CHAPTER 1

Introduction to the Catalyst 3900

This chapter contains the following information about the Catalyst 3900:

Product Overview

The Catalyst 3900 is a stackable Token Ring switch that provides the following:

- Expandable configuration up to eight switches
- Scalable bandwidth between switches using fault-tolerant TokenChannels or Inter-Switch Link (ISL) Channel configurations
- Low-latency, cut-through switching in a variety of bridging and switching modes
- Configurable ports that can function in half-duplex (HDX) or full-duplex (FDX) modes, as a concentrator or end station
- Transmission priority queues
- Ability to filter frames based on Media Access Control (MAC) address or protocol
- Notification of port errors and beacon situations
- Support for the Cisco Discovery Protocol (CDP)
- Ability to subdivide the switch into virtual LANs (VLANs)
- Support for the VLAN Trunking Protocol (VTP) and VTP Pruning
- Support for Simple Network Management Protocol (SNMP)-based management
- Remote monitoring (RMON) support
- Ability to monitor port traffic
- Ability to monitor soft error conditions occurring in your network and to receive notification of the stations that are exceeding user-defined error thresholds on a port
- Ability to issue a Remove Ring Station MAC frame to remove a station from a ring

Interconnection of Switches

The Catalyst 3900 can be used as a standalone switch, or it can be interconnected with up to seven other switches in a ProStack configuration. The ProStack system is formed by connecting two to eight switches with SCSI II-type cables via a ProStack Matrix crossbar switch. A two-switch ProStack can be formed by directly connecting two switches.

In addition, two switches can be interconnected by a number of parallel Token Ring connections, called *TokenChannels*, or by parallel Inter-Switch Link (ISL) connections, called *ISL Channels*. A TokenChannel is two to eight parallel Token Ring links between Catalyst 3900 switches. An ISL Channel consists of two to four parallel connections treated as a single interface. The traffic between the switches is shared via the connections.

The Catalyst 3900 channels provide the following benefits:

- Logical aggregation of bandwidth of up to 256 Mbps (128 Mbps full duplex) for TokenChannel configurations and up to 800 Mbps (400-Mbps full duplex) for ISL Channel configurations
- Load balancing
- Fault tolerance

For more information about stacking Catalyst switches and using TokenChannels or ISL Channels, refer to the "Interconnecting Catalyst 3900 Switches" chapter.

Bridging Modes

The Catalyst 3900 supports the following bridging and switching modes:

- Source-Route Bridging (SRB)
- Source-Route Transparent Bridging (SRT)
- Source-Route Switching

Note You can enable either SRB or SRT modes for the logical connections between a Token Ring Concentrator Relay Function (TrCRF) and Token Ring Bridge Relay Function (TrBRF). Source-route switching is used for frame forwarding within the TrCRF and is always enabled.

For more information about these bridging modes and TrBRFs and TrCRFs, refer to the "Understanding Token Ring Switching" appendix.

Token Ring Port Operation

Each of the 20 Token Ring ports can operate in one of the following modes:

- Half-duplex concentrator port—The port is connected to a single station in HDX mode. In this case, the port behaves like an active media access unit (MAU) port for classical Token Ring.
- Half-duplex station emulation—The port is connected to a port on an MAU. In this case, the port behaves like a station connected to a classical Token Ring segment that contains multiple stations.
- Full-duplex concentrator port—The port is connected to a single station in FDX mode.
- Full-duplex station emulation—The port is connected to another Token Ring switch in FDX mode.

The mode of operation can be configured, or it can be automatically sensed when equipment is connected to the port. The media speed (4 or 16 Mbps) can also be configured or automatically sensed in all port modes.

Ring In/Ring Out Ports

Two of the ports on the Catalyst 3900 are designed to enable attachment to a traditional main ring path coming from either an MAU or a controlled access unit (CAU). You can configure the two ports, 19 and 20, to connect to the ring in (RI) or ring out (RO) ports of a MAU or CAU.

Note All of the ports on the 4-port fiber Token Ring module can be connected to the RI or RO ports of a MAU or CAU. For more information on the 4-port fiber Token Ring, refer to the "Expansion Modules" chapter.

A loopback function has been implemented on ports 19 and 20 so that if the port is disabled or the switch is powered off there will not be a break in the attached main ring. This function means that attaching a cable from the RI port of a MAU port to one of the two switch ports in effect joins the primary and the backup ring in a MAU/CAU main ring system. Connecting the other end of the main ring to the other switch port creates redundant paths because the two switch ports are connected to the same segment. Therefore, the Spanning-Tree Protocol (STP) must be enabled, which will place one port in forwarding mode and the other in blocked mode. If there is a break in the main ring the STP will place both ports in forwarding mode and all MAC addresses on both segments will be relearned.

Note It is not possible to automatically verify whether the port has been connected according to the configuration. Any errors, such as attaching port 19 or 20 to a normal MAU port when the Catalyst 3900 port has been configured for RI/RO, will cause a complete disruption of the ring to which the port is attached. Therefore, be careful when using the RI/RO feature.

Transmission Priority Queues

To address the needs of delay-sensitive data, such as multimedia, the Token Ring ports of the Catalyst 3900 have two transmit queues, a high-priority queue and a low-priority queue.

The queue for a frame is determined by the value of the priority field in the frame control (FC) byte of the frame. If FC priority is above a configurable level (the default is 3), the frame is put in the high-priority queue. If an output port becomes congested, you can dynamically configure the port to transmit all frames at high priority regardless of the FC byte contents.

The Catalyst 3900 CPU software monitors the size of the output queue at each Token Ring port to minimize the effects of congestion at output ports. When port congestion is detected, the Catalyst 3900 does the following:

- Raises the transmit priority to a higher level for low-priority frames
- Discards the oldest frames when the output queue is almost full

Filtering

Many bridged networks today employ filtering to reduce broadcast traffic, block protocols, and provide simple security. The Catalyst 3900 provides filtering capabilities for the same purpose. You can filter frames based on the following:

- MAC address (source address, destination address)
- Protocol (destination service access point [DSAP]/Subnetwork Access Protocol [SNAP] Type)

MAC address filters and broadcast filters can be applied only at input ports. DSAP and SNAP filters can be applied at input ports and output ports.

Notification of Port Errors and Beacon Situations

The Catalyst 3900 is notified when a serious error, such as signal loss, is detected. The Token Ring port is then instructed to discard all frames in the output queue and to reject new frames.

The Catalyst 3900 is also notified when a Token Ring beacon state is detected on the ring and when it disappears. If the beacon state remains for more than a specified amount of time, the port is instructed to discard all frames in the output queue and to reject new frames. When the beacon state disappears, the port is instructed to once again accept frames.

Cisco Discovery Protocol Support

The CDP support allows the Catalyst 3900 to establish communication with other models of Cisco equipment. CDP support is provided as part of the Cisco IOS software that runs on many types of Cisco equipment.

CDP is a media- and protocol-independent protocol that is intended to be run on Cisco-manufactured equipment including routers, bridges, access servers, and switches. With CDP, Cisco's network management applications and Cisco devices can learn the device type and the SNMP agent address of neighboring devices, which enables applications to send SNMP queries to neighboring devices.

CDP runs on various media that support the SNAP, including LAN, Frame Relay, and Asynchronous Transfer Mode (ATM) media. CDP runs over the data link layer only. Therefore, two systems that support different network-layer protocols can learn about each other.

Each device configured for CDP sends periodic messages to a multicast address. Each device advertises at least one address at which it can receive SNMP messages. The advertisements also contain time-to-live, or holdtime, information, which indicates the length of time a receiving device should hold CDP information before discarding it.

Virtual LANs

A VLAN is an administratively defined broadcast domain. The VLAN feature allows you to partition a Catalyst 3900 into multiple VLANs by assigning multiple ports within a single switch or a stacked configuration of switches to the same logical ring number. For each VLAN that you establish, you can configure separate IP, SNMP, and spanning-tree parameters. You can also configure the Catalyst 3900 to bridge traffic between the logical rings of a switch or switch stack.

There are two levels of VLANs supported by the Catalyst 3900. The first level is the TrCRF. This is the level of VLAN to which the ports are assigned. The second level is the TrBRF. This is the parent VLAN to which TrCRF VLANs are assigned. Traffic is switched between ports in a TrCRF and bridged between TrCRFs in a TrBRF.

The Catalyst 3900 maintains certain configuration information and management statistics on a per VLAN basis. Therefore, when you access VLAN-specific Catalyst 3900 configuration or management panels (such as the Current Spanning Tree Information panel), you will be prompted to specify the desired TrBRF or TrCRF.

For more information about Token Ring VLANs (TrCRFs and TrBRFs), refer to the "Token Ring VLANs" section on page A-8 of the "Understanding Token Ring Switching" appendix.

VTP and VTP Pruning

VTP enables you to set up and manage VLANs across an administrative domain (also known as a VTP management domain). When VLANs are created or existing VLANs are modified, VTP can automatically distribute the configuration information to the trunk ports of all the devices in the administrative domain. VTP ensures VLAN naming consistency and connectivity between all devices in a VLAN.

A feature of VTP, *VTP pruning* enhances the use of network bandwidth by reducing unnecessary flooded traffic (for example, broadcast and multicast traffic). VTP pruning restricts the flooded traffic to only those ISL trunk links that the traffic must traverse to access the appropriate network devices.

For more information about VTP and VTP pruning, including how to configure the features, see the "Configuring VLANs and VTP" section on page 6-7 of the "Configuring the Catalyst 3900" chapter.

Configuration and Management

The Catalyst 3900 switch offers network management and control through a series of menu-driven configuration and management panels that you can access via a connected terminal attached to the EIA 232 management port or from a remote terminal via Telnet. Up to five Telnet sessions are permitted at any one time. In addition, you can manage the Catalyst 3900 using an SNMP-based manager and monitor the Catalyst 3900 using an RMON agent or external monitoring device.

The Catalyst 3900 switch supports the following network management features:

- Simple Network Management Protocol (SNMP)
- Remote Monitoring (RMON)
- Switch Port Analyzer (SPAN)
- Soft Error Monitoring and Remove Adapter support

SNMP-Based Management

The Catalyst 3900 can be managed via an SNMP manager. The Catalyst 3900 supports twelve Management Information Bases (MIBs). Nine of the MIBs are standard MIBs, which are defined by RFCs and are included with most SNMP management applications. Three of the MIBs are private MIBs and can be obtained from CCO.

The standard MIBs supported are:

- Management Information Base for Network Management of TCP/IP-based Internets: MIB-II (RFC 1213)
- Evolution of Interfaces Group of MIB-II (RFC 1573)
- Definitions of Managed Objects for Bridges (RFC 1493)
- Token Ring Extensions to the Managed Objects for Bridges (RFC 1525)

- IEEE 802.5 Token Ring MIB (RFC 1748)
- RMON MIB/Token Ring Extensions (RFC 1757/1513) partial support
- IEEE 802.5 DTR Concentrator MIB
- IEEE 802.5 DTR MAC MIB

The private MIBs supported are:

- Catalyst 3900 Proprietary MIB
- Cisco VLAN Trunking Protocol MIB
- Cisco Discovery Protocol MIB

Most user configurable variables are supported in either the standard MIBs or private MIBs. Configuration settings, such as port attributes, and operational information, such as address tables, are fully accessible through SNMP. Certain other settings, such as passwords and console settings, cannot be viewed or modified via SNMP for security reasons.

RMON Support

RMON is an industry-standard method for providing network statistics monitoring using SNMP. It also collects fault, performance, and configuration statistics. RMON can monitor continuously, even when communication with the management station is not possible or efficient. It can then notify the management station when an exceptional condition occurs.

In typical SNMP management, the SNMP client has to continuously poll the Catalyst 3900 for fault, performance, and configuration information while waiting for the value to change. This causes increased traffic through the network. With RMON, you can have the switch monitor a particular statistic internally, and when the statistic reaches a threshold, the Catalyst 3900 will send a trap to the client. This monitoring method reduces traffic between the SNMP client and the Catalyst 3900 switch.

As an option, the Catalyst 3900 provides RMON support statistics, history, alarms, and events. It also provides support for the following groups of the Token Ring extensions to the Remote Network Monitoring MIB (RFC 1513):

- MAC-layer Statistics Group

  A collection of MAC-layer statistics kept for each Token Ring interface, such as the total number of MAC packets received and the number of times the port entered a beaconing state.

- Promiscuous Statistics Group

  A collection of promiscuous statistics kept for non-MAC packets on each Token Ring interface, such as the total number of good non-MAC frames received that were directed to an LLC broadcast address.

- Token Ring Ring Station Group

  The Catalyst 3900 series Token Ring switches support the ringStationControlTable and the ringStationTable portions of the Token Ring Ring Station Group. This support allows a Catalyst 3900 series switch to gather segment information from each ring segment to which it is attached. This segment information includes Ring State, Beacon State, Beacon NAUN, Active Monitor MAC Address, Station Order Changes, and Report Soft Error MAC frames. This support also enables you to remove a station from a ring.

- Token Ring Ring Station Order Group

  A listing of the order of stations on the monitored rings.

You can use an external RMON probe for full RMON support.

Access to RMON data is available only via an SNMP management application that supports RFC 1757 and RFC 1513. You cannot access RMON via the Catalyst 3900 console interface; however, the console statistics provide similar information. For full utilization of RMON data, you should use Cisco's TrafficDirector.

Switch Port Analyzer

To aid in network management, the Catalyst 3900 allows you to copy traffic from any Token Ring port to the Switched Port Analyzer (SPAN) port. You can then attach an external Token Ring monitor (network analyzer) or RMON probe to the SPAN port. The Catalyst 3900 switch also enables you to configure SPAN port to monitor the traffic on one or more TrCRFs on a Catalyst 3900 ATM module or on a TrCRF on an Catalyst 3900 ISL module.

Note Forwarding to the SPAN port takes place independently of the normal forwarding.

Soft Error Monitoring and Remove Adapter Support

The Catalyst 3900 switch software Release 4.1(1) and later performs error detection and isolation by monitoring the Report Soft Error MAC frames generated by stations on each port. Soft errors occur during normal ring operation and do not typically disrupt traffic on the ring. However, soft errors can occur at a rate that could potentially degrade the performance of the ring.

Using the Catalyst 3900, you can configure soft error thresholds and sampling intervals for a port. During the interval you define, the Catalyst 3900 monitors the stations on the port and if the threshold is exceeded, generates a trap indicating the port number and station on which the threshold was exceeded. If necessary, you can issue a Remove Ring Station MAC frame to remove the station from the ring.

In summary, the Catalyst 3900 switch:

- Monitors the Report Soft Error MAC frames generated by stations on each port, collects the data from each soft error frame, and generates a trap containing the port number and station where the user-defined soft error threshold is exceeded.
- Reports the soft error monitoring statistics via the console and SNMP.
- Provides the ability to issue a Remove Ring Station MAC frame to remove a station that is reporting a high level of errors or is not authorized to be on a ring.

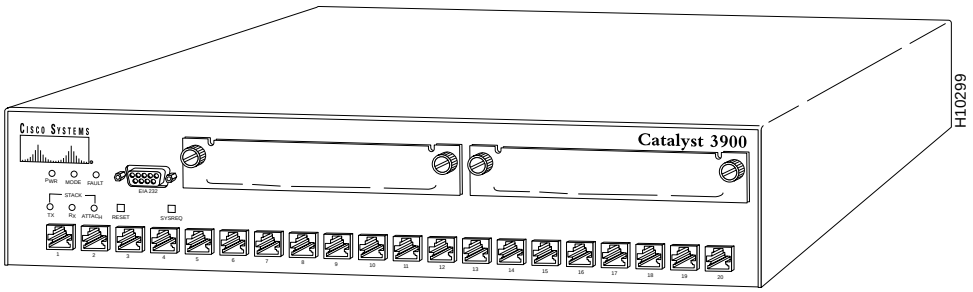
Self-Diagnostics

The Catalyst 3900 performs a self-diagnostic test when it is powered on. The results of these diagnostics are displayed at the console and saved in a diagnostic test results file, which can be viewed later from the console. System information and warning messages are displayed at the console and saved in a message log file, which may also be viewed later from the console. The message log file is not preserved across a system reset.

Physical Characteristics of the Catalyst 3900

The Catalyst 3900 has a CPU planar board with 20 RJ-45 Token Ring ports, two adapter expansion slots, one ProStack port, and one RS-232 port for management and configuration. Figure 1-1 shows the front of the Catalyst 3900.

Figure 1-1 Front View of the Catalyst 3900



Token Ring Ports

The base unit of the Catalyst 3900 has 20 shielded RJ-45 connectors for Token Ring connections. These ports allow HDX or FDX connections to other switches, hubs, or end nodes. They support the IBM Cabling System via 150-ohm, shielded twisted-pair (STP) or 100- or 120-ohm twisted-pair via Category 3, 4, or 5 cables.

EIA 232 Port

This 9-pin, male, management port functions as a data terminal equipment (DTE) port.

This port enables attachment of a terminal or terminal emulator that is used to customize the configuration of the switch, monitor switch activity and status, and test the switch. Console access can be either local, by direct attachment to the EIA 232 port, or remote, through a modem connection.

The EIA 232 port automatically detects the baud rate of the terminal to which it is attached.

Expansion Slots

The Catalyst 3900 contains two expansion slots that accommodate optional, field-installable, expansion module. The expansion modules can be used to provide additional connections. Installation and configuration instructions are included with each expansion module.

Reset Button

The Catalyst 3900 has a reset button located on the front panel of the switch. Pressing the reset button resets the hardware and software and clears all tables and memory, including the address tables. Pressing the reset button *does not* clear those values stored in NVRAM. The reset button is recessed to prevent accidental activation.

System Request Button

The System Request (SYSREQ) button is on the front panel next to the Reset button. This button causes the System Request Menu to appear on the console attached to the EIA 232 port. The System Request Menu contains options for downloading new software, resetting the switch, and clearing NVRAM.

Caution If this button is pressed for longer than 5 seconds, a download of the main image will be forced. This function should be used only at the direction of service personnel. The button is recessed to prevent accidental activation.

Status and Activity Indicators

The Catalyst 3900 has LEDs that indicate the status and activity of the base switch and its ports. There are three LEDs associated with the base switch: power, mode, and fault. There are three LEDs associated with the stack: transmit, receive, and attach. There are two LEDs associated with each of the 20 ports: port status and activity.

Power Connector

The power connector is located on the back of the Catalyst 3900. There is no power switch.

Catalyst 3900 Switch Modules

The Catalyst 3900 Token Ring switch supports the following switching expansion modules:

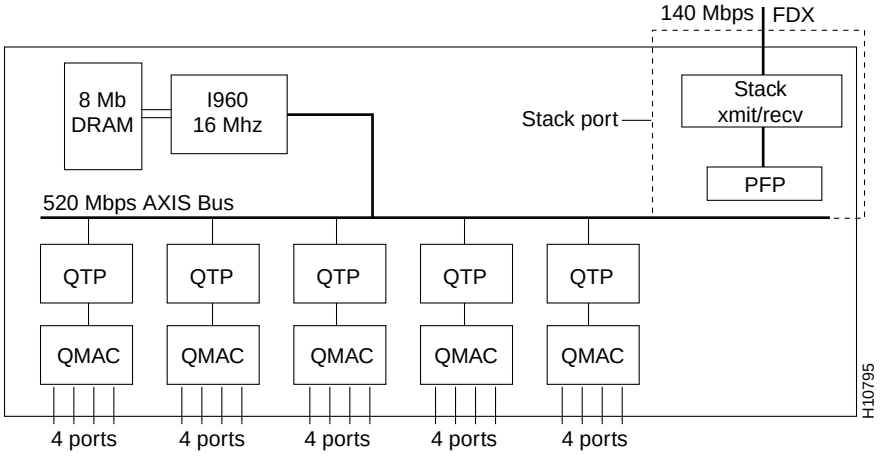
- Stack port module
- 4-port UTP/STP Token Ring module
- 4-port fiber Token Ring module
- Multimode fiber ATM module
- 2-port UTP/STP ISL module
- 2-port fiber ISL module

For more information on these modules, refer to the “Expansion Modules” chapter.

System Architecture

The internal components that comprise the system architecture of the Catalyst 3900 handle the processing and switching of the frames. The principle components are described in this section.

Figure 1-2 Internal Components of the Catalyst 3900



CPU

The CPU performs all of the system initialization and switch table maintenance. The CPU is an Intel 960SA processor, operating at 16 MHz. It has 512 bytes of internal direct-mapped instruction cache and an integrated interrupt controller.

Program Memory DRAM

The program memory dynamic random-access memory (DRAM) is used for program and data storage. It consists of four banks of DRAM providing up to 8 MB of storage.

AXIS Bus

The architecture of the Catalyst 3900 centers around the AXIS bus, a 520 Mbps switching fabric through which all switched ports communicate. The AXIS bus is a partially asynchronous time division multiplexed bus used for switching packets between heterogeneous LAN modules.

Quad Token Ring Port ASIC

The Quad Token Ring Port (QTP) ASIC interfaces directly to the Quad Media Access Controller (QMAC) ASIC and provides the necessary functions for switching directly between the four Token Ring ports connected to the QMAC, or between these and any other port within the switch.

Quad Media Access Controller ASIC

The QMAC ASIC contains four protocol handlers to support four Token Ring physical connections and interfaces directly to the QTP ASIC. It provides support for early token release (ETR) and FDX operation, concentrator and adapter modes for dedicated Token Ring and normal operation, as well as automatic mode detection.

Proprietary Fat Pipe

The Proprietary Fat Pipe is the interface to a ProStack port. The ProStack port operates in FDX mode at speeds of 140 Mbps. It switches packets at wire speeds with low forwarding latency. A proprietary 4-byte header is used to allow the members of the stack to function as one operational system.