in privileged EXEC mode, follow these steps to change the port priority, which is used when two switches tie for position as the root switch. The *stp-list* is the list of VLANs to which the STP command applies.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to be configured.
Step 3	**spanning-tree** [**vlan** *stp-list*] **port-priority** *port-priority*	Configure the port priority for a specified instance of STP. Enter a number from 0 to 255. The lower the number, the higher the priority.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show running-config**	Verify your entry.

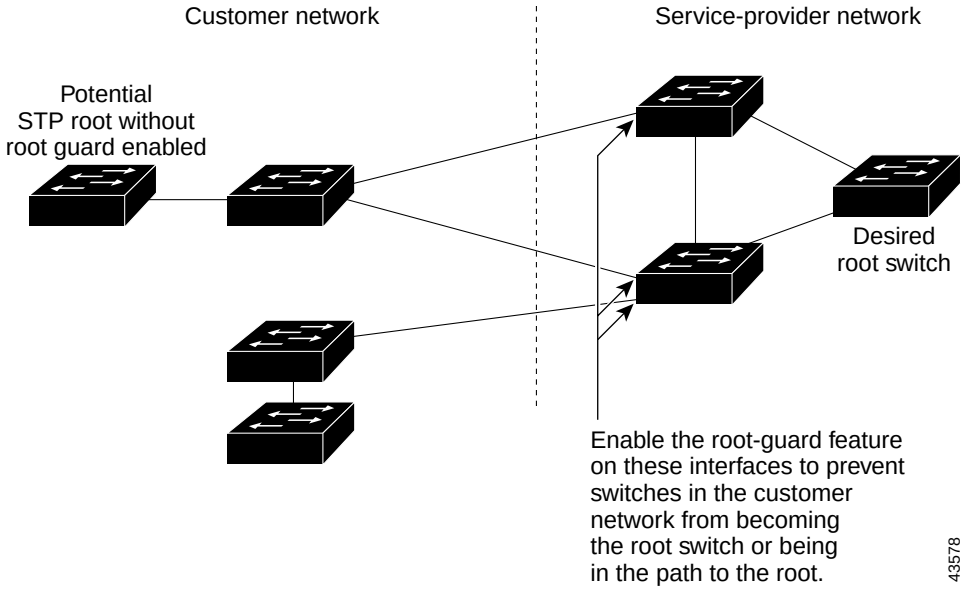
Configuring STP Root Guard

The Layer 2 network of a service provider (SP) can include many connections to switches that are not owned by the SP. In such a topology, STP can reconfigure itself and select a *customer switch* as the STP root switch, as shown in Figure 6-9. You can avoid this situation by configuring the root-guard feature on interfaces that connect to switches outside of your customer's network. If STP calculations cause an interface in the customer network to be selected as the root port, root guard then places the interface into the root-inconsistent (blocked) state to prevent the customer switch from becoming the root switch or being in the path to the root.

If a switch outside the network becomes the root switch, the interface is blocked (root-inconsistent state), and STP selects a new root switch. The customer switch does not become the root switch and is not in the path to the root.

Caution Misuse of this feature can cause a loss of connectivity.

Figure 6-9 STP in a Service Provider Network



Root guard enabled on a port applies to all the VLANs that the port belongs to. Each VLAN has its own instance of STP.

Beginning in privileged EXEC mode, follow these steps to set root guard on a port:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to be configured.
Step 3	**spanning-tree rootguard**	Enable root guard on the port.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show running-config**	Verify that the port is configured for root guard.

Use the **no** version of the **spanning-tree rootguard** command to disable the root guard feature.

Managing the ARP Table

To communicate with a device (over Ethernet, for example), the software first must determine the 48-bit MAC or the local data link address of that device. The process of determining the local data link address from an IP address is called *address resolution*.

The Address Resolution Protocol (ARP) associates a host IP address with the corresponding media or MAC addresses and the VLAN ID. Taking an IP address as input, ARP determines the associated MAC address. Once a MAC address is determined, the IP-MAC address association is stored in an ARP cache for rapid retrieval. Then the IP datagram is encapsulated in a link-layer frame and sent over the network. Encapsulation of IP datagrams and ARP requests and replies on IEEE 802 networks other than Ethernet is specified by the Subnetwork Access Protocol (SNAP). By default, standard Ethernet-style ARP encapsulation (represented by the **arpa** keyword) is enabled on the IP interface.

ARP entries added manually to the table do not age and must be manually removed.

For CLI procedures, refer to the Cisco IOS Release 12.0 documentation on Cisco.com for additional information and CLI procedures.

Controlling IP Multicast Packets through CGMP

CGMP reduces the unnecessary flooding of IP multicast packets by limiting the transmission of these packets to CGMP clients that request them. The Fast Leave feature accelerates the removal of unused CGMP groups. By default, CGMP is enabled, and the Fast Leave feature is disabled.

End stations issue join messages to become part of a CGMP group and issue leave messages to leave the group. The membership of these groups is managed by the switch and by connected routers through the further exchange of CGMP messages.

CGMP groups are maintained on a per-VLAN basis: a multicast IP address packet can be forwarded to one list of ports in one VLAN and to a different list of ports in another VLAN. When a CGMP group is added, it is added on a per-VLAN, per-group basis. When a CGMP group is removed, it is only removed in a given VLAN.



Note The same multicast MAC addresses cannot belong to both CGMP and Multicast VLAN Registration (MVR) groups. CGMP does not dynamically learn addresses that are MVR group members. If you want CGMP to learn an address that is already an MVR group member, remove the address from the MVR group.

Conversely, you cannot add an address to an MVR group if it is already a CGMP group member. If you want an address that is already a CGMP group member to be an MVR group member, remove the address from the CGMP group, and then statically add it to the MVR group. For information about MVR, see the "Configuring MVR" section on page 6-49.

Enabling the Fast Leave Feature

The CGMP Fast Leave feature reduces the delay when group members leave groups. When an end station requests to leave a CGMP group, the group remains enabled for that VLAN until all members have requested to leave. With the Fast Leave feature enabled, the switch immediately verifies if there are other group members attached to its ports. If there are no other members, the switch removes the port from the group. If there are no other ports in the group, the switch sends a message to routers connected to the VLAN to delete the entire group.

The Fast Leave feature functions only if CGMP is enabled. The client must be running IGMP version 2 for the Fast Leave feature to function properly.

Beginning in privileged EXEC mode, follow these steps to enable the CGMP Fast Leave feature:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**cgmp leave-processing**	Enable CGMP and CGMP Fast Leave.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show running-config**	Verify your entry.

Disabling the CGMP Fast Leave Feature

Beginning in privileged EXEC mode, follow these steps to disable the CGMP Fast Leave feature:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**no cgmp leave-processing**	Disable CGMP and CGMP Fast Leave.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show running-config**	Verify your entry.

Changing the CGMP Router Hold-Time

The router hold-time is the number of seconds the switch waits before removing (aging) a router entry and ceasing to exchange messages with the router. If it is the last router entry in a VLAN, all CGMP groups on that VLAN are removed. You can thus enter a lower router hold-time to accelerate the removal of CGMP groups.

Note You can remove router ports before the router hold-time has expired.

Beginning in privileged EXEC mode, follow these steps to change the router hold-time.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**cgmp holdtime 400**	Configure the number of seconds the switch waits before dropping a router entry.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show running-config**	Verify your entry.

Removing Multicast Groups

You can reduce the forwarding of IP multicast packets by removing groups from the Current Multicast Groups table. Each entry in the table consists of the VLAN, IGMP multicast address, and ports.

You can use the CLI to clear all CGMP groups, all CGMP groups in a VLAN, or all routers, their ports, and their expiration times. Beginning in privileged EXEC mode, follow these steps to remove all multicast groups.

	Command	Purpose
Step 1	**clear cgmp group**	Clear all CGMP groups on all VLANs on the switch.
Step 2	**show cgmp**	Verify your entry by displaying CGMP information.

Configuring MVR

Multicast VLAN Registration (MVR) is designed for applications using wide-scale deployment of multicast traffic (for example, broadcast of multiple television channels) across an Ethernet ring-based service provider network. MVR allows a subscriber on a port to subscribe and unsubscribe to a multicast stream on the network-wide multicast VLAN. It allows the single multicast VLAN to be shared in the network while subscribers remain in separate VLANs. This provides the ability to continuously send multicast streams in the multicast VLAN, but to isolate the streams from the subscriber VLANs for bandwidth and security reasons.

MVR assumes that subscriber ports subscribe and unsubscribe (join and leave) these multicast streams by sending out Internet Group Management Protocol (IGMP) join and leave messages. These messages can originate from an IGMP version-2-compatible set-top box with an Ethernet connection or from a PC capable of generating IGMP version-2 messages. The switch CPU identifies IP multicast streams and their associated MAC addresses in the switch forwarding table, intercepts the IGMP messages, and modifies the forwarding table to include or remove the subscriber as a receiver of the multicast stream. This forwarding behavior selectively allows traffic to cross between the two VLANs.

Because MVR does not support IGMP dynamic joins, the user or administrator must configure static multicast addresses on the router.

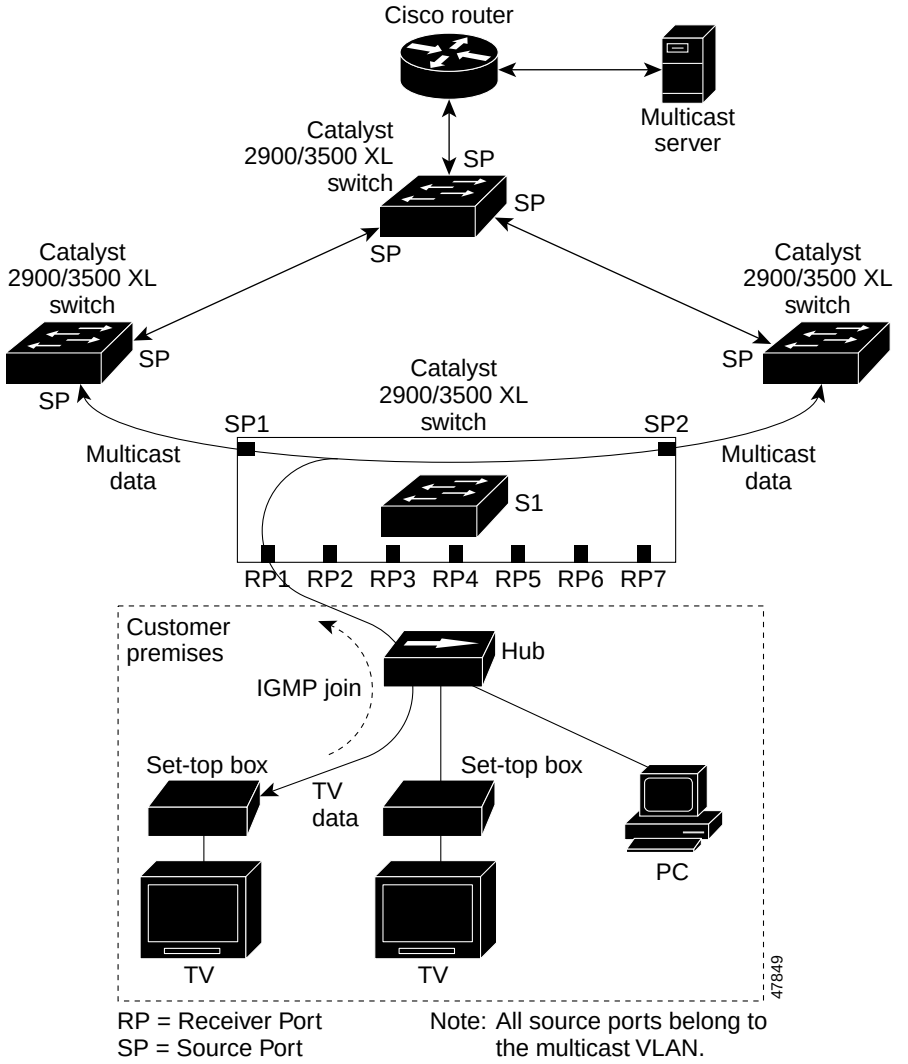
Using MVR in a Multicast Television Application

In a multicast television application, a PC or a television with a set-top box can receive the multicast stream. Multiple set-top boxes or PCs can be connected to one subscriber port. (See Figure 6-10.) DHCP assigns an IP address to the set-top box or the PC. When a subscriber selects a channel, the set-top box or PC sends an IGMP report to the access layer switch (S1 switch) to join the appropriate multicast. If the IGMP report matches one of the configured multicast MAC addresses, the switch CPU modifies the hardware address table to include this receiver port and VLAN as a forwarding destination of the specified multicast stream when it is received from the multicast VLAN over the source port.

When a subscriber changes channels or turns off the television, the set-top box sends an IGMP leave message for the multicast stream. The switch CPU sends an IGMP group-specific query through the receiver port VLAN. If there is another

set-top box in the VLAN still subscribing to this group, that set-top box must respond within the maximum response time. If the CPU does not receive a response, it eliminates the receiver port as a forwarding destination for this group.

Figure 6-10 Multicast VLAN Registration Example



MVR eliminates the need to duplicate television-channel multicast traffic for subscribers in each VLAN. Multicast traffic for all channels is sent only once around the VLAN trunk—only on the multicast VLAN. Although the IGMP leave and join messages originate with a subscriber, they appear to be initiated by a port in the multicast VLAN rather than in the VLAN to which the subscriber port is assigned. These messages dynamically register for streams of multicast traffic in the multicast VLAN on the switch. The access layer switch (S1 switch) modifies the forwarding behavior to allow the traffic to be forwarded from the multicast VLAN to the subscriber port in a different VLAN, selectively allowing traffic to cross between two VLANs.

IGMP reports are sent to the same MAC addresses as the multicast data. The S1 CPU must capture all IGMP join and leave messages from subscriber ports. Because the Catalyst 2900 and Catalyst 3500 hardware cannot distinguish IP multicast data packets from IP multicast packets carrying IGMP protocol data, all packets from subscriber ports destined for the configured multicast MAC addresses are forwarded to the switch CPU, which distinguishes IGMP packets from regular multicast traffic.

Configuration Guidelines and Limitations

Follow these guidelines when configuring MVR:

- All receiver ports on a switch must belong to the same VLAN and must not be trunk ports.
- In applications where the receiver ports represent subscribers to a service, we recommend configuring receiver ports as follows:
  - Enable protected port on all receiver ports to isolate the ports from one another.
  - Enable port blocking on all receiver ports to prevent unknown unicast and multicast packets.
- Before configuring MVR groups, configure all MVR parameters, including the multicast VLAN. If you want to change the MVR parameters after MVR groups have been configured, follow these steps:
  a. Enter the **no mvr** command to disable MVR.
  b. Enter the **mvr vlan** <*vlan-id*> command to change the multicast VLAN.

c. The maximum number of mvr entries is determined by the switch hardware. Each MVR group represents a TV channel.

d. Enter the **mvr** command to enable MVR. You do not need to reconfigure the MVR groups. The switch uses the MVR groups when you re-enable MVR.

- Each channel is one multicast stream destined for a unique IP multicast address.
- Make sure the router is statically configured to forward multicast traffic for the MVR groups to the switch. The router should not depend on IGMP join requests from hosts (forwarded by the switch) to forward multicast traffic to the switch.
- The receiver VLAN is the VLAN to which the first configured receiver port belongs. If the first receiver port is a dynamic port with an unassigned VLAN, it becomes an inactive receiver port and does not take part in MVR unless it is assigned to the receiver VLAN. The receiver VLAN is reset whenever there are no remaining receiver ports on the switch (active or inactive), which means that the receiver VLAN might change every time the first receiver port is configured.

MVR implementation has the following limitations:

- MVR is supported on only modular Catalyst 2900 XL switches.
- Unknown multicast packets, unknown unicast packets, and broadcast packets are leaked from the multicast VLAN to the receiver ports.
- MVR does not support IP-address aliasing and therefore requires that each IP multicast address maps to only one Layer 2 MAC address. In MVR, you cannot configure multiple IP addresses that map to the same MAC address.
- The same multicast MAC addresses cannot belong to both CGMP and MVR groups. CGMP does not dynamically learn addresses that are MVR group members. If you want CGMP to learn an address that is already an MVR group member, remove the address from the MVR group.

  Conversely, you cannot add an address to an MVR group if it is already a CGMP group member. If you want an address that is already a CGMP group member to be an MVR group member, remove the address from the CGMP group, and then statically add it to the MVR group. For information about CGMP, see the "Controlling IP Multicast Packets through CGMP" section on page 6-46.

Setting MVR Parameters

You do not need to set MVR parameters if you choose to use the default settings. If you do want to change the default parameters, you must do so before enabling MVR.

Beginning in privileged EXEC mode, follow these steps to configure MVR parameters:

	Command	Purpose
Step 1	configure terminal	Enter global configuration mode.
Step 2	**mvr querytime** *value*	(Optional) Define the maximum time to wait for IGMP report memberships on a receiver port before removing the port from multicast group membership. The value is in units of tenths of a second. The default is 5 tenths or one-half second.
Step 3	**mvr vlan** *vlan-id*	(Optional) Specify the VLAN in which multicast data will be received; all source ports must belong to this VLAN. The default is VLAN 1.
Step 4	interface *interface*	Enter interface configuration mode, and enter the type and number of the port to configure, for example, fastethernet 0/1.
Step 5	**mvr threshold** *value*	(Optional) Define the maximum of multicast data packets received on a receiver port before it is administratively shut down. The default is 20.
Step 6	**end**	Exit configuration mode.
Step 7	**show mvr** **show mvr interface**	Verify the configuration.
Step 8	**copy running-config startup-config**	Save your configuration changes to nonvolatile RAM (NVRAM).

Configuring MVR

Beginning in privileged EXEC mode, follow these steps to configure MVR:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**mvr**	Enable MVR on the switch.
Step 3	**mvr group** *ip-address* [*count*]	Configure an IP multicast address on the switch or use the *count* parameter to configure a contiguous series of IP addresses. Any multicast data sent to this address is sent to all source ports on the switch and all receiver ports that have elected to receive data on that multicast address. Each multicast address would correspond to one television channel. **Note** Each IP address translates to a multicast 48-bit MAC address. If an IP address being configured translates (aliases) to a previously configured MAC address, the command fails.
Step 4	**interface** *interface*	Enter interface configuration mode, and enter the type and number of the port to configure, for example, fastethernet 0/1.
Step 5	**mvr type** *value*	Configure the port as either an MVR receiver port or an MVR source port. • Configure a port as a receiver port if it is a subscriber port and should only receive multicast data. It does not receive data unless it becomes a member of the multicast group by using IGMP leave and join messages. All receiver ports on a switch must belong to the same VLAN. In most cases, you should configure receiver ports as protected ports with port blocking enabled. • Configure uplink ports that receive and send multicast data as source ports. All source ports on a switch belong to the single multicast VLAN.

	Command	Purpose
Step 6	**mvr immediate**	(Optional) Enables the Immediate Leave feature of MVR on the port. **Note** This command applies only to receiver ports and should only be enabled on receiver ports to which a single receiver device is connected.
Step 7	**end**	Exit configuration mode.
Step 8	**show mvr** **show mvr interface** **show mvr members**	Verify the configuration.
Step 9	**copy running-config startup-config**	Save your configuration changes to NVRAM.

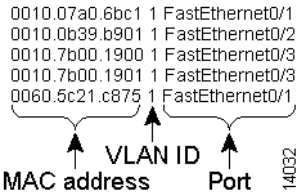
Managing the MAC Address Tables

You can manage the MAC address tables that the switch uses to forward traffic between ports. All MAC addresses in the address tables are associated with one or more ports. These MAC tables include the following types of addresses:

- Dynamic address: a source MAC address that the switch learns and then drops when it is not in use.
- Secure address: a manually entered unicast address that is usually associated with a secured port. Secure addresses do not age.
- Static address: a manually entered unicast or multicast address that does not age and that is not lost when the switch resets.

The address tables list the destination MAC address and the VLAN ID, module, and port number associated with the address. Figure 6-11 shows an example list of addresses as they would appear in the dynamic, secure, or static address table.

Figure 6-11 Contents of the Address Table



MAC Addresses and VLANs

All addresses are associated with a VLAN. An address can exist in more than one VLAN and have different destinations in each. Multicast addresses, for example, could be forwarded to port 1 in VLAN 1 and ports 9, 10, and 11 in VLAN 5.

Each VLAN maintains its own logical address table. A known address in one VLAN is unknown in another until it is learned or statically associated with a port in the other VLAN. An address can be secure in one VLAN and dynamic in another. Addresses that are statically entered in one VLAN must be static addresses in all other VLANs.

Changing the Address Aging Time

Dynamic addresses are source MAC addresses that the switch learns and then drops when they are not in use. The aging time parameter defines how long the switch retains unseen addresses in the table. This parameter applies to all VLANs.

Setting too short an aging time can cause addresses to be prematurely removed from the table. Then when the switch receives a packet for an unknown destination, it floods the packet to all ports in the same VLAN as the receiving port. This unnecessary flooding can impact performance. Setting too long an aging time can cause the address table to be filled with unused addresses; it can cause delays in establishing connectivity when a workstation is moved to a new port.

Beginning in privileged EXEC mode, follow these steps to configure the dynamic address table aging time.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**mac-address-table aging-time** *seconds*	Enter the number of seconds that dynamic addresses are to be retained in the address table. You can enter a number from 10 to 1000000.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show mac-address-table aging-time**	Verify your entry.

Removing Dynamic Address Entries

Beginning in privileged EXEC mode, follow these steps to remove a dynamic address entry:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**no mac-address-table dynamic** *hw-addr*	Enter the MAC address to be removed from dynamic MAC address table.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show mac-address-table**	Verify your entry.

You can remove all dynamic entries by using the **clear mac-address-table dynamic** command in privileged EXEC mode.

Adding Secure Addresses

The secure address table contains secure MAC addresses and their associated ports and VLANs. A secure address is a manually entered unicast address that is forwarded to only one port per VLAN. If you enter an address that is already assigned to another port, the switch reassigns the secure address to the new port.

You can enter a secure port address even when the port does not yet belong to a VLAN. When the port is later assigned to a VLAN, packets destined for that address are forwarded to the port.

Beginning in privileged EXEC mode, follow these steps to add a secure address:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**mac-address-table secure** *hw-addr interface* **vlan** *vlan-id*	Enter the MAC address, its associated port, and the VLAN ID.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show mac-address-table secure**	Verify your entry.

Removing Secure Addresses

Beginning in privileged EXEC mode, follow these steps to remove a secure address:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**no mac-address-table secure** *hw-addr* **vlan** *vlan-id*	Enter the secure MAC address, its associated port, and the VLAN ID to be removed.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show mac-address-table secure**	Verify your entry.

You can remove all secure addresses by using the **clear mac-address-table secure** command in privileged EXEC mode.

Adding Static Addresses

A static address has the following characteristics:

- It is manually entered in the address table and must be manually removed.
- It can be a unicast or multicast address.
- It does not age and is retained when the switch restarts.

You can determine how a port that receives a packet forwards it to another port for transmission. Because all ports are associated with at least one VLAN, the switch acquires the VLAN ID for the address from the ports that you select on the forwarding map.

A static address in one VLAN must be a static address in other VLANs. A packet with a static address that arrives on a VLAN where it has not been statically entered is flooded to all ports and not learned.

Static addresses are entered in the address table with an *in-port-list*, an *out-port-list*, and a VLAN ID, if needed. Packets received from the in-port list are forwarded to ports listed in the out-port-list.

Note If the in-port-list and out-port-list parameters are all access ports in a single VLAN, you can omit the VLAN ID. In this case, the switch recognizes the VLAN as that associated with the in-port VLAN. Otherwise, you must supply the VLAN ID.

Beginning in privileged EXEC mode, follow these steps to add a static address:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**mac-address-table static** *hw-addr in-port out-port-list* **vlan** *vlan-id*	Enter the MAC address, the input port, the ports to which it can be forwarded, and the VLAN ID of those ports.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show mac-address-table static**	Verify your entry.

Removing Static Addresses

Beginning in privileged EXEC mode, follow these steps to remove a static address:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**no mac-address-table static** *hw-addr* **in-port** *in-port* **out-port-list** *out-port-list* **vlan** *vlan-id*	Enter the static MAC address, the input port, the ports to which it can be forwarded, and the VLAN ID to be removed.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show mac-address-table static**	Verify your entry.

You can remove all secure addresses by using the **clear mac-address-table static** command in privileged EXEC mode.

Configuring Static Addresses for EtherChannel Port Groups

Follow these rules if you are configuring a static address to forward to ports in an EtherChannel port group:

- For default source-based port groups, configure the static address to forward to *all ports* in the port group to eliminate lost packets.
- For destination-based port groups, configure the address to forward to *only one port* in the port group to avoid the transmission of duplicate packets.

Configuring TACACS+

The Terminal Access Controller Access Control System Plus (TACACS+) provides the means to manage network security (authentication, authorization, and accounting [AAA]) from a server. This section describes how TACACS+ works and how you can configure it. For complete syntax and usage information for the commands described in this chapter, refer to the *Cisco IOS Release 12.0 Security Command Reference*.

You can only configure this feature by using the CLI; you cannot configure it through the Cluster Management Suite.

In large enterprise networks, the task of administering passwords on each device can be simplified by centralizing user authentication on a server. TACACS+ is an access-control protocol that allows a switch to authenticate all login attempts through a central server. The network administrator configures the switch with the address of the TACACS+ server, and the switch and the server exchange messages to authenticate each user before allowing access to the management console.

TACACS+ consists of three services: authentication, authorization, and accounting. Authentication determines who the user is and whether or not the user is allowed access to the switch. Authorization is the action of determining what the user is allowed to do on the system. Accounting is the action of collecting data related to resource usage.

The TACACS+ feature is disabled by default. However, you can enable and configure it by using the CLI. You can access the CLI through the console port or through Telnet. To prevent a lapse in security, you cannot configure TACACS+ through a network-management application. When enabled, TACACS+ can authenticate users accessing the switch through the CLI.



Note Although the TACACS+ configuration is performed through the CLI, the TACACS+ server authenticates HTTP connections that have been configured with a privilege level of 15.

Configuring the TACACS+ Server Host

Use the **tacacs-server host** command to specify the names of the IP host or hosts maintaining an AAA/TACACS+ server. On TACACS+ servers, you can configure the following additional options:

- Number of seconds that the switch waits while trying to contact the server before timing out.
- Encryption key to encrypt and decrypt all traffic between the router and the daemon.
- Number of attempts that a user can make when entering a command that is being authenticated by TACACS+.

Beginning in privileged EXEC mode, follow these steps to configure the TACACS+ server:

	Command	Purpose
Step 1	**tacacs-server host** *name* [**timeout** *integer*] [**key** *string*]	Define a TACACS+ host. Entering the **timeout** and **key** parameters with this command overrides the global values that you can enter with the **tacacs-server timeout** (Step 3) and the **tacacs-server key** commands (Step 5).
Step 2	**tacacs-server retransmit** *retries*	Enter the number of times the server searches the list of TACACS+ servers before stopping. The default is two.
Step 3	**tacacs-server timeout** *seconds*	Set the interval that the server waits for a TACACS+ server host to reply. The default is 5 seconds.
Step 4	**tacacs-server attempts** *count*	Set the number of login attempts that can be made on the line.
Step 5	**tacacs-server key** *key*	Define a set of encryption keys for all of TACACS+ and communication between the access server and the TACACS daemon. Repeat the command for each encryption key.
Step 6	**exit**	Return to privileged EXEC mode.
Step 7	**show tacacs**	Verify your entries.

Configuring Login Authentication

Beginning in privileged EXEC mode, follow these steps to configure login authentication by using AAA/TACACS+:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**aaa new-model**	Enable AAA/TACACS+.
Step 3	**aaa authentication login** {**default** | *list-name*} *method1* [*method2...*]	Enable authentication at login, and create one or more lists of authentication methods.
Step 4	**line** [**aux** | **console** | **tty** | **vty**] *line-number* [*ending-line-number*]	Enter line configuration mode, and configure the lines to which you want to apply the authentication list.
Step 5	**login authentication** {**default** | *list-name*}	Apply the authentication list to a line or set of lines.
Step 6	**exit**	Return to privileged EXEC mode.
Step 7	**show running-config**	Verify your entries.

The variable *list-name* is any character string used to name the list you are creating. The *method* variable refers to the actual methods the authentication algorithm tries, in the sequence entered. You can choose one of these methods:

- **line**—Uses the line password for authentication. You must define a line password before you can use this authentication method. Use the **password** *password* line configuration command.
- **local**—Uses the local username database for authentication. You must enter username information into the database. Use the **username** *password* global configuration command.
- **tacacs+—**Uses TACACS+ authentication. You must configure the TACACS+ server before you can use this authentication method. For more information, see the "Configuring the TACACS+ Server Host" section on page 6-62.

To create a default list that is used if **no list** is specified in the **login authentication** line configuration command, use the **default** keyword followed by the methods you want used in default situations.

The additional methods of authentication are used only if the previous method returns an error, not if it fails. To specify that the authentication succeed even if all methods return an error, specify **none** as the final method in the command line.

Specifying TACACS+ Authorization for EXEC Access and Network Services

You can use the **aaa authorization** global configuration command with the **tacacs+** keyword to set parameters that restrict a user's network access to Cisco IOS privilege mode (EXEC access) and to network services such as Serial Line Internet Protocol (SLIP), Point-to-Point Protocol (PPP) with Network Control Protocols (NCPs), and AppleTalk Remote Access (ARA).

The **aaa authorization exec tacacs+ local** command sets the following authorization parameters:

- Uses TACACS+ for EXEC access authorization if authentication was done using TACACS+.
- Uses the local database if authentication was not done using TACACS+.

Note Authorization is bypassed for authenticated users who login through the CLI even if authorization has been configured.

Beginning in privileged EXEC mode, follow these steps to specify TACACS+ authorization for EXEC access and network services:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**aaa authorization network tacacs+**	Configure the switch for user TACACS+ authorization for all network-related service requests, including SLIP, PPP NCPs, and ARA protocols.
Step 3	**aaa authorization exec tacacs+**	Configure the switch for user TACACS+ authorization to determine if the user is allowed EXEC access. The **exec** keyword might return user profile information (such as **autocommand** information).
Step 4	**exit**	Return to privileged EXEC mode.

Starting TACACS+ Accounting

You use the **aaa accounting** command with the **tacacs+** keyword to turn on TACACS+ accounting for each Cisco IOS privilege level and for network services.

Beginning in privileged EXEC mode, follow these steps to enable TACACS+ accounting:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**aaa accounting exec start-stop tacacs+**	Enable TACACS+ accounting to send a start-record accounting notice at the beginning of an EXEC process and a stop-record at the end.
Step 3	**aaa accounting network start-stop tacacs+**	Enable TACACS+ accounting for all network-related service requests, including SLIP, PPP, and PPP NCPs.
Step 4	**exit**	Return to privileged EXEC mode.



Note These commands are documented in the "Accounting and Billing Commands" chapter of the *Cisco IOS Release 12.0 Security Command Reference*.

Configuring a Switch for Local AAA

You can configure AAA to operate without a server by setting the switch to implement AAA in local mode. The switch then verifies authentication and authorization. No accounting is available in this configuration.

Beginning in privileged EXEC mode, follow these steps to configure the switch for local AAA:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**aaa new-model**	Enable AAA.
Step 3	**aaa authentication login default local**	Set the login authorization to default to local.
Step 4	**aaa authorization exec local**	Configure user AAA authorization for all network-related service requests, including SLIP, PPP NCPs, and ARA protocols.
Step 5	**aaa authorization network local**	Configure user AAA authorization to determine if the user is allowed to run an EXEC shell.
Step 6	**username** *name* **password** *password* **privilege** *level*	Enter the local database. Repeat this command for each user.



Configuring the Switch Ports

This chapter provides information about changing port configuration settings. It includes command-line interface (CLI) procedures for using commands that have been specifically created or changed for the Catalyst 2900 XL or Catalyst 3500 XL switches. For complete syntax and usage information for the commands used in this chapter, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

Note Certain port features can conflict with one another. Review the "Avoiding Configuration Conflicts" section on page 9-2 before you change the port settings.

This chapter does not repeat the concepts and CLI procedures provided in the standard Cisco IOS Release 12.0 documentation. For switch features that use standard Cisco IOS Release 12.0 commands, refer to the Cisco IOS Release 12.0 documentation on Cisco.com for additional information and CLI procedures.

For information about configuring these settings from Cluster Management Suite (CMS), refer to the online help.

Note Some features can be implemented only by using the CLI.

Changing the Port Speed and Duplex Mode

Caution If you reconfigure the port through which you are managing the switch, a Spanning Tree Protocol (STP) reconfiguration could cause a temporary loss of connectivity.

Note The Ethernet link settings on the Long-Reach Ethernet (LRE) ports have special considerations and different default settings than from the 10/100 ports. For this information, see the "LRE Ethernet Links" section on page 7-25.

Follow these guidelines when configuring the duplex and speed settings:

- Gigabit Ethernet ports are always set to 1000 Mbps but can negotiate full or half duplex with the attached device.
- Gigabit Ethernet ports that do not match the settings of an attached device lose connectivity and do not generate statistics.
- Asynchronous Transfer Mode (ATM) ports are always set to full duplex and do not autonegotiate duplex or speed settings.
- GigaStack-to-GigaStack stack connections operate in half-duplex mode, and GigaStack-to-GigaStack point-to-point connections operate in full-duplex mode.
- If STP is enabled, the switch can take up to 30 seconds to check for loops when a port is reconfigured. The port LED is amber while STP reconfigures.

Connecting to Devices That Do Not Autonegotiate

To connect to a remote 100BASE-T device that does not autonegotiate, set the duplex setting to **Full** or **Half**, and set the speed setting to **Auto**. Autonegotiation for the speed setting selects the correct speed even if the attached device does not autonegotiate, but the duplex setting must be explicitly set.

To connect to a remote Gigabit Ethernet device that does not autonegotiate, disable autonegotiation on the local device, and set the duplex and flow control parameters to be compatible with the other device.

Setting Speed and Duplex Parameters

Beginning in privileged EXEC mode, follow these steps to set the speed and duplex parameters on a port:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to be configured.
Step 3	**speed** {**10** | **100** | **auto**}	Enter the speed parameter for the port. You cannot enter the speed on Gigabit Ethernet or ATM ports.
Step 4	**duplex** {**full** | **half** | **auto**}	Enter the duplex parameter for the port.
Step 5	**end**	Return to privileged EXEC mode.
Step 6	**show running-config**	Verify your entries.
Step 7	**copy running-config startup-config**	(Optional) Save your entry in the configuration file. This retains the configuration when the switch restarts.

Configuring Flow Control on Gigabit Ethernet Ports

Beginning in privileged EXEC mode, follow these steps to configure flow control on a Gigabit Ethernet port.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to be configured.
Step 3	**flowcontrol** [**asymmetric** | **symmetric**]	Configure flow control for the port.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show running-config**	Verify your entries.
Step 6	**copy running-config startup-config**	(Optional) Save your entry in the configuration file. This retains the configuration when the switch restarts.

Configuring Flooding Controls

You can use the following flooding techniques to block the forwarding of unnecessary flooded traffic:

- Enable storm control for unicast, multicast, or broadcast packets
- Block the forwarding of unicast and broadcast packets on a per-port basis
- Flood all unknown packets to a network port (configured only by using CLI)

Enabling Storm Control

A packet storm occurs when a large number of broadcast, unicast, or multicast packets are received on a port. Forwarding these packets can cause the network to slow down or to time out. Storm control is configured for the switch as a whole but operates on a per-port basis. By default, storm control is disabled.

Storm control uses high and low thresholds to block and then restore the forwarding of broadcast, unicast, or multicast packets. You can also set the switch to shut down the port when the rising threshold is reached.

The rising threshold is the number of packets that a switch port can receive before forwarding is blocked. The falling threshold is the number of packets below which the switch resumes normal forwarding. In general, the higher the threshold, the less effective the protection against broadcast storms. The maximum half-duplex transmission on a 100BASE-T link is 148,000 packets per second, but you can enter a threshold of up to 4294967295 broadcast packets per second.

With the exception of the **broadcast** keyword, the following procedure could also be used to enable storm control for unicast or multicast packets.

Beginning in privileged EXEC mode, follow these steps to enable broadcast-storm control.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to configure.
Step 3	**port storm-control broadcast** [**threshold** {**rising** *rising-number* **falling** *falling-number*}]	Enter the rising and falling thresholds for broadcast packets. Make sure the rising threshold is greater than the falling threshold.
Step 4	**port storm-control trap**	Generate an SNMP trap when the traffic on the port crosses the rising or falling threshold.
Step 5	**end**	Return to privileged EXEC mode.
Step 6	**show port storm-control** [*interface*]	Verify your entries.

Disabling Storm Control

Beginning in privileged EXEC mode, follow these steps to disable broadcast-storm control.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to configure.
Step 3	**no port storm-control broadcast**	Disable port storm control.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show port storm-control** [*interface*]	Verify your entries.

Blocking Flooded Traffic on a Port

By default, the switch floods packets with unknown destination MAC addresses to all ports. Some configurations do not require flooding. For example, a port that has only manually assigned addresses has no unknown destinations, and flooding serves no purpose. Therefore, you can disable the flooding of unicast and multicast packets on a per-port basis. Ordinarily, flooded traffic does not cross VLAN boundaries, but multi-VLAN ports flood traffic to all VLANs they belong to.

Beginning in privileged EXEC mode, follow these steps to disable the flooding of multicast and unicast packets to a port:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to configure.
Step 3	**port block multicast**	Block unknown multicast forwarding to the port.
Step 4	**port block unicast**	Block unknown unicast flooding to the port.
Step 5	**end**	Return to privileged EXEC mode.
Step 6	**show port block** {**multicast** | **unicast**} *interface*	Verify your entries, entering the appropriate command once for the **multicast** option and once for the **unicast** option.

Resuming Normal Forwarding on a Port

Beginning in privileged EXEC mode, follow these steps to resume normal forwarding on a port:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to configure.
Step 3	**no port block multicast**	Enable unknown multicast forwarding to the port.
Step 4	**no port block unicast**	Enable unknown unicast flooding to the port.
Step 5	**end**	Return to privileged EXEC mode
Step 6	**show port block** {**multicast** | **unicast**} *interface*	Verify your entries, entering the appropriate command once for the **multicast** option and once for the **unicast** option.

Enabling a Network Port

Network ports are assigned per VLAN and can reduce flooded traffic on your network. The switch forwards all traffic with unknown destination addresses to the network port instead of flooding the traffic to all ports in the VLAN.

When you configure a port as the network port, the switch deletes all associated addresses from the address table and disables learning on the port. If you configure other ports in the VLAN as secure ports, the addresses on those ports are not aged. If you move a network port to a VLAN without a network port, it becomes the network port for the new VLAN.

You cannot change the settings for unicast and multicast flooding on a network port. You can assign only one network port per VLAN. For the restrictions that apply to a network port, see the "Changing the Password" section on page 6-15.

Caution A network port cannot link cluster members.

Beginning in privileged EXEC mode, follow these steps to define a network port:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to be configured.
Step 3	**port network**	Define the port as the network port.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show running-config**	Verify your entry.

Disabling a Network Port

Beginning in privileged EXEC mode, follow these steps to disable a network port:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to be configured.
Step 3	**no port network**	Disable the port as the network port.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show running-config**	Verify your entry.

Configuring UniDirectional Link Detection

UniDirectional Link Detection (UDLD) is a Layer 2 protocol that detects and shuts down unidirectional links. You can configure UDLD on the entire switch or on an individual port. Use the **udld reset** command to reset all ports that have been shut down by UDLD.

Beginning in privileged EXEC mode, follow these steps to configure UDLD on a switch:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**udld enable**	Enable UDLD on all switch ports. Use the **udld** interface configuration command to enable UDLD on a specific port.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show running-config**	Verify the entry by displaying the running configuration.

Creating EtherChannel Port Groups

Fast EtherChannel (FEC) and Gigabit EtherChannel port groups act as single, logical ports for high-bandwidth connections between switches or between switches and servers.

Note You can create port groups of either Gigabit Ethernet ports or 100BASE-TX ports, but you cannot create a port group that has both port speeds.

For the restrictions that apply to port groups, see the "Avoiding Configuration Conflicts" section on page 9-2.

Understanding EtherChannel Port Grouping

This software release supports two different types of port groups: source-based forwarding port groups and destination-based forwarding port groups.

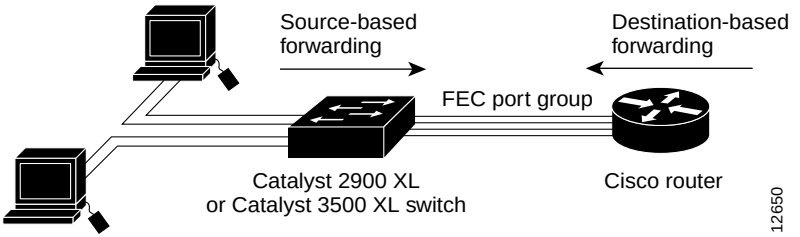
Source-based forwarding port groups distribute packets forwarded to the group based on the source address of incoming packets. You can configure up to eight ports in a source-based forwarding port group. Source-based forwarding is enabled by default.

Destination-based port groups distribute packets forwarded to the group based on the destination address of incoming packets. You can configure an unlimited number of ports in a destination-based port group.

You can create up to 12 port groups. All ports in each group must be of the same type; for example, they must be all source-based or all destination-based. You can have source-based port groups and destination-based source groups. You can independently configure port groups that link switches, but you must consistently configure both ends of a port group.

In Figure 7-1, a port group of two workstations communicates with a router. Because the router is a single-MAC-address device, source-based forwarding ensures that the switch uses all available bandwidth to the router. The router is configured for destination-based forwarding because the large number of stations ensures that the traffic is evenly distributed through the port-group ports on the router.

Figure 7-1 Source-Based Forwarding



The switch treats the port group as a single logical port; therefore, when you create a port group, the switch uses the configuration of the first port for all ports added to the group. If you add a port and change the forwarding method, it changes the forwarding for all ports in the group. After the group is created, changing STP or VLAN membership parameters for one port in the group automatically changes the parameters for all ports. Each port group has one port that carries all unknown multicast, broadcast, and STP packets.

Port Group Restrictions on Static-Address Forwarding

The following restrictions apply to entering static addresses that are forwarded to port groups:

- If the port group forwards based on the source MAC address (the default), configure the static address to forward to all ports in the group. This method eliminates the chance of lost packets.
- If the port group forwards based on the destination address, configure the static address to forward to only one port in the port group. This method avoids the possible transmission of duplicate packets. For more information, see the "Adding Static Addresses" section on page 6-59.

Creating EtherChannel Port Groups

Beginning in privileged EXEC mode, follow these steps to create a two-port group:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port of the first port to be added to the group.
Step 3	**port group 1 distribution destination**	Assign the port to group 1 with destination-based forwarding.
Step 4	**interface** *interface*	Enter the second port to be added to the group.
Step 5	**port group 1 distribution destination**	Assign the port to group 1 with destination-based forwarding.
Step 6	**end**	Return to privileged EXEC mode.
Step 7	**show running-config**	Verify your entries.

Configuring Protected Ports

Some applications require that no traffic be forwarded by the Layer 2 protocol between ports on the same switch. In such an environment, there is no exchange of unicast, broadcast, or multicast traffic between ports on the switch, and traffic between ports on the same switch is forwarded through a Layer 3 device such as a router.

To meet this requirement, you can configure Catalyst 2900 XL and Catalyst 3500 XL ports as protected ports (also referred to as private VLAN edge ports). Protected ports do not forward any traffic to protected ports on the same switch. This means that all traffic passing between protected ports—unicast, broadcast, and multicast—must be forwarded through a Layer 3 device. Protected ports can forward any type of traffic to nonprotected ports, and they forward as usual to all ports on other switches.



Note Sometimes unknown unicast traffic from a nonprotected port is flooded to a protected port because a MAC address has timed out or has not been learned by the switch. Use the **port block** command to guarantee that in such a case no unicast and multicast traffic is flooded to the port. See the "Configuring Flooding Controls" section on page 7-4 for more information.

Beginning in privileged EXEC mode, follow these steps to define a port as a protected port:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to be configured.
Step 3	port protected	Enable protected port on the port.
Step 4	end	Return to privileged EXEC mode.
Step 5	show port protected	Verify that the protected port option is enabled.

Use the **no** version of the **port protected** interface configuration command to disable the protected port option.

Enabling Port Security

Secured ports restrict a port to a user-defined group of stations. When you assign secure addresses to a secure port, the switch does not forward any packets with source addresses outside the group of addresses you have defined. If you define the address table of a secure port to contain only one address, the workstation or server attached to that port is guaranteed the full bandwidth of the port. As part of securing the port, you can also define the size of the address table for the port.

Secured ports generate address-security violations under the following conditions:

- The address table of a secured port is full and the address of an incoming packet is not found in the table.
- An incoming packet has a source address assigned as a secure address on another port.

Limiting the number of devices that can connect to a secure port has the following advantages:

- Dedicated bandwidth—If the size of the address table is set to 1, the attached device is guaranteed the full bandwidth of the port.
- Added security—Unknown devices cannot connect to the port.

The following options validate port security or indicate security violations:

Interface	Port to secure.
Security	Enable port security on the port.
Trap	Issue a trap when an address-security violation occurs.
Shutdown Port	Disable the port when an address-security violation occurs.
Secure Addresses	Number of addresses in the address table for this port. Secure ports have at least one address.
Max Addresses	Number of addresses that the address table for the port can contain.
Security Rejects	The number of unauthorized addresses seen on the port.

For the restrictions that apply to secure ports, see the "Avoiding Configuration Conflicts" section on page 9-2.

Defining the Maximum Secure Address Count

A secure port can have from 1 to 132 associated secure addresses. Setting one address in the MAC address table for the port ensures that the attached device has the full bandwidth of the port.

Enabling Port Security

Beginning in privileged EXEC mode, follow these steps to enable port security.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode for the port you want to secure.
Step 3	**port security max-mac-count 1**	Secure the port and set the address table to one address.
Step 4	**port security action shutdown**	Set the port to shutdown when a security violation occurs.
Step 5	**end**	Return to privileged EXEC mode.
Step 6	**show port security**	Verify the entry.

Disabling Port Security

Beginning in privileged EXEC mode, follow these steps to disable port security.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode for the port you want to unsecure.
Step 3	**no port security**	Disable port security.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show port security**	Verify the entry.

Enabling SPAN

You can use Switch Port Analyzer (SPAN) to monitor traffic on a given port by forwarding incoming and outgoing traffic on the port to another port in the same VLAN. A SPAN port cannot monitor ports in a different VLAN, and a SPAN port must be a static-access port. You can define any number of ports as SPAN ports, and any combination of ports can be monitored.

For the restrictions that apply to SPAN ports, see the "Avoiding Configuration Conflicts" section on page 9-2.

Beginning in privileged EXEC mode, follow these steps to enable SPAN:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port that acts as the monitor port.
Step 3	**port monitor** *interface*	Enable port monitoring on the port.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show running-config**	Verify your entries.

Disabling SPAN

Beginning in privileged EXEC mode, follow these steps to disable SPAN:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port number of the monitor port.
Step 3	**no port monitor** *interface*	Disable port monitoring on the port.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show running-config**	Verify your entries.

Configuring Voice Ports

The Catalyst 2900 XL and Catalyst 3500 XL switches can connect to a Cisco 7960 IP Phone and carry IP voice traffic. If necessary, the Catalyst 3524-PWR XL can supply electrical power to the circuit connecting it to the Cisco 7960 IP Phone.

Because the sound quality of an IP telephone call can deteriorate if the data is unevenly transmitted, this release of IOS supports quality of service (QoS) based on IEEE 802.1p class of service (CoS). QoS uses classification and scheduling to transmit network traffic from the switch in a predictable manner. The Cisco 7960 IP Phone itself is also a configurable device, and you can configure it to forward traffic with an 802.1p priority. You can use the CLI to configure the Catalyst 3524-PWR XL to honor or ignore a traffic priority assigned by a Cisco 7960 IP Phone.

The Cisco 7960 IP Phone contains an integrated three-port 10/100 switch. The ports are dedicated connections to the following devices:

- Port 1 connects to the Catalyst 3524-PWR XL switch or other voice-over-IP device.
- Port 2 is an internal 10/100 interface that carries the phone traffic.
- Port 3 connects to a PC or other device.

Figure 7-2 shows one way to configure a Cisco 7960 IP Phone.

Figure 7-2 Cisco 7960 IP Phone Connected to a Catalyst 3524-PWR XL Switch



Preparing a Port for a Cisco 7960 IP Phone Connection

Before you configure a Catalyst 3524-PWR XL port to carry IP voice traffic, configure the port as an 802.1Q trunk and as a member of the voice VLAN (VVID). See the "Configuring a Trunk Port" section on page 8-38 for instructions.

Configuring a Port to Connect to a Cisco 7960 IP Phone

Because a Cisco 7960 IP Phone also supports connection to a PC or other device, a port connecting a Catalyst 3524-PWR XL switch to a Cisco 7960 IP Phone can carry mixed traffic. There are three configurations for a port connected to a Cisco 7960 IP Phone:

- All traffic is transmitted according to the default COS priority of the port. This is the default.
- Voice traffic is given a higher priority by the phone, and all traffic is in the same VLAN.
- Voice and data traffic are carried on separate VLANs, and voice traffic always has a CoS priority of 5.

Beginning in privileged EXEC mode, follow these steps to configure a port to instruct the phone to give voice traffic a higher priority and to forward all traffic through the 802.1Q native VLAN.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to be configured.
Step 3	**switchport voice vlan dot1p**	Instruct the switch to use 802.1p priority tagging for voice traffic and to use VLAN 0 (default native VLAN) to carry all traffic.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show interface** *interface* **switchport**	Verify the port configuration.

Overriding the CoS Priority of Incoming Frames

A PC or other data device can connect to a Cisco 7960 IP Phone port. The PC can generate packets with an assigned CoS value. If you want, you can use the Catalyst 3524-PWR XL CLI to override the priority of frames arriving on the phone port from connected devices. You can also set the phone port to accept (trust) the priority of frames arriving on the port.

Beginning in privileged EXEC mode, follow these steps to override the CoS priority setting received from the non-voice port on the Cisco 7960 IP Phone:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the switch port to be configured.
Step 3	**switchport priority extend cos 3**	Set the phone port to override the priority received from the PC or the attached device and forward the received data with a priority of 3.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show interface** *interface* **switchport**	Verify the change.

Use the **no switchport priority extend** command to return the port to its default setting.

Configuring Voice Ports to Carry Voice and Data Traffic on Different VLANs

The Cisco 7960 IP Phone has an integrated three-port 10/100 switch that can connect to a PC or other device. You can configure a switch port to instruct the phone to forward voice and data traffic on different virtual LANs (VLANs).

In the following configuration, VLAN 1 carries data traffic, and VLAN 2 carries voice traffic. In this configuration, you must connect all Cisco IP Phones and other voice-related devices to switch ports that belong to VLAN 2.

Beginning in privileged EXEC mode, follow these steps to configure a port to receive voice and data from a Cisco IP Phone in different VLANs:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to be configured.
Step 3	**switchport priority default (0)**	Assign an IEEE 802.1p priority to untagged traffic that is received on the switch port. The Cisco IP Phone forwards this traffic through the native VLAN, VLAN 1.
Step 4	**switchport voice vlan (2)**	Instruct the Cisco IP Phone to forward all voice traffic through VLAN 2. The Cisco IP Phone forwards the traffic with an 802.1p priority of 5.
Step 5	**end**	Return to privileged EXEC mode.
Step 6	**show interface** *interface* **switchport**	Verify the configuration.

Configuring Inline Power on the Catalyst 3524-PWR Ports

The Catalyst 3524-PWR XL can supply inline power to the Cisco 7960 IP Phone, if necessary. The Cisco 7960 IP Phone can also be connected to an AC power source and supply its own power to the voice circuit. When the Cisco 7960 IP Phone supplies its own power, any Catalyst 2900 XL or Catalyst 3500 XL can forward IP voice traffic to and from the phone.

The Catalyst 3524-PWR XL senses if it is connected to a Cisco 7960 IP Phone. If there is *no* power on the circuit, the switch supplies the power. If there is power on the circuit, the switch does not supply it.

You can configure the switch to never supply power to the Cisco 7960 IP Phone and to disable the detection mechanism. See the "Configuring Voice Ports" section on page 7-17 for the CLI commands that you use to supply inline power to a Cisco 7960 IP Phone.

Beginning in privileged EXEC mode, follow these steps to configure a port to never supply power to Cisco 7960 IP Phones.

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to be configured.
Step 3	**power inline never**	Permanently disable inline power on the port. To enable inline power when a Cisco 7960 IP Phone is detected, use the **power inline auto** command.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show power inline** *interface* **configured**	Verify the change.

Configuring the LRE Ports

The Catalyst 2900 LRE XL switches use Long-Reach Ethernet (LRE) technology to transfer data and voice traffic over existing standard telephone lines. Connecting a switch LRE switch port to a remote Ethernet device requires two types of connections:

- LRE link—This is the connection between the switch LRE port and the WALL port on the Cisco 575 LRE customer premises equipment (CPE). This connection can be through a standard telephone line (categorized and noncategorized unshielded twisted-pair cable) and can extend to distances of up to 4921 ft (1500 m).
- Ethernet link—This is the connection between the 10/100 Ethernet port on the CPE and an Ethernet device, such as a PC. This connection is through standard Category 5 cabling and can extend to distances of up to 328 ft (100 m).

The actual link rate between an LRE port and a remote Ethernet device, in either direction, depends on the active profile for the LRE port and the Ethernet link speed. For example, if a PC Ethernet port is configured to 100 Mbps and the LRE port is configured with an upstream link rate of 5.69 Mbps, the actual upload rate provided to the PC user is 5.69 Mbps, not 100 Mbps. Conversely, if the PC Ethernet port is configured to 10 Mbps and the LRE port is configured with an upstream link rate of 17.06 Mbps, the actual upload rate provided to the PC user is 17.06 Mbps.

LRE Links and LRE Profiles

The LRE link settings on the LRE ports define the connection between the switch LRE port and the WALL port on the Cisco 575 LRE CPE. The LRE link provides symmetric and asymmetric bandwidth for voice and data traffic. Symmetrical transmission is when the downstream and upstream bandwidth are the same. Asymmetrical transmission is when the downstream and the upstream bandwidth differ. Downstream transmission refers to the data traveling from the LRE port to the CPE. Upstream transmission refers to the data traveling from the CPE to the LRE port.

Bandwidth within the LRE link is controlled by the switch by using configurations called *profiles*. An LRE profile configures the upstream and downstream rates on the LRE link. Depending on the profile, the upstream and downstream bands on an LRE link can be approximately 5, 10, or 15 Mbps.

You can assign profiles on a per-port or switch-wide basis. When the LRE port establishes a link with the CPE, the switch downloads its profile settings to the CPE port so that both ports on both devices operate with the same configuration.

The Catalyst 2900 LRE XL switches are shipped with predefined profiles (Table 7-1) categorized as public (global) mode and private (per-port) mode profiles. By default, all LRE ports on the switch are enabled with the LRE-10 private profile in effect.

- Public—We strongly recommend using a public profile if the switch is used with equipment connected to a Public Switched Telephone Network (PSTN). When the switch is configured with a public profile, all LRE ports use the same configuration to prevent the switch from causing interference with the other lines on the PSTN.

  The standards for spectral profiles have not yet been ratified. The PUBLIC-ANSI profile corresponds to ANSI Plan 998. The PUBLIC-ETSI profile corresponds to ETSI Plan 997. Both plans are draft standards. Contact Cisco Systems for the latest information about standards ratification or for updates to the public profiles.

- Private—You can use a private profile if the LRE switch is not used with equipment connected to a PSTN. Three private profiles offer different link speeds and maximum distances. In general, the higher the link speed, the shorter the maximum distance. Private profiles are assigned on a per-port basis. The ports on an LRE switch can be assigned the same or different private profiles.

Note Use the rates and distances in Table 7-1 as guidelines only. Factors such as the type of cable you use, how it is bundled, and the interference and noise on the LRE link can affect the actual LRE link performance. Contact Cisco Systems for information about limitations and optimization of LRE link performance.

The net data rates in Table 7-1 are slightly less than the gross data rates displayed by the **show controllers lre profile names** privileged EXEC command.

Table 7-1 LRE Profiles

Profile Name	Profile Type	LRE Link Downstream Rate (Mbps)	LRE Link Upstream Rate (Mbps)	Maximum Distance between the LRE Port and the CPE
PUBLIC-ANSI	Public	15.17	4.27	4101 ft (1250 m)
PUBLIC-ETSI	Public	11.38	4.27	4101 ft (1250 m)
LRE-5	Private	5.69	5.69	4921 ft (1500 m)
LRE-10 (default)	Private	11.38	11.38	4101 ft (1250 m)
LRE-15	Private	15.17	17.06	3445 ft (1050 m)

When assigning a profile to an LRE port, keep the following considerations in mind:

- An LRE port always has a private profile assigned to it. However, public profiles have priority over private profiles.

  If you assign a public profile to the switch, the switch ignores the private profile settings and uses the public profile settings on all LRE ports. If you assign a different public profile, the change immediately takes effect.

  If a public profile is configured on the switch and you want the LRE ports to use private profiles, you must first disable the public profile by using CMS or by using the **no lre profile global** global configuration command.

  If no public profile is configured on the switch, the LRE port uses its private profile. If you assign a different private profile to the LRE port, the change immediately takes effect.

- A configuration conflict occurs if a switch cluster has LRE switches using both private and public profiles. If one LRE switch in a cluster is assigned a public profile, all LRE switches in that cluster must have that same public profile. Before you add an LRE switch to a cluster, make sure that you assign it the same public profile used by other LRE switches in the cluster.

  A cluster can have a mix of LRE switches using different private profiles.

  For more information about clusters, see Chapter 5, "Clustering Switches."

Use the **show controllers lre** privileged EXEC commands to display the LRE link statistics and profile information on the LRE ports. For information about these commands, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference.*

LRE Ethernet Links

The Ethernet link settings on the LRE ports are for configuring the remote CPE Ethernet port, and they define the connection between the Ethernet port on the Cisco 575 LRE CPE and an Ethernet device such as a PC or a television set-top box. You can set the CPE Ethernet port to operate at 10 or 100 Mbps and at half- or full-duplex mode, depending on the capability of the remote Ethernet device. Autonegotiation for port speed and duplex mode is supported. The default speed for the CPE Ethernet port is auto; the default duplex mode is half duplex.

When configuring the Ethernet link on the LRE ports, keep in mind the following guidelines:

- The speeds on the LRE and Ethernet links do not need to match. However, to prevent the possible loss of data when the LRE link is configured to be slower than the Ethernet link, choose one of the following:
  - Configure the LRE port to use half-duplex mode, which is the default.
  - Use duplex autonegotiation or full-duplex mode only if the remote device supports 802.1x full-duplex flow control.



Note You cannot configure the flow control setting on the LRE ports. The flow control setting on the remote CPE Ethernet port is automatically disabled on LRE ports in half-duplex mode, and is automatically enabled on LRE ports in full-duplex mode.

The PC user should notice no significant difference in performance between 100-Mbps half duplex and 100-Mbps full duplex.

- Enable CDP either globally on the LRE switch or on the specific LRE ports.
- The switch 10/100 port defaults are not the same as the defaults for the Ethernet link on the LRE ports.



Note We recommend that you use the **lre shutdown** interface configuration command to disable the LRE chipset transmitter on any LRE ports that are not connected to a CPE. This prevents access to the LRE port and prevents the power emitted from the port from affecting other ports.

Use the **show controllers ethernet-controller** privileged EXEC command to display the internal switch statistics, the statistics collected by the switch LRE chipset, and the statistics collected by the CPE LRE chipset. For information about this command, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

Assigning a Public Profile to All LRE Ports

Public profiles are set on a switch-wide (global) basis. The public profile you select should be compatible with the PSTN to which the LRE switch is connected.

Public profiles have priority over private profiles. If you assign a public profile to the switch, the switch ignores the private profile settings and uses the public profile settings on all LRE ports. To disable the public profile on the switch, use the **no lre profile global** global configuration command.

Changes to the public profile settings are immediately put in effect, and the public mode automatically becomes the active mode.

Beginning in privileged EXEC mode, follow these steps to assign a public profile to the LRE ports:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**lre profile global** *profile_name*	Enter the public profile name: PUBLIC-ANSI or PUBLIC-ETSI.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show controllers lre profile mapping**	Verify the change.

Use the **show controllers lre** commands to display the LRE link statistics and profile information on the LRE ports. For information about these commands, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

Assigning a Private Profile to an LRE Port

Private profiles are set on a per-port basis. You can assign the same private profile or different private profiles to the LRE ports on the switch. The default active private profile on all LRE ports is LRE-10.

The switch resets the ports with the updated profile settings.

Beginning in privileged EXEC mode, follow these steps to assign a private profile to an LRE port:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *LRE-interface*	Enter interface configuration mode, and enter the number of the LRE port to be configured.
Step 3	**lre profile** *profile_name*	Enter the private profile name: LRE-5, LRE-10, or LRE-15. The default profile is LRE-10.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show controllers lre profile mapping**	Verify the change.

Use the **show controllers lre** commands to display the LRE link statistics and profile information on the LRE ports. For information about these commands, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.



Configuring VLANs

This chapter provides information about configuring virtual LANs (VLANs). It includes command-line interface (CLI) procedures for using commands that have been specifically created or changed for the Catalyst 2900 XL or Catalyst 3500 XL switches. For complete syntax and usage information for the commands used in this chapter, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

Note Certain port features can conflict with one another. Review the "Avoiding Configuration Conflicts" section on page 9-2 before you change the port settings.

This chapter does not repeat the concepts and CLI procedures provided in the standard Cisco IOS Release 12.0 documentation. For switch features that use standard Cisco IOS Release 12.0 commands, refer to the Cisco IOS Release 12.0 documentation on Cisco.com for additional information and CLI procedures.

For information about configuring these settings from Cluster Management Suite (CMS), refer to the online help.

Note Some features can be implemented only by using the CLI.

Overview

A virtual LAN (VLAN) is a switched network that is logically segmented by function, project team, or application, without regard to the physical locations of the users. Any switch port can belong to a VLAN, and unicast, broadcast, and multicast packets are forwarded and flooded only to stations in the VLAN. Each VLAN is considered a logical network, and packets destined for stations that do not belong to the VLAN must be forwarded through a router or bridge as shown in Figure 8-1. VLANs are identified with a number of 1 to 1001.

Because a VLAN is considered a separate logical network, it contains its own bridge Management Information Base (MIB) information and can support its own implementation of the Spanning Tree Protocol (STP). For information about managing VLAN STP instances, see the "Supported STP Instances" section on page 6-24.

Figure 8-1 VLANs as Logically Defined Networks

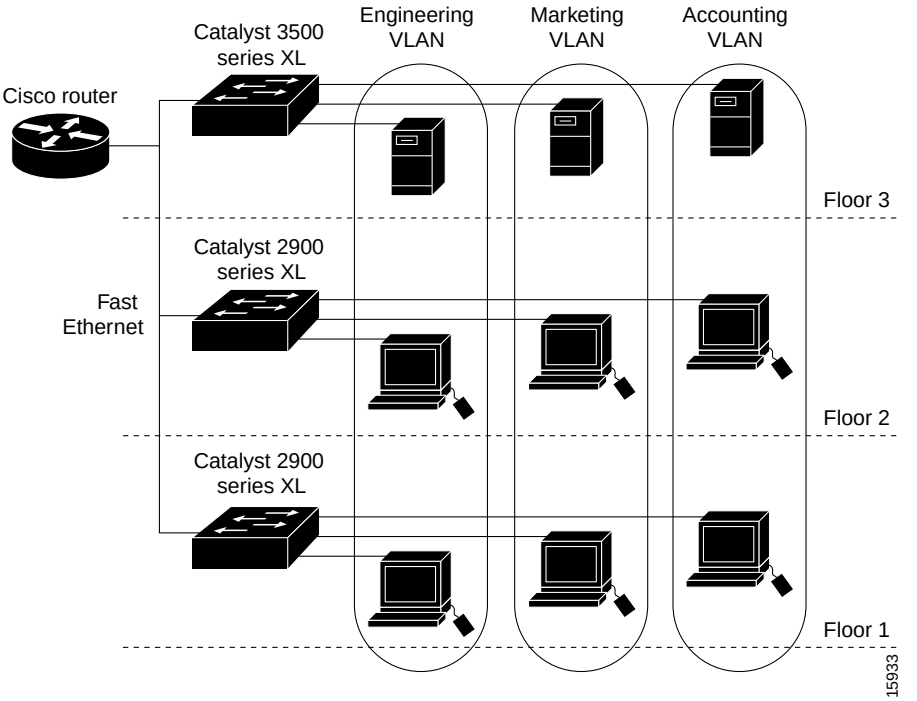


Table 8-1 lists the number of supported VLANs on the switches.

Table 8-1 Maximum Number of Supported VLANs

Switch	Number of Supported VLANs	Trunking Supported?
Catalyst 2912 XL, Catalyst 2924 XL, and Catalyst 2924C XL switches	64	Yes
Catalyst 2900 LRE XL switches	250	Yes
Catalyst 2912M and Catalyst 2924M modular switches	250	Yes
Catalyst 3500 XL switches	250	Yes

The switches in Table 8-1 support both Inter-Switch Link (ISL) and IEEE 802.1Q trunking methods for transmitting VLAN traffic over 100BASE-T and Gigabit Ethernet ports.

The GigaStack GBIC also supports both trunking methods. When you are configuring a cascaded stack of Catalyst 3500 XL switches using the GigaStack GBIC and want to include more than one VLAN in the stack, be sure to configure all of the GigaStack GBIC interfaces as trunk ports by using the **switchport mode trunk** interface configuration command and to use the same encapsulation method by using the **switchport encapsulation** {**isl** | **dot1q**} interface configuration command. For more information on these commands, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

Trunking is not supported on all switches and modules. For the list of products that support trunking, refer to the release notes.

Management VLANs

Communication with the switch management interfaces is through the switch IP address. The IP address is associated with the management VLAN, which by default is VLAN 1.

The management VLAN has the following characteristics:

- It is created from CMS or through the CLI on static-access, multi-VLAN, and dynamic-access and trunk ports. You cannot create or remove the management VLAN through Simple Network Management Protocol (SNMP).
- Only one management VLAN can be administratively active at a time.
- With the exception of VLAN 1, the management VLAN can be deleted.
- When created, the management VLAN is administratively down.

Before changing the management VLAN on your switch network, make sure you follow these guidelines:

- The new management VLAN should not have an Hot Standby Router Protocol (HSRP) standby group configured on it.
- You must be able to move your network management station to a switch port assigned to the same VLAN as the new management VLAN.
- Connectivity through the network must exist from the network management station to all switches involved in the management VLAN change.
- Switches running a version of IOS software that is earlier than Cisco IOS 12.0(5)XP cannot change the management VLAN.
- Switches running Cisco IOS 12.0(5)XP should be upgraded to the current software release as described in the release notes.

If you are using SNMP or CMS to manage the switch, ensure that the port through which you are connected to a switch is in the management VLAN.

For information about the role management VLANs play in switch clusters, see the "Management VLAN" section on page 5-11.

Changing the Management VLAN for a New Switch

If you add a new switch to an existing cluster and the cluster is using a management VLAN other than the default VLAN 1, the command switch automatically senses that the new switch has a different management VLAN and has not been configured. The command switch issues commands to change the management VLAN on the new switch to match the one in use by the cluster. This automatic change of the VLAN only occurs for new, out-of-box switches that do not have a config.text file and for which there have been no changes to the running configuration.

Before a new switch can be added to a cluster, it must be connected to a port that belongs to the cluster management VLAN. If the cluster is configured with a management VLAN other than the default, the command switch changes the management VLAN for new switches when they are connected to the cluster. In this way, the new switch can exchange CDP messages with the command switch and be proposed as a cluster candidate.



Note For the command switch to change the management VLAN on a new switch, there must have been no changes to the new switch configuration, and there must be no config.text file.

Because the switch is new and unconfigured, its management VLAN is changed to the cluster management VLAN when it is first added to the cluster. All ports that have an active link at the time of this change become members of the new management VLAN.

For information about the role management VLANs play in switch clusters, see the "Management VLAN" section on page 5-11.

Changing the Management VLAN Through a Telnet Connection

Before you start, review the "Management VLANs" section on page 8-4. Beginning in privileged EXEC mode on the command switch, follow these steps to configure the management VLAN interface through a Telnet connection:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**cluster management-vlan** *vlanid*	Change the management VLAN for the cluster. This ends your Telnet session. Move the port through which you are connected to the switch to a port in the new management VLAN.
Step 3	show running-config	Verify the change.

Assigning VLAN Port Membership Modes

You configure a port to belong to a VLAN by assigning a membership mode that determines the kind of traffic the port carries and the number of VLANs it can belong to. Table 8-2 lists the membership modes and characteristics.

Table 8-2 Port Membership Modes

Membership Mode	VLAN Membership Characteristics
Static-access	A static-access port can belong to one VLAN and is manually assigned. By default, all ports are static-access ports assigned to VLAN 1.
Multi-VLAN	A multi-VLAN port can belong to up to 250 VLANs (some models only support 64 VLANs) and is manually assigned. You cannot configure a multi-VLAN port when a trunk is configured on the switch. VLAN traffic on the multi-VLAN port is not encapsulated.
Trunk (ISL, ATM, or IEEE 802.1Q)	A trunk is a member of all VLANs in the VLAN database by default, but membership can be limited by configuring the allowed-VLAN list. You can also modify the pruning-eligible list to block flooded traffic to VLANs on trunk ports that are included in the list. VLAN Trunk Protocol (VTP) maintains VLAN configuration consistency by managing the addition, deletion, and renaming of VLANs on a network-wide basis. VTP exchanges VLAN configuration messages with other switches over trunk links. **Note** By using the Asynchronous Transfer Mode (ATM) module CLI, you can map the LAN emulation (LANE) client to a VLAN or bind one or more permanent virtual connections (PVCs) to a VLAN. The VLAN ID is then displayed in the Assigned VLANs column of the VLAN Membership window. An ATM port can only be a trunk port. For more information, refer to the *Catalyst 2900 Series XL ATM Modules Installation and Configuration Guide*.
Dynamic access	A dynamic-access port can belong to one VLAN and is dynamically assigned by a VLAN Membership Policy Server (VMPS). The VMPS can be a Catalyst 5000 series switch but never a Catalyst 2900 XL or Catalyst 3500 XL switch.

When a port belongs to a VLAN, the switch learns and manages the addresses associated with the port on a per-VLAN basis. For more information, see the "Managing the MAC Address Tables" section on page 6-56.

VLAN Membership Combinations

You can configure your switch ports in various VLAN membership combinations as listed in Table 8-3.

Table 8-3 VLAN Combinations

Port Mode	VTP Required?	Configuration Procedure	Comments
Static-access ports	No	"Assigning Static-Access Ports to a VLAN" section on page 8-10	If you do not want to use VTP to globally propagate the VLAN configuration information, you can assign a static-access port to a VLAN and set the VTP mode to *transparent* to disable VTP.
Static-access and multi-VLAN ports	No	"Overlapping VLANs and Multi-VLAN Ports" section on page 8-11 "Assigning Static-Access Ports to a VLAN" section on page 8-10	You must connect the multi-VLAN port to a router or server. The switch automatically transitions to VTP transparent mode (VTP is disabled). No VTP configuration is required. Some restrictions apply to multi-VLAN ports. For more information, see the "Avoiding Configuration Conflicts" section on page 9-2.

Table 8-3 VLAN Combinations (continued)

Port Mode	VTP Required?	Configuration Procedure	Comments
Static-access and trunk ports	Recommended	"Configuring VTP Server Mode" section on page 8-21 Add, modify, or remove VLANs in the database as described in the "Configuring VLANs in the VTP Database" section on page 8-32 "Assigning Static-Access Ports to a VLAN" section on page 8-35 "Configuring a Trunk Port" section on page 8-38	You can configure at least one trunk port on the switch and make sure that this trunk port is connected to the trunk port of a second switch. Some restrictions apply to trunk ports. For more information, see the "Trunks Interacting with Other Features" section on page 8-37. You can change the VTP version on the switch and enable VTP pruning. You can define the allowed-VLAN list, change the pruning-eligible list, and configure the native VLAN for untagged traffic on the trunk port.
Dynamic-access and trunk ports	Yes	"Configuring Dynamic VLAN Membership" section on page 8-57 "Configuring Dynamic Ports on VMPS Clients" section on page 8-58 "Configuring a Trunk Port" section on page 8-38 so that the VMPS client can receive VTP information from the VMPS	You must connect the dynamic-access port to an end station and not to another switch. Configure the VMPS and the client with the same VTP domain name. You can change the reconfirmation interval and the retry count on the VMPS client switch. You can define the allowed-VLAN list, change the pruning-eligible list, and configure the native VLAN for untagged traffic on the trunk port.

Assigning Static-Access Ports to a VLAN

By default, all ports are static-access ports assigned to the management VLAN, VLAN 1.

You can assign a static-access port to a VLAN without having VTP globally propagate VLAN configuration information (VTP is disabled). Configuring the switch for VTP transparent mode disables VTP.

Beginning in privileged EXEC mode, follow these steps to assign ports for multi-VLAN membership:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to be added to the VLAN.
Step 3	**switchport mode multi**	Enter the VLAN membership mode for multi-VLAN ports.
Step 4	**switchport multi vlan** *vlan-list*	Assign the port to more than one VLAN. Separate nonconsecutive VLAN IDs with a comma; use a hyphen to designate a range of IDs. Configuring a switch port for multi-VLAN mode causes VTP to transition to transparent mode, which disables VTP.
Step 5	**end**	Return to privileged EXEC mode.
Step 6	**show interface** *interface-id* **switchport**	Verify your entries.

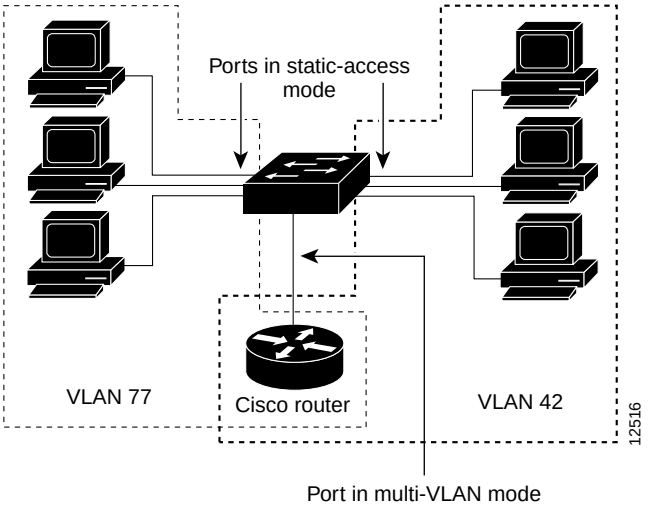
Overlapping VLANs and Multi-VLAN Ports

A multi-VLAN port connected to a router can link two or more VLANs. Intra-VLAN traffic stays within the boundaries of the respective VLANs as shown in Figure 8-2. Connectivity between VLANs is through the router connected to the multi-VLAN port.

A multi-VLAN port performs normal switching functions in all its assigned VLANs. For example, when a multi-VLAN port receives an unknown Media Access Control (MAC) address, all the VLANs to which the port belongs learn the address. Multi-VLAN ports also respond to the STP messages generated by the different instances of STP in each VLAN.

For the restrictions that apply to multi-VLAN ports, see the "Avoiding Configuration Conflicts" section on page 9-2.

Figure 8-2 Two VLANs Sharing a Port Connected to a Router



Caution To avoid unpredictable STP behavior and a loss of connectivity, do not connect multi-VLAN ports to hubs or switches. Connect multi-VLAN ports to routers or servers.

Beginning in privileged EXEC mode, follow these steps to assign ports for multi-VLAN membership:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and enter the port to be added to the VLAN.
Step 3	**switchport mode multi**	Enter the VLAN membership mode for multi-VLAN ports.
Step 4	**switchport multi vlan** *vlan-list*	Assign the port to more than one VLAN. Separate nonconsecutive VLAN IDs with a comma; use a hyphen to designate a range of IDs. Configuring a switch port for multi-VLAN mode causes VTP to transition to transparent mode, which disables VTP.
Step 5	**end**	Return to privileged EXEC mode.
Step 6	**show interface** *interface-id* **switchport**	Verify your entries.

Using VTP

VTP is a Layer 2 messaging protocol that maintains VLAN configuration consistency by managing the addition, deletion, and renaming of VLANs on a network-wide basis. VTP minimizes misconfigurations and configuration inconsistencies that can cause several problems, such as duplicate VLAN names, incorrect VLAN-type specifications, and security violations.

Before you create VLANs, you must decide whether to use VTP in your network. Using VTP, you can make configuration changes centrally on a single switch, such as a Catalyst 2900 XL or Catalyst 3500 XL switch, and have those changes automatically communicated to all the other switches in the network. Without VTP, you cannot send information about VLANs to other switches.

The VTP Domain

A VTP domain (also called a VLAN management domain) consists of one switch or several interconnected switches under the same administrative responsibility. A switch can be in only one VTP domain. You make global VLAN configuration changes for the domain by using the CLI, Cluster Management software, or SNMP.

By default, a Catalyst 2900 XL or Catalyst 3500 XL switch is in the no-management-domain state until it receives an advertisement for a domain over a trunk link (a link that carries the traffic of multiple VLANs) or until you configure a domain name. The default VTP mode is server mode, but VLAN information is not propagated over the network until a domain name is specified or learned.

If the switch receives a VTP advertisement over a trunk link, it inherits the domain name and configuration revision number. The switch then ignores advertisements with a different domain name or an earlier configuration revision number.

When you make a change to the VLAN configuration on a VTP server, the change is propagated to all switches in the VTP domain. VTP advertisements are sent over all trunk connections, including Inter-Switch Link (ISL), IEEE 802.1Q, IEEE 802.10, and ATM LANE.

If you configure a switch for VTP transparent mode, you can create and modify VLANs, but the changes are not transmitted to other switches in the domain, and they affect only the individual switch.

For domain name and password configuration guidelines, see the "Domain Names" section on page 8-18.

VTP Modes and Mode Transitions

You can configure a supported switch to be in one of the VTP modes listed in Table 8-4.

Table 8-4 VTP Modes

VTP Mode	Description
VTP server	In this mode, you can create, modify, and delete VLANs and specify other configuration parameters (such as VTP version) for the entire VTP domain. VTP servers advertise their VLAN configurations to other switches in the same VTP domain and synchronize their VLAN configurations with other switches based on advertisements received over trunk links. In VTP server mode, VLAN configurations are saved in nonvolatile RAM. VTP server is the default mode.
VTP client	In this mode, a VTP client behaves like a VTP server, but you cannot create, change, or delete VLANs on a VTP client. In VTP client mode, VLAN configurations are saved in nonvolatile RAM.
VTP transparent	In this mode, VTP transparent switches do not participate in VTP. A VTP transparent switch does not advertise its VLAN configuration and does not synchronize its VLAN configuration based on received advertisements. However, transparent switches do forward VTP advertisements that they receive from other switches. You can create, modify, and delete VLANs on a switch in VTP transparent mode. In VTP transparent mode, VLAN configurations are saved in nonvolatile RAM, but they are not advertised to other switches.

Two configurations can cause a switch to automatically change its VTP mode:

- When the network is configured with more than the maximum 250 VLANs (some models support a maximum of 64 VLANs), the switch automatically changes from VTP server or client mode to VTP transparent mode. The switch then operates with the VLAN configuration that preceded the one that sent it into transparent mode.
- When a multi-VLAN port is configured on a supported switch in VTP server mode or client mode, the switch automatically changes to transparent mode.

The "VTP Configuration Guidelines" section on page 8-18 provides tips and caveats for configuring VTP.

VTP Advertisements

Each switch in the VTP domain sends periodic global configuration advertisements from each trunk port to a reserved multicast address. Neighboring switches receive these advertisements and update their VTP and VLAN configurations as necessary.

Note Because trunk ports send and receive VTP advertisements, you must ensure that at least one trunk port is configured on the switch and that this trunk port is connected to the trunk port of a second switch. Otherwise, the switch cannot receive any VTP advertisements.

VTP advertisements distribute the following global domain information in VTP advertisements:

- VTP domain name
- VTP configuration revision number
- Update identity and update timestamp
- MD5 digest

VTP advertisements distribute the following VLAN information for each configured VLAN:

- VLAN ID
- VLAN name
- VLAN type
- VLAN state
- Additional VLAN configuration information specific to the VLAN type

VTP Version 2

VTP version 2 supports the following features not supported in version 1:

- Token Ring support—VTP version 2 supports Token Ring LAN switching and VLANs (Token Ring Bridge Relay Function [TrBRF] and Token Ring Concentrator Relay Function [TrCRF]). For more information about Token Ring VLANs, see the "VLANs in the VTP Database" section on page 8-27.
- Unrecognized Type-Length-Value (TLV) support—A VTP server or client propagates configuration changes to its other trunks, even for TLVs it is not able to parse. The unrecognized TLV is saved in nonvolatile RAM when the switch is operating in VTP server mode.
- Version-Dependent Transparent Mode—In VTP version 1, a VTP transparent switch inspects VTP messages for the domain name and version and forwards a message only if the version and domain name match. Because only one domain is supported, VTP version 2 forwards VTP messages in transparent mode without checking the version and domain name.
- Consistency Checks—In VTP version 2, VLAN consistency checks (such as VLAN names and values) are performed only when you enter new information through the CLI, the Cluster Management software, or SNMP. Consistency checks are not performed when new information is obtained from a VTP message or when information is read from nonvolatile RAM. If the digest on a received VTP message is correct, its information is accepted without consistency checks.

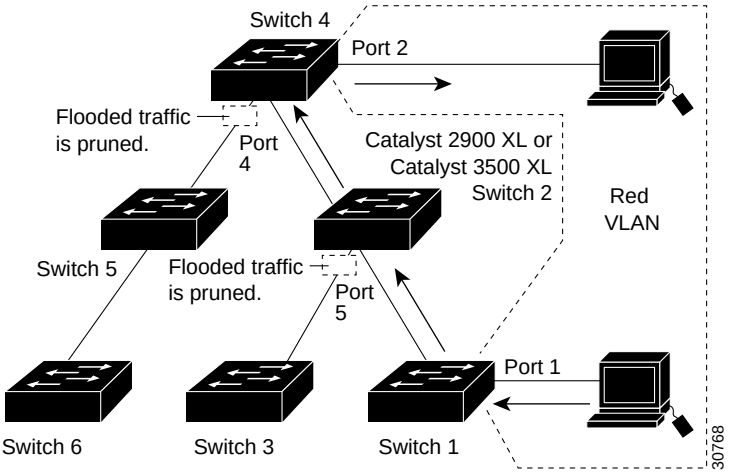
VTP Pruning

Pruning increases available bandwidth by restricting flooded traffic to those trunk links that the traffic must use to reach the destination devices. Without VTP pruning, a switch floods broadcast, multicast, and unknown unicast traffic across all trunk links within a VTP domain even though receiving switches might discard them.

VTP pruning blocks unneeded flooded traffic to VLANs on trunk ports that are included in the pruning-eligible list. Only VLANs included in the pruning-eligible list can be pruned. By default, VLANs 2 through 1001 are pruning eligible on Catalyst 2900 XL and Catalyst 3500 XL trunk ports. If the VLANs are configured as pruning-ineligible, the flooding continues. VTP pruning is also supported with VTP version 1 and version 2.

Figure 8-3 shows a switched network with VTP pruning enabled. The broadcast traffic from Switch 1 is not forwarded to Switches 3, 5, and 6 because traffic for the Red VLAN has been pruned on the links indicated (port 5 on Switch 2 and port 4 on Switch 4).

Figure 8-3 Optimized Flooded Traffic with VTP Pruning



VTP Configuration Guidelines

The following sections describe the guidelines you should follow when configuring the VTP domain name and password and the VTP version number.

Domain Names

When configuring VTP for the first time, you must always assign a domain name. All switches in the VTP domain must also be configured with the same domain name. Switches in VTP transparent mode do not exchange VTP messages with other switches, and you do not need to configure a VTP domain name for them.

Caution Do not configure a VTP domain if all switches are operating in VTP client mode. If you configure the domain, it is impossible to make changes to the VLAN configuration of that domain. Therefore, make sure you configure at least one switch in the VTP domain for VTP server mode.

Passwords

You can configure a password for the VTP domain, but it is not required. All domain switches must share the same password. Switches without a password or with the wrong password reject VTP advertisements.

Caution The domain does not function properly if you do not assign the same password to each switch in the domain.

If you configure a VTP password for a domain, a Catalyst 2900 XL or Catalyst 3500 XL switch that is booted without a VTP configuration does not accept VTP advertisements until you configure it with the correct password. After the configuration, the switch accepts the next VTP advertisement that uses the same password and domain name in the advertisement.

If you are adding a new switch to an existing network that has VTP capability, the new switch learns the domain name only after the applicable password has been configured on the switch.

Upgrading from Previous Software Releases

When you upgrade from a software version that supports VLANs but does not support VTP, such as Cisco IOS Release 11.2(8)SA3, to a version that does support VTP, ports that belong to a VLAN retain their VLAN membership, and VTP enters transparent mode. The domain name becomes UPGRADE, and VTP does not propagate the VLAN configuration to other switches.

If you want the switch to propagate VLAN configuration information to other switches and to learn the VLANs enabled on the network, you must configure the switch with the correct domain name, the domain password, and change the VTP mode to VTP server.

VTP Version

Follow these guidelines when deciding which VTP version to implement:

- All switches in a VTP domain must run the same VTP version.
- A VTP version 2-capable switch can operate in the same VTP domain as a switch running VTP version 1 if version 2 is disabled on the version 2-capable switch. Version 2 is disabled by default.
- Do not enable VTP version 2 on a switch unless all of the switches in the same VTP domain are version-2-capable. When you enable version 2 on a switch, all of the version-2-capable switches in the domain enable version 2. If there is a version 1-only switch, it will not exchange VTP information with switches with version 2 enabled.
- If there are Token Ring networks in your environment (TrBRF and TrCRF), you must enable VTP version 2 for Token Ring VLAN switching to function properly. To run Token Ring and Token Ring-Net, disable VTP version 2.
- Enabling or disabling VTP pruning on a VTP server enables or disables VTP pruning for the entire VTP domain.

Default VTP Configuration

Table 8-5 shows the default VTP configuration.

Table 8-5 VTP Default Configuration

Feature	Default Value
VTP domain name	Null.
VTP mode	Server.
VTP version 2 enable state	Version 2 is disabled.
VTP password	None.
VTP pruning	Disabled.

Configuring VTP

You can configure VTP through the CLI by entering commands in the VLAN database command mode. When you enter the **exit** command in VLAN database mode, it applies all the commands that you entered. VTP messages are sent to other switches in the VTP domain, and you enter privileged EXEC mode.

If you are configuring VTP on a cluster member switch to a VLAN, first log in to the member switch by using the privileged EXEC **rcommand** command. For more information on how to use this command, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

Note The Cisco IOS **end** and Ctrl-Z commands are not supported in VLAN database mode.

After you configure VTP, you must configure a trunk port so that the switch can send and receive VTP advertisements. For more information, see the "How VLAN Trunks Work" section on page 8-36.

Configuring VTP Server Mode

When a switch is in VTP server mode, you can change the VLAN configuration and have it propagated throughout the network.

Beginning in privileged EXEC mode, follow these steps to configure the switch for VTP server mode:

	Command	Purpose
Step 1	**vlan database**	Enter VLAN database mode.
Step 2	**vtp domain** *domain-name*	Configure a VTP administrative-domain name. The name can be from 1 to 32 characters. All switches operating in VTP server or client mode under the same administrative responsibility must be configured with the same domain name.
Step 3	**vtp password** *password-value*	(Optional) Set a password for the VTP domain. The password can be from 8 to 64 characters. If you configure a VTP password, the VTP domain does not function properly if you do not assign the same password to each switch in the domain.
Step 4	**vtp server**	Configure the switch for VTP server mode (the default).
Step 5	**exit**	Return to privileged EXEC mode.
Step 6	**show vtp status**	Verify the VTP configuration. In the display, check the VTP Operating Mode and the VTP Domain Name fields.

Configuring VTP Client Mode

When a switch is in VTP client mode, you cannot change its VLAN configuration. The client switch receives VTP updates from a VTP server in the VTP domain and then modifies its configuration accordingly.

Caution Do not configure a VTP domain name if all switches are operating in VTP client mode. If you do so, it is impossible to make changes to the VLAN configuration of that domain. Therefore, make sure you configure at least one switch as the VTP server.

Beginning in privileged EXEC mode, follow these steps to configure the switch for VTP client mode:

	Command	Purpose
Step 1	**vlan database**	Enter VLAN database mode.
Step 2	**vtp client**	Configure the switch for VTP client mode. The default setting is VTP server.
Step 3	**vtp domain** *domain-name*	Configure a VTP administrative-domain name. The name can be from 1 to 32 characters. All switches operating in VTP server or client mode under the same administrative responsibility must be configured with the same domain name.
Step 4	**vtp password** *password-value*	(Optional) Set a password for the VTP domain. The password can be from 8 to 64 characters. If you configure a VTP password, the VTP domain does not function properly if you do not assign the same password to each switch in the domain.
Step 5	**exit**	Update the VLAN database, propagate it throughout the administrative domain, and return to privileged EXEC mode.
Step 6	**show vtp status**	Verify the VTP configuration. In the display, check the VTP Operating Mode field.

Disabling VTP (VTP Transparent Mode)

When you configure the switch for VTP transparent mode, you disable VTP on the switch. The switch then does not send VTP updates and does not act on VTP updates received from other switches. However, a VTP transparent switch does forward received VTP advertisements on all of its trunk links.

Beginning in privileged EXEC mode, follow these steps to configure the switch for VTP transparent mode:

	Command	Purpose
Step 1	**vlan database**	Enter VLAN database mode.
Step 2	**vtp transparent**	Configure the switch for VTP transparent mode. The default setting is VTP server. This step disables VTP on the switch.
Step 3	**exit**	Return to privileged EXEC mode.
Step 4	**show vtp status**	Verify the VTP configuration. In the display, check the VTP Operating Mode field.

Enabling VTP Version 2

VTP version 2 is disabled by default on VTP version 2-capable switches. When you enable VTP version 2 on a switch, every VTP version 2-capable switch in the VTP domain enables version 2.

Caution VTP version 1 and VTP version 2 are not interoperable on switches in the same VTP domain. Every switch in the VTP domain must use the same VTP version. Do not enable VTP version 2 unless every switch in the VTP domain supports version 2.

Note In a Token Ring environment, you must enable VTP version 2 for Token Ring VLAN switching to function properly.

For more information on VTP version configuration guidelines, see the "VTP Version" section on page 8-19.

Beginning in privileged EXEC mode, follow these steps to enable VTP version 2:

	Command	Purpose
Step 1	**vlan database**	Enter VLAN configuration mode.
Step 2	**vtp v2-mode**	Enable VTP version 2 on the switch. VTP version 2 is disabled by default on VTP version 2-capable switches.
Step 3	**exit**	Update the VLAN database, propagate it throughout the administrative domain, and return to privileged EXEC mode.
Step 4	**show vtp status**	Verify that VTP version 2 is enabled. In the display, check the VTP V2 Mode field.

Disabling VTP Version 2

Beginning in privileged EXEC mode, follow these steps to disable VTP version 2:

	Command	Purpose
Step 1	**vlan database**	Enter VLAN configuration mode.
Step 2	**no vtp v2-mode**	Disable VTP version 2.
Step 3	**exit**	Update the VLAN database, propagate it throughout the administrative domain, and return to privileged EXEC mode.
Step 4	**show vtp status**	Verify that VTP version 2 is disabled. In the display, check the VTP V2 Mode field.

Enabling VTP Pruning

Pruning increases available bandwidth by restricting flooded traffic to those trunk links that the traffic must use to access the destination devices. You enable VTP pruning on a switch in VTP server mode.

Pruning is supported with VTP version 1 and version 2. If you enable pruning on the VTP server, it is enabled for the entire VTP domain.

Only VLANs included in the pruning-eligible list can be pruned. By default, VLANs 2 through 1001 are pruning eligible on Catalyst 2900 XL and Catalyst 3500 XL trunk ports. For information, see the "Changing the Pruning-Eligible List" section on page 8-42.

Beginning in privileged EXEC mode, follow these steps to enable VTP pruning:

	Command	Purpose
Step 1	**vlan database**	Enter VLAN configuration mode.
Step 2	**vtp pruning**	Enable pruning in the VTP administrative domain. By default, pruning is disabled. You only need to enable pruning on one switch in VTP server mode.
Step 3	**exit**	Update the VLAN database, propagate it throughout the administrative domain, and return to privileged EXEC mode.
Step 4	**show vtp status**	Verify your entries. In the display, check the VTP Pruning Mode field.

Monitoring VTP

You monitor VTP by displaying its configuration information: the domain name, the current VTP revision, and the number of VLANs. You can also display statistics about the advertisements sent and received by the switch.

Beginning in privileged EXEC mode, follow these steps to monitor VTP activity:

	Command	Purpose
Step 1	**show vtp status**	Display the VTP switch configuration information.
Step 2	**show vtp counters**	Display counters about VTP messages being sent and received.

VLANs in the VTP Database

You can set the following parameters when you add a new VLAN to or modify an existing VLAN in the VTP database:

- VLAN ID
- VLAN name
- VLAN type (Ethernet, Fiber Distributed Data Interface [FDDI], FDDI network entity title [NET], TrBRF or TrCRF, Token Ring, Token Ring-Net)
- VLAN state (active or suspended)
- Maximum transmission unit (MTU) for the VLAN
- Security Association Identifier (SAID)
- Bridge identification number for TrBRF VLANs
- Ring number for FDDI and TrCRF VLANs
- Parent VLAN number for TrCRF VLANs
- STP type for TrCRF VLANs
- VLAN number to use when translating from one VLAN type to another

The "Default VLAN Configuration" section on page 8-28 lists the default values and possible ranges for each VLAN media type.

Token Ring VLANs

Although the Catalyst 2900 XL and Catalyst 3500 XL switches do not support Token Ring connections, a remote device such as a Catalyst 5000 series switch with Token Ring connections could be managed from one of the supported switches. Switches running this IOS release advertise information about the following Token Ring VLANs when running VTP version 2:

- Token Ring TrBRF VLANs
- Token Ring TrCRF VLANs

For more information on configuring Token Ring VLANs, refer to the *Catalyst 5000 Series Software Configuration Guide*.

VLAN Configuration Guidelines

Follow these guidelines when creating and modifying VLANs in your network:

- A maximum of 250 VLANs can be active on supported switches, but some models only support 64 VLANs. If VTP reports that there are 254 active VLANs, 4 of the active VLANs (1002 to 1005) are reserved for Token Ring and FDDI.
- Before you can create a VLAN, the switch must be in VTP server mode or VTP transparent mode. For information on configuring VTP, see the "Configuring VTP" section on page 8-20.
- Switches running this IOS release do not support Token Ring or FDDI media. The switch does not forward FDDI, FDDI-Net, TrCRF, or TrBRF traffic, but it does propagate the VLAN configuration through VTP.

Default VLAN Configuration

Table 8-6 through Table 8-10 shows the default configuration for the different VLAN media types.

Note Catalyst 2900 XL and Catalyst 3500 XL switches support Ethernet interfaces exclusively. Because FDDI and Token Ring VLANs are not locally supported, you configure FDDI and Token Ring media-specific characteristics only for VTP global advertisements to other switches.

Table 8-6 Ethernet VLAN Defaults and Ranges

Parameter	Default	Range
VLAN ID	1	1–1005
VLAN name	VLAN*xxxx*, where *xxxx* is the VLAN ID	No range
802.10 SAID	100000+VLAN ID	1–4294967294
MTU size	1500	1500–18190
Translational bridge 1	0	0–1005
Translational bridge 2	0	0–1005
VLAN state	active	active, suspend

Table 8-7 FDDI VLAN Defaults and Ranges

Parameter	Default	Range
VLAN ID	1002	1–1005
VLAN name	VLAN*xxxx*, where *xxxx* is the VLAN ID	No range
802.10 SAID	100000+VLAN ID	1–4294967294
MTU size	1500	1500–18190
Ring number	None	1–4095
Parent VLAN	0	0–1005
Translational bridge 1	0	0–1005
Translational bridge 2	0	0–1005
VLAN state	active	active, suspend

Table 8-8 FDDI-Net VLAN Defaults and Ranges

Parameter	Default	Range
VLAN ID	1004	1–1005
VLAN name	VLAN*xxxx*, where *xxxx* is the VLAN ID	No range
802.10 SAID	100000+VLAN ID	1–4294967294
MTU size	1500	1500–18190
Bridge number	0	0–15
STP type	ieee	auto, ibm, ieee
Translational bridge 1	0	0–1005
Translational bridge 2	0	0–1005
VLAN state	active	active, suspend

Table 8-9 Token Ring (TrBRF) VLAN Defaults and Ranges

Parameter	Default	Range
VLAN ID	1005	1–1005
VLAN name	VLAN*xxxx*, where *xxxx* is the VLAN ID	No range
802.10 SAID	100000+VLAN ID	1–4294967294
MTU size	VTPv1 1500; VTPv2 4472	1500–18190
Bridge number	VTPv1 0; VTPv2 user-specified	0–15
STP type	ibm	auto, ibm, ieee
Translational bridge 1	0	0–1005
Translational bridge 2	0	0–1005
VLAN state	active	active, suspend

Table 8-10 Token Ring (TrCRF) VLAN Defaults and Ranges

Parameter	Default	Range
VLAN ID	1003	1–1005
VLAN name	VLAN*xxxx*, where *xxxx* is the VLAN ID	No range
802.10 SAID	100000+VLAN ID	1–4294967294
Ring Number	VTPv1 default 0; VTPv2 user-specified	1–4095
Parent VLAN	VTPv1 default 0; VTPv2 user-specified	0–1005
MTU size	VTPv1 default 1500; VTPv2 default 4472	1500–18190
Translational bridge 1	0	0–1005
Translational bridge 2	0	0–1005
VLAN state	active	active, suspend
Bridge mode	srb	srb, srt
ARE max hops	7	0–13
STE max hops	7	0–13
Backup CRF	disabled	disable; enable

Configuring VLANs in the VTP Database

You use the CLI **vlan database** VLAN database command to add, change, and delete VLANs. In VTP server or transparent mode, commands to add, change, and delete VLANs are written to the file vlan.dat, and you can display them by entering the privileged EXEC **show vlan** command. The vlan.dat file is stored in nonvolatile memory. The vlan.dat file is upgraded automatically, but you cannot return to an earlier version of Cisco IOS after you upgrade to this release.

Caution You can cause inconsistency in the VLAN database if you attempt to manually delete the vlan.dat file. If you want to modify the VLAN configuration or VTP, use the VLAN database commands described in the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

You use the interface configuration command mode to define the port membership mode and add and remove ports from VLANs. The results of these commands are written to the running-configuration file, and you can display the file by entering the privileged EXEC **show running-config** command.

Note VLANs can be configured to support a number of parameters that are not discussed in detail in this section. For complete information on the commands and parameters that control VLAN configuration, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

Adding a VLAN

Each VLAN has a unique, 4-digit ID that can be a number from 1 to 1001. To add a VLAN to the VLAN database, assign a number and name to the VLAN. For the list of default parameters that are assigned when you add a VLAN, see the "Default VLAN Configuration" section on page 8-28.

If you do not specify the VLAN media type, the VLAN is an Ethernet VLAN.

Beginning in privileged EXEC mode, follow these steps to add an Ethernet VLAN:

	Command	Purpose
Step 1	**vlan database**	Enter VLAN database mode.
Step 2	**vlan** *vlan-id* **name** *vlan-name*	Add an Ethernet VLAN by assigning a number to it. If no name is entered for the VLAN, the default is to append the *vlan-id* to the word VLAN. For example, VLAN0004 could be a default VLAN name. If you do not specify the VLAN media type, the VLAN is an Ethernet VLAN.
Step 3	**exit**	Update the VLAN database, propagate it throughout the administrative domain, and return to privileged EXEC mode.
Step 4	**show vlan name** *vlan-name*	Verify the VLAN configuration.

Modifying a VLAN

Beginning in privileged EXEC mode, follow these steps to modify an Ethernet VLAN:

	Command	Purpose
Step 1	**vlan database**	Enter VLAN configuration mode.
Step 2	**vlan** *vlan-id* **mtu** *mtu-size*	Identify the VLAN, and change the MTU size.
Step 3	**exit**	Update the VLAN database, propagate it throughout the administrative domain, and return to privileged EXEC mode.
Step 4	**show vlan** *vlan-id*	Verify the VLAN configuration.

Deleting a VLAN from the Database

When you delete a VLAN from a switch that is in VTP server mode, the VLAN is removed from all switches in the VTP domain. When you delete a VLAN from a switch that is in VTP transparent mode, the VLAN is deleted only on that specific switch.

You cannot delete the default VLANs for the different media types: Ethernet VLAN 1 and FDDI or Token Ring VLANs 1002 to 1005.



Caution When you delete a VLAN, any ports assigned to that VLAN become inactive. They remain associated with the VLAN (and thus inactive) until you assign them to a new VLAN.

Beginning in privileged EXEC mode, follow these steps to delete a VLAN on the switch:

	Command	Purpose
Step 1	**vlan database**	Enter VLAN configuration mode.
Step 2	**no vlan** *vlan-id*	Remove the VLAN by using the VLAN ID.
Step 3	**exit**	Update the VLAN database, propagate it throughout the administrative domain, and return to privileged EXEC mode.
Step 4	**show vlan brief**	Verify the VLAN removal.

Assigning Static-Access Ports to a VLAN

By default, all ports are static-access ports assigned to VLAN 1, which is the default management VLAN. If you are assigning a port on a cluster member switch to a VLAN, first log in to the member switch by using the privileged EXEC **rcommand** command. For more information on how to use this command, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

Beginning in privileged EXEC mode, follow these steps to assign a port to a VLAN in the VTP database:

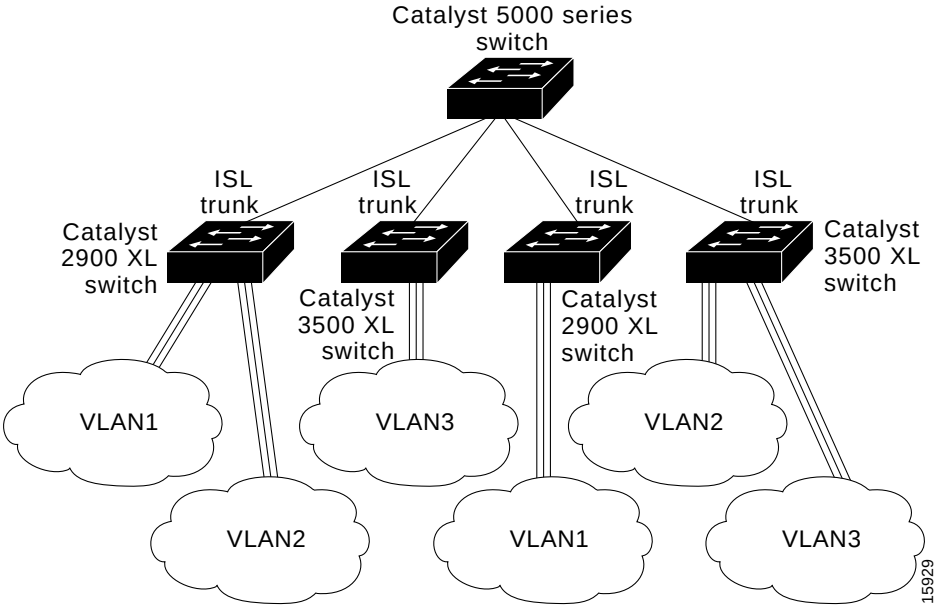
	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode, and define the interface to be added to the VLAN.
Step 3	**switchport mode access**	Define the VLAN membership mode for this port.
Step 4	**switchport access vlan 3**	Assign the port to the VLAN.
Step 5	**exit**	Return to privileged EXEC mode.
Step 6	**show interface** *interface-id* **switchport**	Verify the VLAN configuration. In the display, check the Operation Mode, Access Mode VLAN, and the Priority for Untagged Frames fields.

How VLAN Trunks Work

A trunk is a point-to-point link that transmits and receives traffic between switches or between switches and routers. Trunks carry the traffic of multiple VLANs and can extend VLANs across an entire network. 100BASE-T and Gigabit Ethernet trunks use Cisco Inter-Switch Link (ISL), the default protocol, or industry-standard IEEE 802.1Q to carry traffic for multiple VLANs over a single link.

Figure 8-4 shows a network of switches that are connected by ISL trunks.

Figure 8-4 Catalyst 2900 XL and Catalyst 3500 XL Switches in an ISL Trunking Environment



IEEE 802.1Q Configuration Considerations

IEEE 802.1Q trunks impose some limitations on the trunking strategy for a network. The following restrictions apply when using 802.1Q trunks:

- Make sure the native VLAN for an 802.1Q trunk is the same on both ends of the trunk link. If the native VLAN on one end of the trunk is different from the native VLAN on the other end, spanning-tree loops might result.
- Disabling STP on the native VLAN of an 802.1Q trunk without disabling STP on every VLAN in the network can potentially cause STP loops. We recommend that you leave STP enabled on the native VLAN of an 802.1Q trunk or disable STP on every VLAN in the network. Make sure your network is loop-free before disabling STP.

Trunks Interacting with Other Features

ISL, IEEE 802.1Q, and ATM trunking interacts with other switch features as described in Table 8-11.

Table 8-11 Trunks Interacting with Other Features

Switch Feature	Trunk Port Interaction
Port monitoring	A trunk port cannot be a monitor port. A static-access port can monitor the traffic of its VLAN on a trunk port.
Network port	When configured as a network port, a trunk port serves as the network port for all VLANs associated with the port. A network port receives all unknown unicast traffic on a VLAN.
Secure ports	A trunk port cannot be a secure port.

Table 8-11 Trunks Interacting with Other Features (continued)

Switch Feature	Trunk Port Interaction
Blocking unicast and multicast packets on a trunk	The **port block** interface configuration command can be used to block the forwarding of unknown unicast and multicast packets to VLANs on a trunk. However, if the trunk port is acting as a network port, unknown unicast packets cannot be blocked.
Port grouping	ISL and 802.1Q trunks can be grouped into EtherChannel port groups, but all trunks in the group must have the same configuration. ATM ports are always trunk ports but cannot be part of an EtherChannel port group. When a group is first created, all ports follow the parameters set for the first port to be added to the group. If you change the configuration of one of the following parameters, the switch propagates the setting you entered to all ports in the group: • Allowed-VLAN list. • STP path cost for each VLAN. • STP port priority for each VLAN. • STP Port Fast setting. • Trunk status: if one port in a port group ceases to be a trunk, all ports cease to be trunks.

Configuring a Trunk Port

You cannot have multi-VLAN and trunk ports configured on the same switch. For information on trunk port interactions with other features, see the "Trunks Interacting with Other Features" section on page 8-37.

Note Because trunk ports send and receive VTP advertisements, you must ensure that at least one trunk port is configured on the switch and that this trunk port is connected to the trunk port of a second switch. Otherwise, the switch cannot receive any VTP advertisements.

Beginning in privileged EXEC mode, follow these steps to configure a port as an ISL or 802.1Q trunk port:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface_id*	Enter the interface configuration mode and the port to be configured for trunking.
Step 3	**switchport mode trunk**	Configure the port as a VLAN trunk.
Step 4	**switchport trunk encapsulation** {**isl** | **dot1q**}	Configure the port to support ISL or 802.1Q encapsulation. You must configure each end of the link with the same encapsulation type.
Step 5	**end**	Return to privileged EXEC mode.
Step 6	**show interface** *interface-id* **switchport**	Verify your entries. In the display, check the Operational Mode and the Operational Trunking Encapsulation fields.
Step 7	**copy running-config startup-config**	Save the configuration.



Note This software release does not support trunk negotiation through the Dynamic Trunk Protocol (DTP), formerly known as Dynamic ISL (DISL). If you are connecting a trunk port to a Catalyst 5000 switch or other DTP device, use the non-negotiate option on the DTP-capable device so that the switch port does not generate DTP frames.

Disabling a Trunk Port

You can disable trunking on a port by returning it to its default static-access mode.

Beginning in privileged EXEC mode, follow these steps to disable trunking on a port:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface_id*	Enter the interface configuration mode and the port to be added to the VLAN.
Step 3	**no switchport mode**	Return the port to its default static-access mode.
Step 4	**end**	Return to privileged EXEC.
Step 5	**show interface** *interface-id* **switchport**	Verify your entries. In the display, check the Negotiation of Trunking field.

Defining the Allowed VLANs on a Trunk

By default, a trunk port sends to and receives traffic from all VLANs in the VLAN database. All VLANs, 1 to 1005, are allowed on each trunk. However, you can remove VLANs from the allowed list, preventing traffic from those VLANs from passing over the trunk. To restrict the traffic a trunk carries, use the **remove** *vlan-list* parameter to remove specific VLANs from the allowed list.

A trunk port can become a member of a VLAN if the VLAN is enabled, if VTP knows of the VLAN, and if the VLAN is in the allowed list for the port. When VTP detects a newly enabled VLAN and the VLAN is in the allowed list for a trunk port, the trunk port automatically becomes a member of the enabled VLAN. When VTP detects a new VLAN and the VLAN is not in the allowed list for a trunk port, the trunk port does not become a member of the new VLAN.

Beginning in privileged EXEC mode, follow these steps to modify the allowed list of a ISL or 802.1Q trunk:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface_id*	Enter interface configuration mode and the port to be added to the VLAN.
Step 3	**switchport mode trunk**	Configure VLAN membership mode for trunks.
Step 4	**switchport trunk allowed vlan remove** *vlan-list*	Define the VLANs that are *not* allowed to transmit and receive on the port. The *vlan-list* parameter is a range of VLAN IDs Separate nonconsecutive VLAN IDs with a comma and no spaces; use a hyphen to designate a range of IDs. Valid IDs are from 2 to 1001.
Step 5	**end**	Return to privileged EXEC.
Step 6	**show interface** *interface-id* **switchport allowed-vlan**	Verify your entries.
Step 7	**copy running-config startup-config**	Save the configuration.

Changing the Pruning-Eligible List

The pruning-eligible list applies only to trunk ports. Each trunk port has its own eligibility list. VTP Pruning must be enabled for the following procedure to take effect. The "Enabling VTP Pruning" section on page 8-25 describes how to enable VTP pruning.

Beginning in privileged EXEC mode, follow these steps to remove VLANs from the pruning-eligible list on a trunk port:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Enter interface configuration mode, and select the trunk port for which VLANs should be pruned.
Step 3	**switchport trunk pruning vlan remove** *vlan-id*	Enter the VLANs to be removed from the pruning-eligible list. Separate nonconsecutive VLAN IDs with a comma and no spaces; use a hyphen to designate a range of IDs. Valid IDs are from 2 to 1001. VLANs that are pruning-ineligible receive flooded traffic.
Step 4	**exit**	Return to privileged EXEC mode.
Step 5	**show interface** *interface-id* **switchport**	Verify your settings.

Configuring the Native VLAN for Untagged Traffic

A trunk port configured with 802.1Q tagging can receive both tagged and untagged traffic. By default, the switch forwards untagged traffic with the native VLAN configured for the port. The native VLAN is VLAN 1 by default.

Note The native VLAN can be assigned any VLAN ID, and it is not dependent on the management VLAN.

For information about 802.1Q configuration issues, see the "IEEE 802.1Q Configuration Considerations" section on page 8-37.

Beginning in privileged EXEC mode, follow these steps to configure the native VLAN on an 802.1Q trunk:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Enter interface configuration mode, and define the interface that is configured as the 802.1Q trunk.
Step 3	**switchport trunk native vlan** *vlan-id*	Configure the VLAN that is sending and receiving untagged traffic on the trunk port. Valid IDs are from 1 to 1001.
Step 4	**show interface** *interface-id* **switchport**	Verify your settings.

If a packet has a VLAN ID the same as the outgoing port native VLAN ID, the packet is transmitted untagged; otherwise, the switch transmits the packet with a tag.

Configuring 802.1p Class of Service

The Catalyst 2900 XL and Catalyst 3500 XL switches provide quality of service (QoS)-based IEEE 802.1p class of service (CoS) values. QoS uses classification and scheduling to transmit network traffic from the switch in a predictable manner. QoS classifies frames by assigning priority-indexed CoS values to them and gives preference to higher-priority traffic such as telephone calls.

How Class of Service Works

Before you set up 802.1p CoS on a Catalyst 2900 XL or Catalyst 3500 XL switch that operates with the Catalyst 6000 family of switches, refer to the Catalyst 6000 documentation. There are differences in the 802.1p implementation, and they should be understood to ensure compatibility.

Port Priority

Frames received from users in the administratively-defined VLANs are classified or *tagged* for transmission to other devices. Based on rules you define, a unique identifier (the tag) is inserted in each frame header before it is forwarded. The tag is examined and understood by each device before any broadcasts or transmissions to other switches, routers, or end stations. When the frame reaches the last switch or router, the tag is removed before the frame is transmitted to the target end station. VLANs that are assigned on trunk or access ports without identification or a tag are called *native* or *untagged* frames.

For ISL or IEEE 802.1Q frames with tag information, the priority value from the header frame is used. For native frames, the default priority of the input port is used.

Port Scheduling

Each port on the switch has a single receive queue buffer (the *ingress* port) for incoming traffic. When an untagged frame arrives, it is assigned the value of the port as its port default priority. You assign this value by using the CLI or CMS software. A tagged frame continues to use its assigned CoS value when it passes through the ingress port.

CoS configures each transmit port (the *egress* port) with a normal-priority transmit queue and a high-priority transmit queue, depending on the frame tag or the port information. Frames in the normal-priority queue are forwarded only after frames in the high-priority queue are forwarded.

Table 8-12 shows the two categories of switch transmit queues.

Table 8-12 Transmit Queue Information

Transmit Queue Category[1]	Transmit Queues
Catalyst 2900 XL switches, Catalyst 2900 XL Ethernet modules (802.1p user priority)	Frames with a priority value of 0 through 3 are sent to a normal-priority queue. Frames with a priority value of 4 through 7 are sent to a high-priority queue.
Catalyst 3500 XL switches, Gigabit Ethernet modules (802.1p user priority)	Frames with a priority value of 0 through 3 are sent to a normal-priority queue. Frames with a priority value of 4 through 7 are sent to a high-priority queue.

1. Catalyst 2900 XL switches with 4 MB of DRAM and the WS-X2914-XL and the WS-X2922-XL modules only have one transmit queue and do not support QoS.

Configuring the CoS Port Priorities

Beginning in privileged EXEC mode, follow these steps to set the port priority for untagged (native) Ethernet frames:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter the interface to be configured.
Step 3	**switchport priority default** *default-priority-id*	Set the port priority on the interface. If you assign a priority level from 0 to 3, frames are forwarded to the normal priority queue of the output port. If you assign a priority level from 4 to 7, frames are forwarded to the high-priority queue of the output port.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show interface** *interface-id* **switchport**	Verify your entries. In the display, check the Priority for Untagged Frames field.

Load Sharing Using STP

Load sharing divides the bandwidth supplied by parallel trunks connecting switches. To avoid loops, STP normally blocks all but one parallel link between switches. With load sharing, you divide the traffic between the links according to which VLAN the traffic belongs.

You configure load sharing on trunk ports by using STP port priorities or STP path costs. For load sharing using STP port priorities, both load-sharing links must be connected to the same switch. For load sharing using STP path costs, each load-sharing link can be connected to the same switch or to two different switches.

For more information about STP, see the "Configuring STP" section on page 6-24.

Load Sharing Using STP Port Priorities

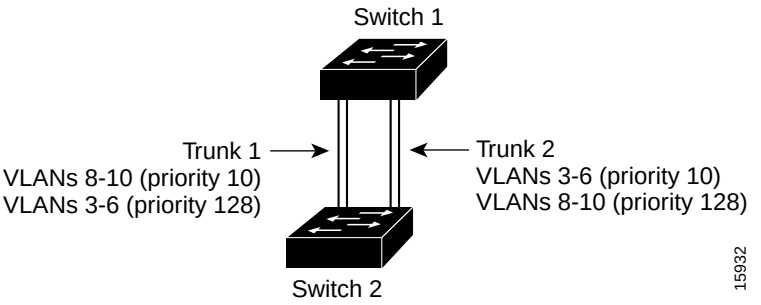
When two ports on the same switch form a loop, the STP port priority setting determines which port is enabled and which port is in standby mode. You can set the priorities on a parallel trunk port so that the port carries all the traffic for a given VLAN. The trunk port with the higher priority (lower values) for a VLAN is forwarding traffic for that VLAN. The trunk port with the lower priority (higher values) for the same VLAN remains in a blocking state for that VLAN. One trunk port transmits or receives all traffic for the VLAN.

Figure 8-5 shows two trunks connecting supported switches. In this example, the switches are configured as follows:

- VLANs 8 through 10 are assigned a port priority of 10 on trunk 1.
- VLANs 3 through 6 retain the default port priority of 128 on trunk 1.
- VLANs 3 through 6 are assigned a port priority of 10 on trunk 2.
- VLANs 8 through 10 retain the default port priority of 128 on trunk 2.

In this way, trunk 1 carries traffic for VLANs 8 through 10, and trunk 2 carries traffic for VLANs 3 through 6. If the active trunk fails, the trunk with the lower priority takes over and carries the traffic for all of the VLANs. No duplication of traffic occurs over any trunk port.

Figure 8-5 Load Sharing by Using STP Port Priorities



Configuring STP Port Priorities and Load Sharing

Beginning in privileged EXEC mode, follow these steps to configure the network shown in Figure 8-5:

	Command	Purpose
Step 1	**vlan database**	On Switch 1, enter VLAN configuration mode.
Step 2	**vtp domain** *domain-name*	Configure a VTP administrative domain. The domain name can be from 1 to 32 characters.
Step 3	**vtp server**	Configure Switch 1 as the VTP server.
Step 4	**exit**	Return to privileged EXEC mode.
Step 5	**show vtp status**	Verify the VTP configuration on both Switch 1 and Switch 2. In the display, check the VTP Operating Mode and the VTP Domain Name fields.
Step 6	**show vlan**	Verify that the VLANs exist in the database on Switch 1.
Step 7	**configure terminal**	Enter global configuration mode.
Step 8	**interface fa0/1**	Enter interface configuration mode, and define Fa0/1 as the interface to be configured as a trunk.
Step 9	**switchport mode trunk**	Configure the port as a trunk port. The trunk defaults to ISL trunking.
Step 10	**end**	Return to privileged EXEC mode.
Step 11	**show interface fa0/1 switchport**	Verify the VLAN configuration.
Step 12		Repeat Steps 7 through 11 on Switch 1 for interface Fa0/2.
Step 13		Repeat Steps 7 through 11 on Switch 2 to configure the trunk ports on interface Fa0/1 and Fa0/2.
Step 14	**show vlan**	When the trunk links come up, VTP passes the VTP and VLAN information to Switch 2. Verify the Switch 2 has learned the VLAN configuration.
Step 15	**configure terminal**	Enter global configuration mode on Switch 1.

	Command	Purpose
Step 16	**interface fa0/1**	Enter interface configuration mode, and define the interface to set the STP port priority.
Step 17	**spanning-tree vlan 8 9 10 port-priority 10**	Assign the port priority of 10 for VLANs 8, 9, and 10.
Step 18	**end**	Return to global configuration mode.
Step 19	**interface fa0/2**	Enter interface configuration mode, and define the interface to set the STP port priority.
Step 20	**spanning-tree vlan 3 4 5 6 port priority 10**	Assign the port priority of 10 for VLANs 3, 4, 5, and 6.
Step 21	**exit**	Return to privileged EXEC mode.
Step 22	**show running-config**	Verify your entries.

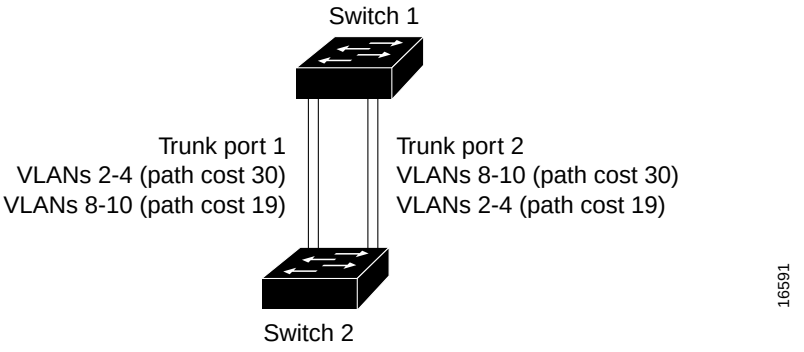
Load Sharing Using STP Path Cost

You can configure parallel trunks to share VLAN traffic by setting different path costs on a trunk and associating the path costs with different sets of VLANs. The VLANs keep the traffic separate; because no loops exist, STP does not disable the ports; and redundancy is maintained in the event of a lost link.

In Figure 8-6, trunk ports 1 and 2 are 100BASE-T ports. The path costs for the VLANs are assigned as follows:

- VLANs 2 through 4 are assigned a path cost of 30 on trunk port 1.
- VLANs 8 through 10 retain the default 100BASE-T path cost on trunk port 1 of 19.
- VLANs 8 through 10 are assigned a path cost of 30 on trunk port 2.
- VLANs 2 through 4 retain the default 100BASE-T path cost on trunk port 2 of 19.

Figure 8-6 Load-Sharing Trunks with Traffic Distributed by Path Cost



Beginning in privileged EXEC mode, follow these steps to configure the network shown in Figure 8-6:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode on Switch 1.
Step 2	**interface fa0/1**	Enter interface configuration mode, and define Fa0/1 as the interface to be configured as a trunk.
Step 3	**switchport mode trunk**	Configure the port as a trunk port. The trunk defaults to ISL trunking.
Step 4	**end**	Return to global configuration mode.
Step 5		Repeat Steps 2 through 4 on Switch 1 interface Fa0/2.
Step 6	**show running-config**	Verify your entries. In the display, make sure that interface Fa0/1 and Fa0/2 are configured as trunk ports.
Step 7	**show vlan**	When the trunk links come up, Switch 1 receives the VTP information from the other switches. Verify that Switch 1 has learned the VLAN configuration.
Step 8	**configure terminal**	Enter global configuration mode.
Step 9	**interface fa0/1**	Enter interface configuration mode, and define Fa0/1 as the interface to set the STP cost.
Step 10	**spanning-tree vlan 2 3 4 cost 30**	Set the spanning-tree path cost to 30 for VLANs 2, 3, and 4.
Step 11	**end**	Return to global configuration mode.
Step 12		Repeat Steps 9 through 11 on Switch 1 interface Fa0/2, and set the spanning-tree path cost to 30 for VLANs 8, 9, and 10.
Step 13	**exit**	Return to privileged EXEC mode.
Step 14	**show running-config**	Verify your entries. In the display, verify that the path costs are set correctly for interface Fa0/1 and Fa0/2.

How the VMPS Works

A switch running this software release acts as a client to the VLAN Membership Policy Server (VMPS) and communicates with it through the VLAN Query Protocol (VQP). When the VMPS receives a VQP request from a client switch, it searches its database for a MAC-address-to-VLAN mapping. The server response is based on this mapping and whether or not the server is in secure mode. Secure mode determines whether the server shuts down the port when a VLAN is not allowed on it or just denies the port access to the VLAN.

In response to a request, the VMPS takes one of the following actions:

- If the assigned VLAN is restricted to a group of ports, the VMPS verifies the requesting port against this group and responds as follows:
  - If the VLAN is allowed on the port, the VMPS sends the VLAN name to the client in response.
  - If the VLAN is not allowed on the port, and the VMPS is not in secure mode, the VMPS sends an *access-denied* response.
  - If the VLAN is not allowed on the port, and the VMPS is in secure mode, the VMPS sends *a port-shutdown* response.
- If the VLAN in the database does not match the current VLAN on the port and active hosts exist on the port, the VMPS sends an *access-denied* or a *port-shutdown* response, depending on the secure mode of the VMPS.

If the switch receives an *access-denied* response from the VMPS, it continues to block traffic from the MAC address to or from the port. The switch continues to monitor the packets directed to the port and sends a query to the VMPS when it identifies a new address. If the switch receives a *port-shutdown* response from the VMPS, it disables the port. The port must be manually reenabled by using the CLI, Cluster Management software, or SNMP.

You can also use an explicit entry in the configuration table to deny access to specific MAC addresses for security reasons. If you enter the **none** keyword for the VLAN name, the VMPS sends an *access-denied* or *port-shutdown* response.

Dynamic Port VLAN Membership

A dynamic (nontrunking) port on the switch can belong to only one VLAN. When the link comes up, the switch does not forward traffic to or from this port until the VMPS provides the VLAN assignment. The VMPS receives the source MAC address from the first packet of a new host connected to the dynamic port and attempts to match the MAC address to a VLAN in the VMPS database.

If there is a match, the VMPS sends the VLAN number for that port. If the client switch was not previously configured, it uses the domain name from the first VTP packet it receives on its trunk port from the VMPS. If the client switch was previously configured, it includes its domain name in the query packet to the VMPS to obtain its VLAN number. The VMPS verifies that the domain name in the packet matches its own domain name before accepting the request and responds to the client with the assigned VLAN number for the client.

If there is no match, the VMPS either denies the request or shuts down the port (depending on the VMPS secure mode setting). For more information on possible VMPS responses, see the "How the VMPS Works" section on page 8-52.

Multiple hosts (MAC addresses) can be active on a dynamic port if they are all in the same VLAN; however, the VMPS shuts down a dynamic port if more than 20 hosts are active on the port.

If the link goes down on a dynamic port, the port returns to an isolated state and does not belong to a VLAN. Any hosts that come online through the port are checked again with the VMPS before the port is assigned to a VLAN.

VMPS Database Configuration File

The VMPS contains a database configuration file that you create. This ASCII text file is stored on a switch-accessible TFTP server that functions as a VMPS server. The file contains VMPS information, such as the domain name, the fall-back VLAN name, and the MAC address-to-VLAN mapping. A Catalyst 2900 XL or Catalyst 3500 XL switch running this software release cannot act as the VMPS. Use a Catalyst 5000 series switch as the VMPS.

The VMPS database configuration file on the server must use the Catalyst 2900 XL and Catalyst 3500 XL convention for naming ports. For example, Fa0/5 is fixed-port number 5.

If the switch is a cluster member, the command switch adds the name of the switch before the Fa. For example, es3%Fa02 refers to fixed 10/100 port 2 on member switch 3. These naming conventions must be used in the VMPS database configuration file when it is configured to support a cluster.

You can configure a fallback VLAN name. If you connect a device with a MAC address that is not in the database, the VMPS sends the fallback VLAN name to the client. If you do not configure a fallback VLAN and the MAC address does not exist in the database, the VMPS sends an *access-denied* response. If the VMPS is in secure mode, it sends a *port-shutdown* response.

The following example shows a sample VMPS database configuration file as it appears on a Catalyst 5000 series switch.

```
!vmps domain <domain-name>
! The VMPS domain must be defined.
!vmps mode { open | secure }
! The default mode is open.
!vmps fallback <vlan-name>
!vmps no-domain-req { allow | deny }
!
! The default value is allow.
vmps domain WBU
vmps mode open
vmps fallback default
vmps no-domain-req deny
!
!
!MAC Addresses
!
vmps-mac-addrs
!
```

```
! address <addr> vlan-name <vlan_name>
!
address 0012.2233.4455 vlan-name hardware
address 0000.6509.a080 vlan-name hardware
address aabb.ccdd.eeff vlan-name Green
address 1223.5678.9abc vlan-name ExecStaff
address fedc.ba98.7654 vlan-name --NONE--
address fedc.ba23.1245 vlan-name Purple
!
!Port Groups
!
!vmps-port-group <group-name>
! device <device-id> { port <port-name> | all-ports }
!
vmps-port-group WiringCloset1
 device 192.168.1.1 port Fa1/3
 device 172.16.1.1 port Fa1/4
vmps-port-group “Executive Row”
 device 192.168.2.2 port es5%Fa0/1
 device 192.168.2.2 port es5%Fa0/2
 device 192.168.2.3 all-ports
!
!VLAN groups
!
!vmps-vlan-group <group-name>
! vlan-name <vlan-name>
!
vmps-vlan-group Engineering
vlan-name hardware
vlan-name software
!
!VLAN port Policies
!
!vmps-port-policies {vlan-name <vlan_name> | vlan-group <group-name> }
! { port-group <group-name> | device <device-id> port <port-name> }
!
vmps-port-policies vlan-group Engineering
 port-group WiringCloset1
vmps-port-policies vlan-name Green
 device 192.168.1.1 port Fa0/9
vmps-port-policies vlan-name Purple
 device 192.168.2.2 port Fa0/10
 port-group “Executive Row”
```

VMPS Configuration Guidelines

The following guidelines and restrictions apply to dynamic port VLAN membership:

- You must configure the VMPS before you configure ports as dynamic.
- The communication between a cluster of switches and VMPS is managed by the command switch and includes port-naming conventions that are different from standard port names. For the cluster-based port-naming conventions, see the "VMPS Database Configuration File" section on page 8-54.
- When you configure a port as dynamic, the spanning-tree Port Fast feature is automatically enabled for that port. The Port Fast mode accelerates the process of bringing the port into the forwarding state. You can disable Port Fast mode on a dynamic port.
- Secure ports cannot be dynamic ports. You must disable port security on the port before it becomes dynamic.
- Trunk ports cannot be dynamic ports, but it is possible to enter the **switchport access vlan dynamic** interface configuration command for a trunk port. In this case, the switch retains the setting and applies it if the port is later configured as an access port.

  You must turn off trunking on the port before the dynamic access setting takes effect.
- Dynamic ports cannot be network ports or monitor ports.
- The VTP management domain of the VMPS client and the VMPS server must be the same.

Default VMPS Configuration

Table 8-13 shows the default VMPS and dynamic port configuration on client switches.

Table 8-13 Default VMPS Client and Dynamic Port Configuration

Feature	Default Configuration
VMPS domain server	None
VMPS reconfirm interval	60 minutes
VMPS server retry count	3
Dynamic ports	None configured

Configuring Dynamic VLAN Membership

You must enter the IP address of the Catalyst 5000 switch or the other device acting as the VMPS to configure the Catalyst 2900 XL or Catalyst 3500 XL switch as a client. If the VMPS is being defined for a cluster of switches, enter the address on the command switch.

Beginning in privileged EXEC mode, follow these steps to enter the IP address of the VMPS:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**vmps server** *ipaddress* **primary**	Enter the IP address of the switch acting as the primary VMPS server.
Step 3	**vmps server** *ipaddress*	Enter the IP address for the switch acting as a secondary VMPS server. You can enter up to three secondary server addresses.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show vmps**	Verify the VMPS server entry. In the display, check the VMPS Domain Server field.

Configuring Dynamic Ports on VMPS Clients

If you are configuring a port on a member switch as a dynamic port, first log into the member switch by using the privileged EXEC **rcommand** command. For more information on how to use this command, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

Caution Dynamic port VLAN membership is for end stations. Connecting dynamic ports to other switches can cause a loss of connectivity.

Beginning in privileged EXEC mode, follow these steps to configure a dynamic port on the VMPS client switches:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface*	Enter interface configuration mode and the switch port that is connected to the end station.
Step 3	**switchport mode access**	Set the port to access mode.
Step 4	**switchport access vlan dynamic**	Configure the port as eligible for dynamic VLAN membership. The dynamic-access port must be connected to an end station.
Step 5	**end**	Return to privileged EXEC mode.
Step 6	**show interface** *interface* **switchport**	Verify the entry. In the display, check the Operational Mode field.

The switch port that is connected to the VMPS server should be configured as a trunk. For more information, see the "Configuring a Trunk Port" section on page 8-38.

Reconfirming VLAN Memberships

Beginning in privileged EXEC mode, follow these steps to confirm the dynamic port VLAN membership assignments that the switch has received from the VMPS:

	Command	Purpose
Step 1	**vmps reconfirm**	Reconfirm dynamic port VLAN membership.
Step 2	**show vmps**	Verify the dynamic VLAN reconfirmation status.

Changing the Reconfirmation Interval

VMPS clients periodically reconfirm the VLAN membership information received from the VMPS. You can set the number of minutes after which reconfirmation occurs.

If you are configuring a member switch in a cluster, this parameter must be equal to or greater than the reconfirmation setting on the command switch. In addition, you must first log into the member switch by using the privileged EXEC **rcommand** command. For more information about this command, refer to the *Catalyst 2900 Series XL and Catalyst 3500 Series XL Command Reference*.

Beginning in privileged EXEC mode, follow these steps to change the reconfirmation interval:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**vmps reconfirm** *minutes*	Enter the number of minutes between reconfirmations of the dynamic VLAN membership. Enter a number from 1 to 120. The default is 60 minutes.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show vmps**	Verify the dynamic VLAN reconfirmation status. In the display, check the Reconfirm Interval field.

Changing the Retry Count

Beginning in privileged EXEC mode, follow these steps to change the number of times that the switch attempts to contact the VMPS before querying the next server:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**vmps retry** *count*	Change the retry count. The retry range is from 1 to 10; the default is 3.
Step 3	**exit**	Return to privileged EXEC mode.
Step 4	**show vmps**	Verify your entry. In the display, check the Server Retry Count field.

Administering and Monitoring the VMPS

You can display information about the VMPS by using the privileged EXEC **show vmps** command. The switch displays the following information about the VMPS:

VMPS VQP Version	The version of VQP used to communicate with the VMPS. The switch queries the VMPS using version 1 of VQP.
Reconfirm Interval	The number of minutes the switch waits before reconfirming the VLAN-to-MAC-address assignments.
Server Retry Count	The number of times VQP resends a query to the VMPS. If no response is received after this many tries, the switch starts to query the secondary VMPS.
VMPS domain server	The IP address of the configured VLAN membership policy servers. The switch sends queries to the one marked *current*. The one marked *primary* is the primary server.
VMPS Action	The result of the most recent reconfirmation attempt. This can happen automatically when the reconfirmation interval expired, or you can force it by entering the privileged EXEC **vmps reconfirm** command or its Cluster Management software or SNMP equivalent.

Troubleshooting Dynamic Port VLAN Membership

The VMPS shuts down a dynamic port under these conditions:

- The VMPS is in secure mode, and it will not allow the host to connect to the port. The VMPS shuts down the port to prevent the host from connecting to the network.
- More than 20 active hosts reside on a dynamic port.

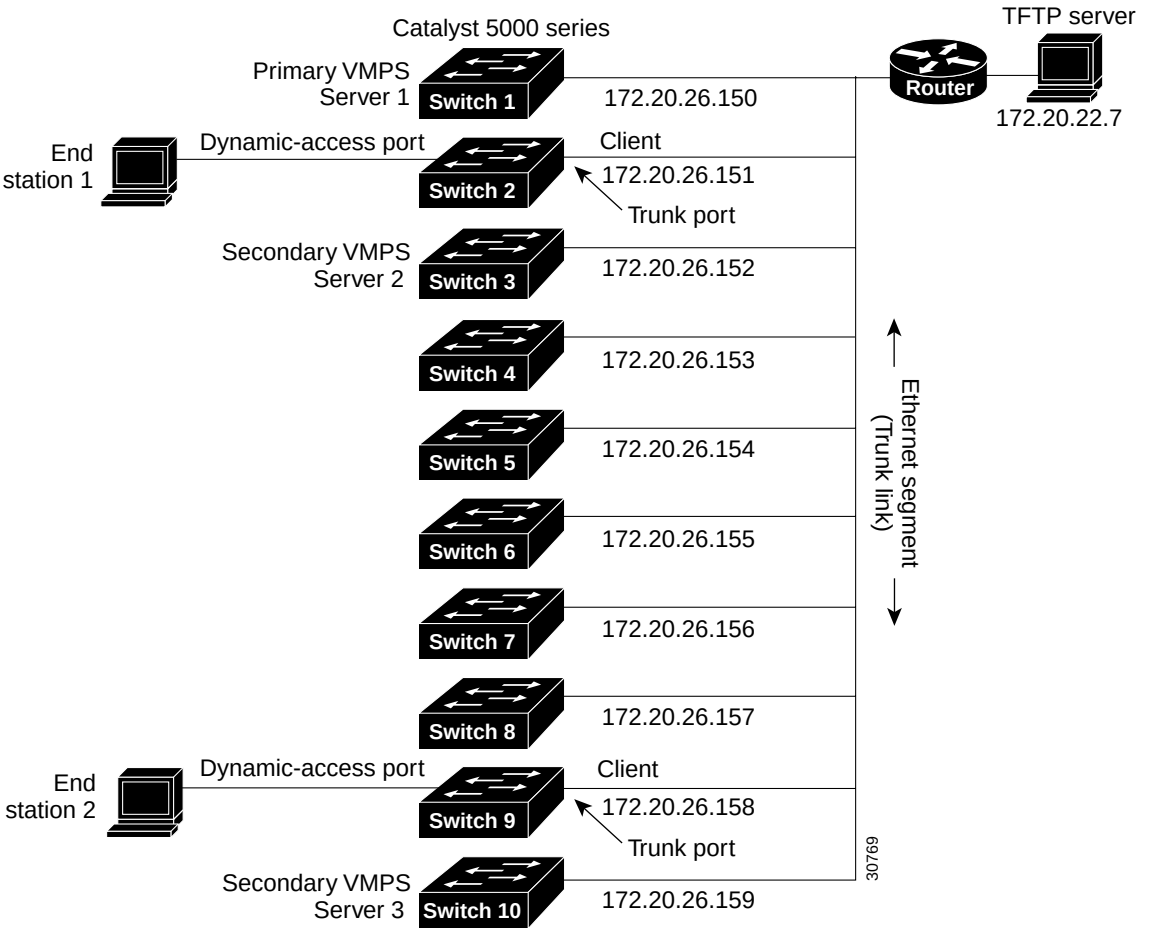
To reenable a shut-down dynamic port, enter the interface configuration **no shutdown** command.

Dynamic Port VLAN Membership Configuration Example

Figure 8-7 shows a network with a VMPS server switch and VMPS client switches with dynamic ports. In this example, these assumptions apply:

- The VMPS server and the VMPS client are separate switches.
- The Catalyst 5000 series Switch 1 is the primary VMPS server.
- The Catalyst 5000 series Switch 3 and Switch 10 are secondary VMPS servers.
- End stations are connected to these clients:
  - Catalyst 2900 XL Switch 2
  - Catalyst 3500 XL Switch 9
- The database configuration file is called Bldg-G.db and is stored on the TFTP server with the IP address 172.20.22.7.

Figure 8-7 Dynamic Port VLAN Membership Configuration





CHAPTER 9

Troubleshooting

This chapter provides the following information about avoiding and resolving problems related to the switch software.

- Avoiding configuration conflicts
- Avoiding autonegotiation mismatches
- Copying configuration files to troubleshooting configuration problems
- Troubleshooting the Long-Reach Ethernet port configuration
- Troubleshooting Cluster Management Suite (CMS) sessions
- Troubleshooting switch upgrades
- Recovering from corrupted software
- Recovering from a lost or forgotten password

For additional troubleshooting information, refer to the switch hardware installation guide.

Avoiding Configuration Conflicts

Certain combinations of port features conflict with one another. For example, if you define a port as the network port for a VLAN, all unknown unicast and multicast traffic is flooded to the port. You could not enable port security on the network port because a secure port limits the traffic allowed on it.

In Table 9-1, *no* means that the two features are incompatible and that both should not be enabled; *yes* means that both can be enabled at the same time and will not cause an incompatibility conflict.

If you try to enable incompatible features by using CMS, CMS issues a warning message that you are configuring a setting that is incompatible with another setting, and the switch does not save the change.

Table 9-1 Conflicting Features

	ATM Port[1]	Port Group	Port Security	SPAN Port	Multi-VLAN Port	Network Port	Connect to Cluster?	Protected Port
ATM Port	N/A	No	No	No	No	No	Yes	No
Port Group	No	–	No	No	Yes	Yes[2]	Yes	Yes
Port Security	No	No	–	No	No	No	Yes	Yes
SPAN Port	No[3]	No	No	–	No	No	Yes	Yes
Multi-VLAN Port	No	Yes	No	No	–	Yes	Yes	Yes
Network Port	No	Yes (source-based only)	No	No	Yes	–	No[4]	Yes
Connect to Cluster	Yes	Yes	Yes	Yes	Yes	No	–	Yes
Protected Port	No	Yes	Yes	Yes[5]	Yes	No	Yes	–

1. Catalyst 2900 XL switches only.
2. Cannot be in a destination-based port group.
3. An Asynchronous Transfer Mode (ATM) port cannot be a monitor port but can be monitored.
4. Cannot connect cluster members to the command switch.
5. Switch Port Analyzer (SPAN) can operate only if the monitor port or the port being monitored is not a protected port.

Avoiding Autonegotiation Mismatches

The IEEE 802.3u autonegotiation protocol manages the switch settings for speed (10 Mbps or 100 Mbps) and duplex (half or full). Sometimes this protocol can incorrectly align these settings, reducing performance. A mismatch occurs under these circumstances:

- A manually set speed or duplex parameter is different from the manually set speed or duplex parameter on the connected port.
- A port is set to autonegotiate, and the connected port is set to full duplex with no autonegotiation.

To maximize switch performance and ensure a link, follow one of these guidelines when changing the settings for duplex and speed:

- Let both ports autonegotiate both speed and duplex.
- Manually set the speed and duplex parameters for the ports on both ends of the connection.



Note If a remote Fast Ethernet device does not autonegotiate, configure the duplex settings on the two ports to match. The speed parameter can adjust itself even if the connected port does not autonegotiate. To connect to a remote Gigabit Ethernet device that does not autonegotiate, disable autonegotiation on the local device, and set the duplex and flow control parameters to be compatible with the remote device.

Troubleshooting LRE Port Configuration

Table 9-2 lists problems you might encounter when configuring and monitoring the Long-Reach Ethernet (LRE) ports on the Catalyst 2900 LRE XL switches.

Table 9-2 LRE Port Problems

Problem	Suggested Solution
LRE port LED is amber	The switch and CPE are unable to establish a LRE link using the selected profile. Change to a profile using a lower quadrature amplitude modulation (QAM) rate. Reduce the effect of stubs or bridge taps by terminating them with 300-Ohm microfilters.
Excessive CRC errors on a LRE link	• A noisy environment (such as motors and power surges) is causing interference with the LRE link. Ensure that the interleaver is set to maximum protection (the interleaver trades latency for noise immunity). Change to a profile using a lower QAM rate, which increases the noise margin. • The LRE link length and quality are close to the limit of operation. Change to a profile using a lower QAM rate. Reduce the effect of stubs or bridge taps by terminating them with 300-Ohm microfilters.
High Reed-Solomon error count without CRC errors	• Interleaver is helping Reed-Solomon error correction to function correctly in a noisy environment. This situation means that the system is on the verge of generating CRC errors. Ensure that the interleaver is set to maximum protection (the interleaver trades latency for noise immunity). Change to a profile using a lower QAM rate, which increases the noise margin. • The LRE link length and quality are close to the limit of operation. Change to a profile using a lower QAM rate. Reduce the effect of stubs or bridge taps by terminating them with 300-Ohm microfilters.
Ethernet performance degradation due to excessive network latency	Interleaver introduces extra latency to increase noise margin. Reduce the interleaver setting while ensuring the noise margin is adequate. If necessary, change to a profile using a lower QAM rate.
LRE link quality reduced in installations with bundled cables	Cross-talk between the LRE links is causing all links to degrade. Disable unused LRE ports by using the **lre shutdown** interface configuration command.

Troubleshooting CMS Sessions

Table 9-3 lists problems commonly encountered when using CMS:

Table 9-3 Common CMS Session Problems

Problem	Suggested Solution
A blank screen appears when you click **Cluster Management Suite or Visual Switch Manager** from the Cisco Systems Access page.	A missing browser Java plug-in or incorrect settings could cause this problem. • CMS requires a Java plug-in to function correctly. For instructions on downloading and installing the plug-in, refer to the release notes. **Note** If your PC is connected to the Internet when you attempt to access CMS, the browser notifies you that the Java plug-in is required if the plug-in is not installed. This notification does not occur if your PC is directly connected to the switch and has no internet connection. • If the plug-in is installed but the Java applet does not initialize, do the following: – Select **Start > Programs > Java Plug-in Control Panel**. In the **Proxies** tab, verify that **Use browser settings** is checked and that no proxies are enabled. – Make sure that the HTTP port number is 80. CMS only works with port 80, which is the default HTTP port number. – Make sure the port that connects the PC to the switch belongs to the same VLAN as the management VLAN. For more information about management VLANs, see the "Management VLANs" section on page 8-4.
The **Applet notinited** message appears at the bottom of the browser window.	You might not have enough disk space. Each time you start CMS, the Java plug-in saves a copy of all the jar files to the disk. Delete the jar files from the location where the browser keeps the temporary files on your computer. Refer to the release notes for the required Java plug-ins.

Table 9-3 Common CMS Session Problems (continued)

Problem	Suggested Solution
In an Internet Explorer browser session, you receive a message stating that the CMS page might not display correctly because your security settings prohibit running ActiveX controls.	A high security level prohibits ActiveX controls, which Internet Explorer uses to launch the Java plug-in, from running. 1. Start Internet Explorer. 2. From the menu bar, select **Tools** > **Internet Options**. 3. Click the **Security** tab. 4. Click the indicated **Zone**. 5. Move the **Security Level for this Zone** slider from **High** to **Medium** (the default). 6. Click **Custom Level** and verify that the four ActiveX settings are set to **prompt** or **enabled**.
Configuration changes are not always reflected in an Internet Explorer 5.0 browser session.	Microsoft Internet Explorer 5.0 does not automatically reflect the latest configuration changes. Make sure you click the browser **Refresh** button for every configuration change.
Link graphs do not display information in an Internet Explorer 5.0 browser. (For switches running software earlier than Cisco IOS Release 12.0(5)WC(1).)	Your browser security settings could be incorrect. If your browser security settings are correct, the lower right corner of your browser screen should have a green circle with a checkmark. If it does not, follow these steps: 1. Start Internet Explorer. 2. From the menu bar, select **Tools** > **Internet Options**. 3. From the Internet Options window, click **Advanced**. 4. Select the **Java logging enabled** and **JIT compiler for virtual machine enabled** check boxes, and click **Apply**. 5. In the Internet Options window, click **General**. 6. In the Temporary Internet Files section, click **Settings**, click **Every visit to the page**, and click **OK**. 7. In the Internet Options window, click **Security**, click **Trusted Sites**, and click **Sites**. 8. Deselect **Require server verification**.

Table 9-3 Common CMS Session Problems (continued)

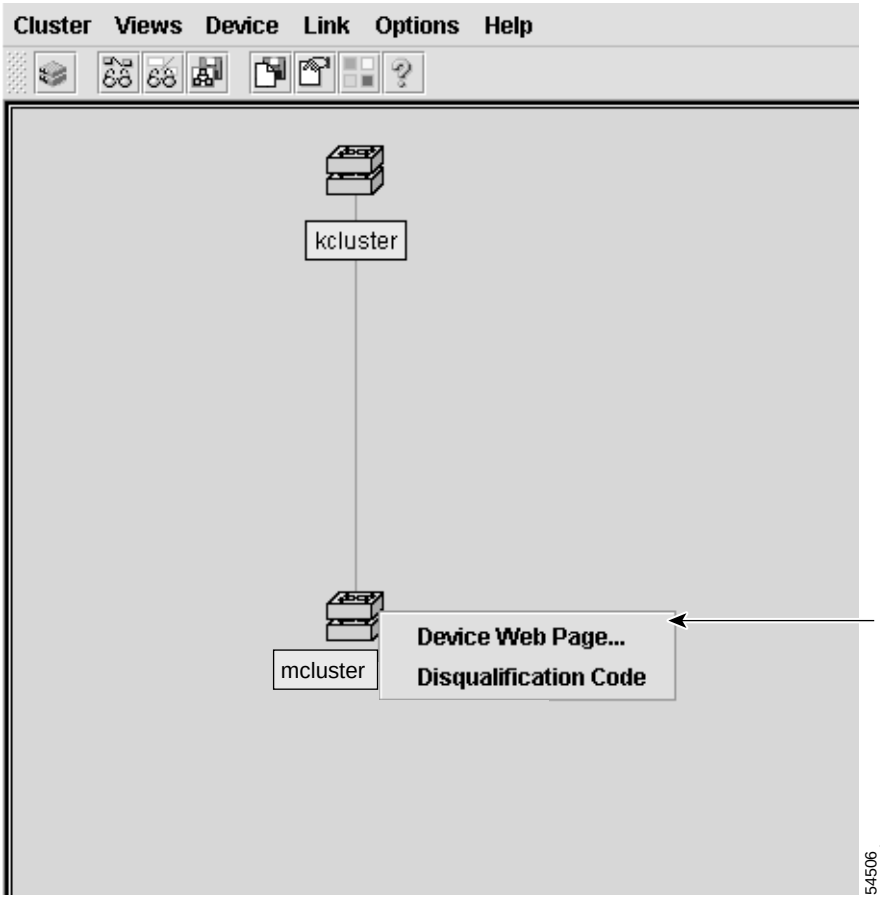
Problem	Suggested Solution
	9. Add the switches you want to manage by entering their URLs in the **Add this web site to the zone** field. Click **Add** to add each switch. A URL is the switch IP address preceded by http://. For example, you might enter: `http://172.20.153.36` 10. After you have finished entering the URLs for your switches, click **OK**. 11. While still in the **Security** tab of the Internet Options window, click **Custom Level**. 12. In the Security Settings window, select **Java > Java permissions**. If you do not see **Java > Java permissions**, you need to reinstall the browser. When you reinstall this browser, make sure to select the **Install Minimal or Customize Your Browser** check box. Then, from the Component Options window in the Internet Explorer 5 section, make sure to click the **Microsoft Virtual Machine** check box to display applets written in Java. 13. Click **Custom**, and click **Java Custom Settings**. 14. In the Trusted Sites window, click **Edit Permissions**. 15. Under **Run Unsigned Content**, click **Enable**, and click **OK**. 16. In the Security Settings window, click **OK**. 17. In the Internet Options window, click **OK**.

For further debugging information, you can use the Java plug-in console to display the current status and actions of CMS. To display the console, select **Start > Programs > Java Plug-in Control Panel**, and select **Java Console**.

Determining Why a Switch Is Not Added to a Cluster

If a switch does not become part of the cluster, you can learn why by selecting **Views > Toggle View** from the menu bar in Cluster Builder. Cluster View displays the cluster as a double-switch icon and shows connections to devices outside the cluster (Figure 9-1). Right-click the device (yellow label), and select **Disqualification Code**.

Figure 9-1 Cluster View



Right-click a device with a yellow label to display the device pop-up menu, and select **Disqualification Code** to display the reason it could not join the cluster.

Copying Configuration Files to Troubleshoot Configuration Problems

You can use the file system in Flash memory to copy files and to troubleshoot configuration problems. This could be useful if you wanted to save configuration files on an external server in case a switch fails. You can then copy the configuration file to a replacement switch and avoid having to reconfigure the switch.

Step 1 Enter the privileged EXEC **dir flash:** command to display the contents of Flash memory:

```
switch# dir flash:
Directory of flash:

  2  -rwx      843947   Mar 01 1993 00:02:18  C2900XL-h-mz-112.8-SA
  4  drwx        3776   Mar 01 1993 01:23:24  html
 66  -rwx         130   Jan 01 1970 00:01:19  env_vars
 68  -rwx        1296   Mar 01 1993 06:55:51  config.text

1728000 bytes total (456704 bytes free)
```

The file system uses a URL-based file specification. The following example uses the TFTP protocol to copy the file config.text from the host *arno* to the switch Flash memory:

```
switch# copy tftp://arno//2900/config.text flash:config.text
```

You can enter the following parameters as part of a filename:

- TFTP
- Flash
- RCP
- XMODEM

Step 2 Enter the **copy running-config startup-config** privileged EXEC command to save your configuration changes to Flash memory so that they are not lost if there is a system reload or power outage. This example shows how to use this command to save your changes:

```
switch# copy running-config startup-config
Building configuration...
```

It might take a minute or two to save the configuration to Flash memory. After it has been saved, the following message appears:

```
[OK]
switch#
```

Troubleshooting Switch Upgrades

Table 9-4 lists problems commonly encountered when upgrading the switch:

Table 9-4 Problems Encountered When Upgrading the Switch

Problem	Suggested Solution
Getting "Address Range" error message and boot up is failing.	This error message appears when a 4-MB Catalyst 2900 XL switch is upgraded to an image that is not supported on this hardware. The switch in this case tries to load the image, but because this switch is not capable of loading this image, the bootup process fails. This also happens in cases when a 4-MB Catalyst 2900 XL switch is upgraded to an IOS 12.0 image. Download the IOS Image File by using X-Modem.
Getting "No Such File or Directory" error message during bootup.	This error message appears when the names of the bootable file and the actual file in the Flash differ. This usually happens due to a mistyped file name when setting the boot parameters, during or after the upgrade. Go to Setting BOOT Parameters at ROMMON (Switch: Prompt) to verify and set the BOOT parameters correctly. If setting the BOOT parameters to the correct file name does not resolve the issue, perform an X-Modem upgrade, as the file present on the Flash memory could be corrupted or invalid.

Table 9-4 Problems Encountered When Upgrading the Switch (continued)

Problem	Suggested Solution
Getting "Permission Denied" error message during the bootup.	This error message appears when the boot parameters are not set correctly. In most of the cases, when setting the boot parameters during or after the upgrade, the word flash: is mistyped or completely missed. Go to Setting BOOT Parameters at ROMMON (Switch: Prompt) to verify and set the BOOT parameters correctly. If setting the BOOT parameters to the correct file name does not resolve the issue, perform an X-Modem upgrade, as the file present on the Flash memory could be corrupted or invalid.
Getting "Error Loading Flash" error messages.	The error loading Flash message means that there is a problem loading the current image in Flash memory. The image could be corrupt or incorrect, or the image in Flash memory could be missing. If the system is unable to load a software image in Flash memory, the system will load the boot helper and bring up a switch prompt. 1. Enter the **dir flash:** command to verify if there is any bootable image on the Flash. The file with .bin extension is the bootable image on the Flash. If you see a bootable image on the Flash, continue to Step 2. If you do not see any bootable image in the Flash, download the IOS Image File by using X-Modem. 2. Enter the **set BOOT flash:** *name of IOS file* command to set the boot variable to the file name displayed in Step 1. **Note** BOOT must be capitalized and make sure to include flash: before the file name. 3. Enter the **boot** command. **Note** If the switch boots properly, enter the **setting boot parameters** global configuration command to verify and set the BOOT parameters (if needed), and proceed to Step 4. If the switch fails to boot properly, download the IOS Image File using X-Modem. 4. After setting the BOOT parameters, reload the switch by entering the **reload** privileged EXEC command. The switch boots up automatically with the correct image.

Table 9-4 Problems Encountered When Upgrading the Switch (continued)

Problem	Suggested Solution
Failed software upgrade; switch is resetting continuously.	This might be due to a corrupt or incorrect image, or the image in Flash might be missing. Following these steps to recover if the switch is in a reset loop after or during the upgrade. 1. Connect the PC to the switch console port. 2. Press the **Enter** key a few times. Are you seeing a `switch: prompt`? If not, go to Step 3. Otherwise, go to Step 4. 3. Disconnect the power cord. Hold down the mode button on the front of the switch, and plug the power cord back in. All LEDs above all ports should come on green. Continue to hold down the mode button until the light above port 1 goes out, and then release the mode button. The prompt should be *switch:*. 4. Download the IOS Image File using X-Modem.
After the upgrade, the switch still boots up with the old image.	This happens when either the BOOT parameters are not correct and the switch is still set to boot from the old image or the upgrade did not go through properly. Verify the BOOT parameters, and correct them if needed. • If the BOOT parameters are correct, download the IOS Image File using TFTP. • If the switch still boots with the old image, download the IOS Image File using X-Modem.
Switch not booting automatically; needs a manual boot at the ROMMON (`switch: prompt`).	The switch boot parameters might be set for manual boot. The switch can be set to boot automatically by following these steps: 1. Use Telnet to access the switch, or connect the PC to the switch console port. 2. Enter the privileged EXEC mode by entering the **enable** command at the `switch> prompt`. 3. Enter the global configuration mode by entering **configure terminal** at the `Switch# prompt`. 4. Enter **no boot manual** to tell the switch to boot automatically. 5. Enter **end** to return to privileged EXEC mode, and save the configuration by entering the **write memory** command. 6. Verify the boot parameters by entering **show boot**. Verify that Manual Boot is set to *no*.

Recovery Procedures

The recovery procedures in this section require that you have physical access to the switch. Recovery procedures include the following topics:

- Recovering from lost member connectivity
- Recovering from a command-switch failure
- Recovering from a lost or forgotten password
- Recovering from corrupted software

Recovering from Lost Member Connectivity

Some configurations can prevent the command switch from maintaining contact with member switches. If you are unable to maintain management contact with a member, and the member switch is forwarding packets normally, check for the following port-configuration conflicts:

- Member switches cannot connect to the command switch through a port that is defined as a network port. For information on the network port feature, see the "Enabling a Network Port" section on page 7-7.
- Member switches must connect to the command switch through a port that belongs to the same management VLAN. For more information, see the "Management VLAN" section on page 5-11.
- Member switches connected to the command switch through a secured port can lose connectivity if the port is disabled due to a security violation. Secured ports are described in the "Enabling Port Security" section on page 7-15.

Recovering from a Command Switch Failure

This section describes how to recover from a failed command switch. If you are running IOS Release 12.0(5)XU, you can configure a redundant command switch group by using the Hot Standby Router Protocol (HSRP). For more information, see the "Designating and Enabling Standby Command Switches" section on page 5-17.

Note HSRP is the preferred method for supplying redundancy to a cluster.

If you have not configured a standby command switch, and your command switch loses power or fails in some other way, management contact with the member switches is lost, and a new command switch must be installed. However, connectivity between switches that are still connected is not affected, and the member switches forward packets as usual. You can manage the members as standalone switches through the console port or, if they have IP addresses, through the other management interfaces.

You can prepare for a command switch failure by assigning an IP address to a member switch or another switch that is command-capable, making a note of the command-switch password, and cabling your cluster to provide redundant connectivity between the member switches and the replacement command switch. This section describes two solutions for replacing a failed command switch:

- Replacing a failed command switch with a cluster member
- Replacing a failed command switch with another switch

For a list of command-capable Catalyst desktop switches, see the release notes.

Replacing a Failed Command Switch with a Cluster Member

Follow these steps to replace a failed command switch with a command-capable member of the same cluster:

Step 1 Disconnect the command switch from the member switches, and physically remove it from the cluster.

Step 2 Use a member switch in place of the failed command switch, and duplicate its connections to the cluster members.

Step 3 Start a command-line interface (CLI) session on the new command switch.

You can access the CLI by using the console port or, if an IP address has been assigned to the switch, by using Telnet. For details about using the console port, refer to the switch installation guide.

Step 4 At the switch prompt, change to privileged EXEC mode:

```
Switch> enable
Switch#
```

Step 5 Enter the password of the *failed command switch*.

Step 6 From privileged EXEC mode, enter global configuration mode.

```
Switch# config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 7 From global configuration mode, remove previous command-switch information from the switch.

```
Switch(config)# no cluster commander-address
```

Step 8 Return to privileged EXEC mode.

```
Switch(config)# exit
Switch#
```

Step 9 Use the setup program to configure the switch IP information.

This program prompts you for an IP address, subnet mask, default gateway, and password. From privileged EXEC mode, enter **setup**, and press **Return**.

```
Switch# setup
         --- System Configuration Dialog ---
At any point you may enter a question mark '?' for help.
Use Ctrl-c to abort configuration dialog at any prompt.
Default settings are in square brackets '[]'.
Continue with configuration dialog? [yes/no]:
```

Step 10 Enter **Y** at the first prompt.

```
Continue with configuration dialog? [yes/no]: y
```

Step 11 Enter the switch IP address, and press **Return**:

```
Enter IP address: ip_address
```

Step 12 Enter the subnet mask, and press **Return**:

```
Enter IP netmask: ip_netmask
```

Step 13 Enter **Y** at the next prompt to specify a default gateway (router):

```
Would you like to enter a default gateway address? [yes]: y
```

Step 14 Enter the IP address of the default gateway, and press **Return**.

```
IP address of the default gateway: ip_address
```

Step 15 Enter a host name for the switch, and press **Return**.



Note On a command switch, the host name is limited to 28 characters; on a member switch to 31 characters. Do not use -*n*, where n is a number, as the last character in a host name for any switch.

```
Enter a host name: host_name
```

Step 16 Enter the password of the *failed command switch*, and press **Return**.

Note The password can be from 1 to 25 alphanumeric characters, can start with a number, is case sensitive, allows spaces, but ignores leading spaces.

```
Enter enable secret: secret_password
```

Step 17 Enter **Y** to enter a Telnet password:

```
Would you like to configure a Telnet password? [yes] y
```

Note The password can be from 1 to 25 alphanumeric characters, is case sensitive, allows spaces, but ignores leading spaces.

Step 18 Enter the Telnet password, and press **Return**:

```
Enter Telnet password: telnet_password
```

Step 19 Enter **Y** to configure the switch as the cluster command switch. Enter **N** to configure it as a member switch or as a standalone switch.

Note If you enter **N**, the switch appears as a candidate switch in Cluster Builder. In this case, the message in Step 20 is not displayed.

```
Would you like to enable as a cluster command switch? y
```

Step 20 Assign a name to the cluster, and press **Return**.

```
Enter cluster name: cls_name
```

Note The cluster name can be 1 to 31 alphanumeric characters, dashes, or underscores.

Step 21 The initial configuration is displayed:

```
The following configuration command script was created:

ip subnet-zero
interface VLAN1
ip address 172.20.153.36 255.255.255.0
```

```
ip default-gateway 172.20.153.01
hostname host_name
enable secret 5 $1$M3pS$cXtAlkyR3/6Cn8/
line vty 0 15
password telnet_password
snmp community private rw
snmp community public ro
cluster enable cls_name

end
```

Step 22 Verify that the information is correct.

- If the information is correct, enter **Y** at the prompt, and press **Return**.
- If the information is not correct, enter **N** at the prompt, press **Return**, and begin again at Step 1.

```
Use this configuration? [yes/no]: y
```

Step 23 Start your browser, and enter the switch IP address that you entered in Step 11.

Step 24 Display the VSM Home page for the switch, and select **Enabled** from the Command Switch drop-down list.

Step 25 Click **Cluster Management**, and display Cluster Builder.

CMS prompts you to add candidate switches. The password of the failed command switch is still valid for the cluster, and you should enter it when candidate switches are proposed for cluster membership.

Replacing a Failed Command Switch with Another Switch

Follow these steps when you are replacing a failed command switch with a switch that is command-capable but not part of the cluster:

Step 1 Insert the new switch in place of the failed command switch, and duplicate its connections to the cluster members.

Step 2 Start a CLI session on the new command switch.

You can access the CLI by using the console port or, if an IP address has been assigned to the switch, by using Telnet. For details about using the console port, refer to the switch hardware installation guide.

Step 3 At the switch prompt, change to privileged EXEC mode:

```
Switch> enable
Switch#
```

Step 4 Enter the password of the *failed command switch.*

Step 5 Use the setup program to configure the switch IP information.

This program prompts you for an IP address, subnet mask, default gateway, and password. From privileged EXEC mode, enter **setup**, and press **Return**.

```
Switch# setup
        --- System Configuration Dialog ---
At any point you may enter a question mark '?' for help.
Use ctrl-c to abort configuration dialog at any prompt.
Default settings are in square brackets '[]'.
Continue with configuration dialog? [yes/no]:
```

Step 6 Enter **Y** at the first prompt.

```
Continue with configuration dialog? [yes/no]: y
```

Step 7 Enter the switch IP address, and press **Return**:

```
Enter IP address: ip_address
```

Step 8 Enter the subnet mask, and press **Return**:

```
Enter IP netmask: ip_netmask
```

Step 9 Enter **Y** at the next prompt to specify a default gateway (router):

```
Would you like to enter a default gateway address? [yes]: y
```

Step 10 Enter the IP address of the default gateway, and press **Return**.

```
IP address of the default gateway: ip_address
```

Step 11 Enter a host name for the switch, and press **Return**.

Note On a command switch, the host name is limited to 28 characters; on a member switch to 31 characters. Do not use -*n*, where n is a number, as the last character in a host name for any switch.

```
Enter a host name: host_name
```

Step 12 Enter the password of the *failed command switch*, and press **Return**.

Note The password can be from 1 to 25 alphanumeric characters, can start with a number, is case sensitive, allows spaces, but ignores leading spaces.

```
Enter enable secret: secret_password
```

Step 13 Enter **Y** to enter a Telnet password:

```
Would you like to configure a Telnet password? [yes] y
```

Note The password can be from 1 to 25 alphanumeric characters, is case sensitive, allows spaces, but ignores leading spaces.

Step 14 Enter the Telnet password, and press **Return**:

```
Enter Telnet password: telnet_password
```

Step 15 Enter **Y** to configure the switch as the cluster command switch. Enter **N** to configure it as a member switch or as a standalone switch.

Note If you enter **N**, the switch appears as a candidate switch in Cluster Builder. In this case, the message in Step 20 is not displayed.

```
Would you like to enable as a cluster command switch? y
```

Step 16 Assign a name to the cluster, and press **Return**.

```
Enter cluster name: cls_name
```

Note The cluster name can be 1 to 31 alphanumeric characters, dashes, or underscores.

Step 17 The initial configuration is displayed:

```
The following configuration command script was created:

ip subnet-zero
interface VLAN1
ip address 172.20.153.36 255.255.255.0
ip default-gateway 172.20.153.01
hostname host_name
enable secret 5 $1$M3pS$cXtAlkyR3/6Cn8/
line vty 0 15
password telnet_password
snmp community private rw
snmp community public ro
cluster enable cls_name

end
```

Step 18 Verify that the information is correct.

- If the information is correct, enter **Y** at the prompt, and press **Return**.
- If the information is not correct, enter **N** at the prompt, press **Return**, and begin again at Step 1.

```
Use this configuration? [yes/no]: y
```

Step 19 Start your browser, and enter the switch IP address that you entered in Step 7.

Step 20 Click **Cluster Manager Suite or Visual Switch Manager**, and display Cluster Builder.

It prompts you to add the candidate switches. The password of the failed command switch is still valid for the cluster. Enter it when candidate switches are proposed for cluster membership, and click **OK**.

Recovering from a Failed Command Switch Without HSRP

If a command switch fails and there is no standby command switch configured, member switches continue forwarding among themselves, and they can still be managed through normal standalone means. You can configure member switches through the console-port CLI, and they can be managed through SNMP, HTML, and Telnet after you assign an IP address to them.

The password you enter when you log in to the command switch gives you access to member switches. If the command switch fails and there is no standby command switch, you can use the command-switch password to recover. For more information, see the "Recovering from a Command Switch Failure" section on page 9-14.

Recovering from a Lost or Forgotten Password

Follow the steps in this procedure if you have forgotten or lost the switch password.

Step 1 Connect a terminal or PC with terminal emulation software to the console port. For more information, refer to the switch installation guide.

Note You can configure your switch for Telnet by following the procedure in the "Accessing the CLI" section on page 3-8.

Step 2 Set the line speed on the emulation software to 9600 baud.

Step 3 Unplug the switch power cord.

Step 4 Press the **Mode** button, and at the same time, reconnect the power cord to the switch.

You can release the **Mode** button a second or two after the LED above port 1X goes off. Several lines of information about the software appear, as do instructions:

```
The system has been interrupted prior to initializing the flash file
system. The following commands will initialize the flash file system,
and finish loading the operating system software:

flash_init
```

```
load_helper
boot
```

Step 5 Initialize the Flash file system:

```
switch: flash_init
```

Step 6 If you had set the console port speed to anything other than 9600, it has been reset to that particular speed. Change the emulation software line speed to match that of the switch console port.

Step 7 Load any helper files:

```
switch: load_helper
```

Step 8 Display the contents of Flash memory:

```
switch: dir flash:
```

The switch file system is displayed:

```
Directory of flash:

  2  -rwx      843947   Mar 01 1993 00:02:18 C2900XL-h-mz-112.8-SA
  4  drwx        3776   Mar 01 1993 01:23:24  html
 66  -rwx         130   Jan 01 1970 00:01:19  env_vars
 68  -rwx        1296   Mar 01 1993 06:55:51  config.text

1728000 bytes total (456704 bytes free)
```

Step 9 Rename the configuration file to config.text.old.

This file contains the password definition.

```
switch: rename flash:config.text flash:config.text.old
```

Step 10 Boot the system:

```
switch: boot
```

You are prompted to start the setup program. Enter **N** at the prompt:

```
Continue with the configuration dialog? [yes/no]: N
```

Step 11 At the switch prompt, change to privileged EXEC mode:

```
switch> enable
```

Step 12 Rename the configuration file to its original name:

```
switch# rename flash:config.text.old flash:config.text
```

Step 13 Copy the configuration file into memory:

```
switch# copy flash:config.text system:running-config
Source filename [config.text]?
Destination filename [running-config]?
```

Press **Return** in response to the confirmation prompts.

The configuration file is now reloaded, and you can use the following normal commands to change the password.

Step 14 Enter global configuration mode:

```
switch# config terminal
```

Step 15 Change the password:

```
switch(config)# enable secret <password>
```

or

```
switch(config)# enable password <password>
```

Step 16 Return to privileged EXEC mode:

```
switch(config)# exit
switch#
```

Step 17 Write the running configuration to the startup configuration file:

```
switch# copy running-config startup-config
```

The new password is now included in the startup configuration.

Recovering from Corrupted Software

Switch software can be corrupted during an upgrade, by downloading the wrong file to the switch, and by deleting the image file. In all these cases, the switch does not pass the power-on self-test (POST), and there is no connectivity.

The following procedure uses the XMODEM Protocol to recover from a corrupt or wrong image file. There are many software packages that support the XMODEM protocol, and this procedure is largely dependent on the emulation software you are using.

Step 1 Connect a PC with terminal-emulation software supporting the XMODEM Protocol to the switch console port.

Step 2 Set the line speed on the emulation software to 9600 baud.

Step 3 Unplug the switch power cord.

Step 4 Reconnect the power cord to the switch.

The software image does not load. The switch starts in boot loader mode, which is indicated by the `switch:` prompt.

Step 5 Use the boot loader to enter commands, and start the transfer.

`switch:` **`copy xmodem: flash:`***`image_filename.bin`*

Step 6 When the XMODEM request appears, use the appropriate command on the terminal-emulation software to start the transfer and to copy the software image to Flash memory.



System Error Messages

This appendix describes the IOS system error messages for the switch. The system software sends these error messages to the console (and, optionally, to a logging server on another system) during operation. Not all system error messages indicate problems with your system. Some messages are purely informational, while others can help diagnose problems with communications lines, internal hardware, or the system software.

This appendix contains the following sections:

- How to Read System Error Messages, page A-2
- Error Message Traceback Reports, page A-4
- Error Message and Recovery Procedures, page A-5

How to Read System Error Messages

System error messages begin with a percent sign (%) and are structured as follows:

%FACILITY-SUBFACILITY-SEVERITY-MNEMONIC: Message-text

- FACILITY is a code consisting of two or more uppercase letters that indicate the facility to which the message refers. A facility can be a hardware device, a protocol, or a module of the system software. Table A-1 lists the system facility codes.

Table A-1 Facility Codes

Code	Facility
CHASSIS	Chassis
CMP	Cluster Membership Protocol
ENVIRONMENT	Environment
GIGASTACK	GigaStack GBIC
LINK	Link
LRE_LINK	LRE Link
MODULE	Module
PORT SECURITY	Port Security
RTD	Runtime Diagnostic
STORM CONTROL	Storm Control

- SEVERITY is a single-digit code from 0 to 7 that reflects the severity of the condition. The lower the number, the more serious the situation. Table A-2 lists the message severity levels.
- MNEMONIC is a code that uniquely identifies the error message.

Table A-2 Message Severity Levels

Severity Level	Description
0 – emergency	System is unusable.
1 – alert	Immediate action required.
2 – critical	Critical condition.
3 – error	Error condition.
4 – warning	Warning condition.
5 – notification	Normal but significant condition.
6 – informational	Informational message only.
7 – debugging	Message that appears during debugging only.

- Message-text is a text string describing the condition. This portion of the message sometimes contains detailed information about the event, including terminal port numbers, network addresses, or addresses that correspond to locations in the system memory address space. Because the information in these variable fields changes from message to message, it is represented here by short strings enclosed in square brackets ([ ]). A decimal number, for example, is represented as [dec]. Table A-3 lists the variable fields in messages.

Table A-3 Representation of Variable Fields in Messages

Representation	Type of Information
[dec]	Decimal
[char]	Single character
[chars]	Character string
[hex]	Hexadecimal integer
[inet]	Internet address

The following is a sample system error message:

%LINK-2-BADVCALL: Interface [chars], undefined entry point

Some error messages also indicate the card and slot reporting the error. These error messages begin with a percent sign (%) and are structured as follows:

%CARD-SEVERITY-MSG:SLOT %FACILITY-SEVERITY-MNEMONIC: Message-text

CARD is a code that describes the type of card reporting the error.

MSG is a mnemonic that means that this is a message. It is always shown as MSG.

SLOT means that the slot number of the card reporting the error. It is shown as SLOT followed by a number. (For example, SLOT5.)

Error Message Traceback Reports

Some messages describe internal errors and contain traceback information. This information is very important and should be included when you report a problem to your technical support representative.

The following sample message includes traceback information:

-Process= "Exec", level= 0, pid= 17

-Traceback= 1A82 1AB4 6378 A072 1054 1860

Error Message and Recovery Procedures

This section lists the switch system messages by facility. Within each facility, the messages are listed by severity levels 0 to 7: 0 is the highest severity level, and 7 is the lowest severity level. Each message is followed by an explanation and a recommended action.

Chassis Message

This section contains the Chassis error message.

`CHASSIS-5-BLADE_EXTRACT`

Explanation The message means that the hot-swap switch has been pressed.

Action Extract the module.

CMP Messages

This section contains the Cluster Membership Protocol (CMP) error messages.

```
CMP-5-ADD: The Device is added to the cluster (Cluster
Name:[chars], CMDR IP Address [inet])
```

Explanation The message means that the device is added to the cluster: [chars] is the cluster name, and [inet] is the Internet address of the command switch.

Action No action is required.

```
CMP-5-MEMBER_CONFIG_UPDATE: Received member configuration from
member [dec]
```

Explanation This message means that the command switch received a member configuration: [dec] is the member number.

Action No action is required.

`CMP-5-REMOVE The Device is removed from the cluster (Cluster Name:[chars])`

Explanation The message means that the device is removed from the cluster: [chars] is the cluster name.

Action No action is required.

Environment Messages

This section contains the Environment error messages.

`ENVIRONMENT-2-FAN_FAULT`

Explanation This message means that an internal fan fault is detected. This message is available only on the Catalyst 3524-PWR XL switch.

Action Either check the switch itself, or use the **show env** privileged EXEC command to check if a fan on the switch has failed. The Catalyst 3524-PWR XL switch can operate normally with one failed fan. Replace the switch at your convenience.

`ENVIRONMENT-2-OVER_TEMP`

Explanation This message means that an overtemperature condition is detected. This message is available only on the Catalyst 3524-PWR XL switch.

Action Use the **show env** command to check if an overtemperature condition exists. If it does:

- Place the switch in an environment that is within 32 to 113°F (0 to 45°C).
- Make sure fan intake and exhaust areas are clear.

If a multiple-fan failure is causing the switch to overheat, replace the switch.

GigaStack Messages

This section contains the GigaStack error messages.

`GIGASTACK-6-LOOP_BROKEN`

Explanation This message means that a loop formed by GigaStack modules is broken because of link loss. Link 2 of the Master Loop Breaker is re-enabled to replace the broken line.

Action No action is required.

`GIGASTACK-6-LOOP_DETECTED`

Explanation This message means that a loop has been detected in the GigaStack, and this GigaStack GBIC is selected as the Master Loop Breaker. Link 2 of this GigaStack GBIC is disabled to break the loop.

Action No action is required.

`GIGASTACK-6-NO_LOOP_DETECT`

Explanation This message means that no acknowledgement for GigaStack loop detection request is received from one of the links on a GigaStack GBIC. Either the neighboring switch does not support the GigaStack Loop breaking algorithm, or the link between the two GigaStack GBICs is broken. Under this condition, a GigaStack loop topology is not automatically detected, and the connectivity between switches in the stack could be lost.

Action If loop topology is used in the GigaStack, make sure the latest software is running on all switches in the stack. Check the GigaStack GBICs involved to make sure they are functioning.

Link Message

This section contains the Link error message.

`LINK-4-ERROR [chars] is experiencing errors.`

Explanation This messages means that excessive errors have occurred on this interface: [char] is the interface.

Action Check for duplex mismatches between both ends of the link.

Note The previous error is a LINK-4-ERROR message, which is logged at the Warning level. LINK-3-ERROR messages are more severe and are logged at the Error level.

LRE Link Messages

This section contains the LRE Link error messages.

`LRE_LINK-3-UPDOWN: Interface changed state to up or down`

Explanation This message means that the link between the LRE port and the CPE device has been lost and that no Ethernet traffic is being transferred. This could be the result of reconfiguring the port, reconfiguring a profile in use by this port, a physical disconnection or reconnection of the LRE connector on the switch, or by someone disconnecting the CPE LRE cable or cycling its power. It might also be caused by any substantial interruption of the signal or cabling between the LRE port and the CPE.

Action If someone is reconfiguring the port or the profile in use, ignore this message. However, if the LRE link does not go back up within a minute or so, it could mean a physical disconnection at the switch or CPE or a loss of power to the CPE.

`LRE_LINK-3-PROFILE_FAILURE: Interface, profile failure`

Explanation When the switch reloads or when the LRE link is lost, the LRE port first attempts to briefly establish link with the CPE in a common, reduced rate mode. This is so that the switch can exchange configuration information

with the CPE to achieve the link rate of the profile configured for the port. When the reduced rate is achieved, link is dropped briefly, and the LRE and CPE ports attempt to establish the profile link rate. If, after a time (typically 30 seconds), no LRE link is established, this message appears, and the port LED is amber. The port continues to attempt to establish link, starting from the reduced rate. This message could also mean that the switch or CPE is faulty.

Action Change the profile on the port to one that has a lower rate or has a longer reach. There might be too many impairments on the connection between the switch and the CPE for the ports to sustain the profile rate. If you suspect the switch or CPE is faulty, contact Cisco Systems.

Module Message

This section contains the Module error message.

`MODULES-3-MAC_TBL_SIZE`

Explanation This messages means that dynamic module insertion supports less MAC addresses.

Action Reboot system to use the module.

Port Security Messages

This section contains the Port Security error message.

`PORT_SECURITY-2-SECURITYREJECT`

Explanation This message means that a packet with an unexpected source address is received on a secure port.

Action Remove the station with the unexpected MAC address from the secure port, or add the MAC address to the secure address table of the secure port.

RTD Messages

This section contains the Runtime Diagnostic (RTD) error messages.

`RTD-1-ADDR_FLAP [chars] relearning [dec] addrs per min`

Explanation Normally, MAC addresses are learned once on a port. Occasionally, when a switched network reconfigures, due to either manual or STP reconfiguration, addresses learned on one port are relearned on a different port. However, if there is a port anywhere in the switched domain that is looped back to itself, addresses will jump back and forth between the real port and the port that is in the path to the looped back port. In this message, [chars] is the interface, and [dec] is the number of addresses being learnt.

Action Determine the real path (port) to the MAC address. Use **debug ethernet-controller addr** to see the alternate path-port on which the address is being learned. Go to the switch attached to that port. Note that the **show cdp neighbors** command is useful in determining the next switch. Repeat this procedure until the port is found that is receiving what it is transmitting, and remove that port from the network.

`RTD-1-LINK_FLAP [chars] link down/up [dec] times per min`

Explanation This message means that an excessive number of link down-up events has been noticed on this interface: [chars] is the interface, and [dec] is the number of times the link goes up and down. This might be the result of reconfiguring the port, or it might indicate a faulty device at the other end of the connection.

Action If someone is reconfiguring the interface or device at the other side of the interface, ignore this message. However, if no one is manipulating the interface or device at the other end of the interface, it is likely that the Ethernet transceiver at one end of the link is faulty and should be replaced.

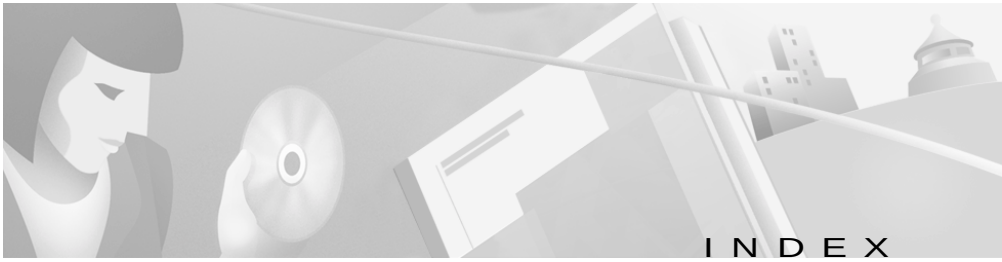
Storm Control Messages

This section contains the Storm Control error message.

`STORM_CONTROL-2-SHUTDOWN`

Explanation This messages means that excessive traffic has been detected on a port that has been configured to be shut down if a storm event is detected

Action Once the source of the packet storm has been fixed, re-enable the port by using port-configuration commands.



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