

Interconnecting Switches

The Catalyst 3900 comes standard with 20 Token Ring ports. Using the two expansion slots and available expansion modules, you can increase the number of Token Ring ports to 28. The Catalyst 3920 comes with 24 Token Ring ports. The Catalyst 5000 series Token Ring switching module comes with 16 Token Ring ports. Using a Catalyst 5500 Switch, you can have up to 176 Token Ring ports.

You can create larger Token Ring port configurations by interconnecting the switches. This chapter discusses the options for interconnecting Catalyst Token Ring switches:

- Using Channel Configurations with Catalyst 3900s
- Stacking Catalyst 3900s
- Using ATM
- Using ISL

You can interconnect Catalyst 3920s with Catalyst 3900s. In this chapter, Catalyst 39xx is used to represent both.

Using Channel Configurations with Catalyst 3900s

The Catalyst 3900 allows you to configure two types of channels: ISL Channels and TokenChannels.

Channel configurations consist of two to eight parallel connections. These parallel connections provide the following:

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

The Catalyst 3900 channel configurations are *fault-tolerant*. This feature enables channels to continue to function as long as there is at least one link active within the channel. This capability ensures that large portions of a network are not disrupted in the event a port or cable fails within the channel by transferring the traffic to one or more of the remaining ports in a channel.

You cannot use the ports of an ATM module in a channel.

Note: When the Catalyst 3900 is configured with channels, all broadcast frames use the lowest numbered active port of the channel.



Caution Physically disconnect or disable the Catalyst 3900 ports before configuring a TokenChannel or ISL Channel. Failure to disconnect or disable the ports might result in network loops.

TokenChannels

A TokenChannel consists of two to eight parallel connections between two Catalyst 3900s. These parallel channels provide improved performance between Catalyst 3900s.

A single TokenChannel can consist of a combination of HDX and FDX connections. For example, a TokenChannel consisting of three connections can have one HDX and two FDX connections. However, both ports in each interconnected pair must be either HDX or FDX. In addition, all ports in a single TokenChannel must belong to the same TrCRF on the Catalyst 3900.

For more information about TrCRFs, see the “Token Ring VLANs and Related Protocols” chapter.



Caution While you can use TokenChannels to interconnect Catalyst 3900s and Catalyst 3920s, you cannot use TokenChannels to interconnect other different models of switches. For example, you cannot use a TokenChannel to interconnect a Catalyst 2600 and a Catalyst 3900. Likewise, you cannot use a TokenChannel to interconnect a Catalyst 3900 and a non-Cisco switch.

ISL Channels

A single ISL Channel can consist of two to four Token Ring ISL ports. Configuring an ISL Channel provides Fast EtherChannel connectivity on the Catalyst 3900. You can configure an ISL Channel between two Catalyst 3900 switches or between a Catalyst 3900 switch and a Catalyst 5000, a Token Ring ISL-capable Cisco router, or a Token Ring ISL network adapter. All connections in an ISL Channel must be FDX.

Stacking Catalyst 3900s

A stack of Catalyst 39xx switches is not just a connection of several switches. A Catalyst 39xx stack of switches combine to form a “virtual” single switch.

A Catalyst stack is configured in one of the following two ways:

- Two Catalyst 39xx switches cabled together in a back-to-back configuration.
- A stack of up to 8 Catalyst 39xx switches connected together via a Catalyst Matrix.

Two Catalyst 39xx switches can be connected to form a stack by using only a stack port cable and an interface card (Catalyst stack port module) plugged into the back of each Catalyst 39xx. This creates a direct connection between the two Catalyst 39xx switches, which is referred to as a *back-to-back* stack. As an alternative, you can use an 8-port Catalyst Matrix switch to create a stack of up to eight Catalyst 39xx switches. 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.

Note: The stack port module is an optional feature on the Catalyst 3900 switch. On the Catalyst 3920 switch, the stack port module is an integrated feature.

When you power-on a Catalyst 39xx, it runs through a set of self-diagnostics. Immediately after the diagnostics are completed, the Catalyst 39xx runs through a *stack discovery mode*. This discovery mode senses whether the switch is cabled to another Catalyst 39xx. If it is determined during the discovery mode that the Catalyst 39xx



is connected to other switches, the switches automatically combine to form a stack. At the end of the discovery mode, if it is determined that the Catalyst 39xx is not connected to another switch, the Catalyst 39xx operates as a standalone switch.

Advantages of the stack include the following:

- Manage the entire stack as a single device
- Single SNMP image for entire stack
 - Easier to customize SNMP applications
- Distributed intelligence between the switches of the stack
 - Shared learning
 - Shared management information
- Hot swap of stack switches
 - When a switch is powered off or removed from the stack, the other switches reform as a stack

Forming a Back-to-Back Catalyst Stack

A proprietary shielded cable, 1 meter in length, with 50-pin connectors, is used to connect the Catalyst switches together. After power-on diagnostics, the stack discovery mode runs. If, during this stack discovery mode, a Catalyst 39xx detects that it is connected to another Catalyst 39xx in a back-to-back configuration, the two switches will begin to form a stack.

As soon as the stack discovery mode is completed, two things happen:

- Each Catalyst 39xx is assigned a box number.
 - The two Catalyst 39xx switches in a back-to-back stack become box 1 and box 2. The box number is determined by the MAC address of each Catalyst 39xx. The Catalyst 39xx with the lower MAC address becomes box 1, and the Catalyst 39xx with the higher MAC address becomes box 2.
- The Catalyst 39xx switches must combine configuration information so that both of the boxes, as a stack, will use certain common parameters. This common information is called the *interbox parameters*. The “Interbox Parameters” section later in this chapter lists the shared parameters. In a stack of switches, one of the switches must become the provider of the interbox parameters.
 - If the Catalyst 39xx switches have the *same* configuration information (whether they are new or have been preconfigured to be the same) when they begin to form a stack, the Catalyst 39xx that becomes box 1 also becomes the provider of the interbox parameters.
 - If the configuration information differs between the two Catalyst 39xx switches, the first switch up provides its configuration information to the other switch. If both switches come up simultaneously, an error message is displayed that instructs the user to briefly press the SYSREQ button on the switch that contains the desired configuration.

After a stack has formed and sets up the interbox parameters, the stack operates the same way whether it is in a back-to-back configuration or is in a multi-unit configuration using the Catalyst Matrix interface.

Creating a Multi-Unit Catalyst Stack with a Catalyst Matrix Interface

Using a Catalyst Matrix, you can create a multi-unit stack of up to 8 Catalyst 39xx switches. The following sections describe how this multi-unit stack is formed:

- Catalyst Matrix Description
- Forming a Multi-Unit Catalyst Stack

Catalyst Matrix Description

The Catalyst Matrix is an eight-port switch matrix interface that connects up to eight Catalyst 39xx switches. The Catalyst 39xx senses if it is connected to a Catalyst Matrix and also senses if there are other Catalyst 39xx switches connected to that Catalyst Matrix. The connected Catalyst 39xx switches and the Catalyst Matrix combine logically to form a stack.

Any combination of up to eight Catalyst 39xx switches can be connected to or disconnected from the Catalyst Matrix while it, or any of the switches, are powered on or powered off. A proprietary shielded cable, 1 meter in length, with 50-pin connectors, is used to connect the Catalyst stack equipment together. The cable has *cross-over* wiring so either end can connect to the Catalyst Matrix, or to the Catalyst 39xx switches. The cable is plugged directly into a stack port I/O connector on the back of the Catalyst Matrix. The other end is plugged into a Catalyst stack port module interface card that is installed in the rear expansion slot in the Catalyst 39xx.

Forming a Multi-Unit Catalyst Stack

When Catalyst 39xx switches first power up, they run through a set of self-diagnostics. Immediately after the diagnostics are completed, the Catalyst 39xx switches run through a stack discovery mode. During this stack discovery mode, if two or more Catalyst 39xx switches are connected to a Catalyst Matrix, the switches detect the connection and combine logically to create a stack configuration.

As soon as the stack discovery mode is completed, each Catalyst 39xx is assigned a box number. With a Catalyst Matrix configuration, the box number for a Catalyst 39xx is determined by the port number the Catalyst 39xx is connected to on the Catalyst Matrix. For example, the Catalyst 39xx plugged into port 3 on the Catalyst Matrix becomes box 3. The box number remains constant as long as that switch is plugged in to that port. If a Catalyst 39xx is moved to another port, the box number for that Catalyst 39xx will change to the number of the port it is moved to.

Note: The switch with the lowest box number becomes the controlling switch.

For a stack to operate as a single entity, the interbox parameters must be the same in all of the switches in a stack. The “Interbox Parameters” section later in this chapter lists the shared parameters. There are two possible ways of providing configuration information to the Catalyst 39xx switches in a stack. These methods are as follows:

- Preconfigure all the Catalyst 39xx switches with the same parameters.
- Allow one of the switches to provide the configuration information to the other switches in the stack.

The first switch that comes up provides the initial configuration to the rest of the switches. If the switches come up simultaneously and their configurations differ, a warning message is displayed that instructs the user to briefly press the SYSREQ button on the switch that contains the desired configuration. Pressing the SYSREQ button causes the selected switch to send out its configuration information to the other switches in the stack.

Note: If you press the SYSREQ button for more than a few seconds, the System Request menu is displayed. If this happens, exit the System Request menu and then briefly press the SYSREQ button.

If the Catalyst 39xx switches are already powered on and *then* connected together, the same procedure as described above occurs, except that because the switches are already powered up and functioning, they will continue to perform their previous internal switching functions. While the normal internal switching functions are still operating, a split stack is formed. Once the split stack is formed, the console displays the same warning message, instructing the user to press the SYSREQ button of the switch that contains the desired configuration.



If Catalyst 3900s have formed a stack and any additional Catalyst 39xxs are added to the stack, the new switches will join the existing stack by altering their interbox parameters to match those of the existing stack.

After a stack has formed and sets up the interbox parameters, the stack operates the same way whether it is in a back-to-back configuration or is in a multi-unit configuration using the Catalyst Matrix interface.

Interbox Parameters

When a stack is formed, certain configuration information within all of the different Catalyst 39xx switches must combine to form a common configuration (interbox parameters). The stack operates as a single entity when all of the Catalyst 39xx switches in that stack use the same interbox parameters.

The following is a list of these shared interbox parameters:

- IP Configuration
 - IP address
 - Default gateway
 - Subnet mask
 - IP state
- Spanning-Tree Protocol (STP)
 - Participation
 - Switch priority
 - Port priority
 - Port cost
 - Maximum message age
 - Hello time
 - Forward delay
- VLAN information
- Limited Multicast Filters
- System password
- Console time-out
- Telnet configuration
 - Number of Telnet sessions allowed
 - Whether new Telnet sessions are allowed
- TFTP download
 - TFTP VLAN
 - TFTP server address
 - TFTP download filename
- Switch and stack information
 - Stack time-out
 - System name
 - System contact
 - System location
- SNMP configuration
 - Authentication traps
 - Trap table
 - Community name table

Using ATM

ATM is a cell-switching and multiplexing technology that combines the benefits of circuit switching (constant transmission delay and guaranteed capacity) with the benefits of packet switching (flexibility and efficiency for intermittent traffic).

ATM switches transmit small units of data called *cells*. The latency in a cell switch is very small because of the short cell size. Short cells have a tiny store-and-forward delay. In the absence of port contention and buffering, cells are switched quickly in hardware.

Both the Catalyst 3900 and the Catalyst 5000 offer ATM modules that you can use to interconnect your switches.

The Catalyst 3900 ATM expansion module is a single-port expansion module that provides high-speed connectivity between the Catalyst 3900 Token Ring switch and an ATM backbone network. The ATM expansion module has a transmission speed of 155 Mbps over a multimode fiber interface using a duplex subscriber connector (SC). The Catalyst 3900 ATM expansion module supports up to 63 ELANs and up to 2048 virtual channel connections (VCCs).

The Catalyst 5000 offers a variety of ATM expansion modules. These modules offer a transmission speed of 155 Mbps over a single-mode fiber connection, a multimode fiber connection, or a UTP connection. Each module supports up to 63 ELANs and up to 4096 VCCs.

For more information about ATM, see the “ATM and Token Ring LANE” chapter.

Using ISL

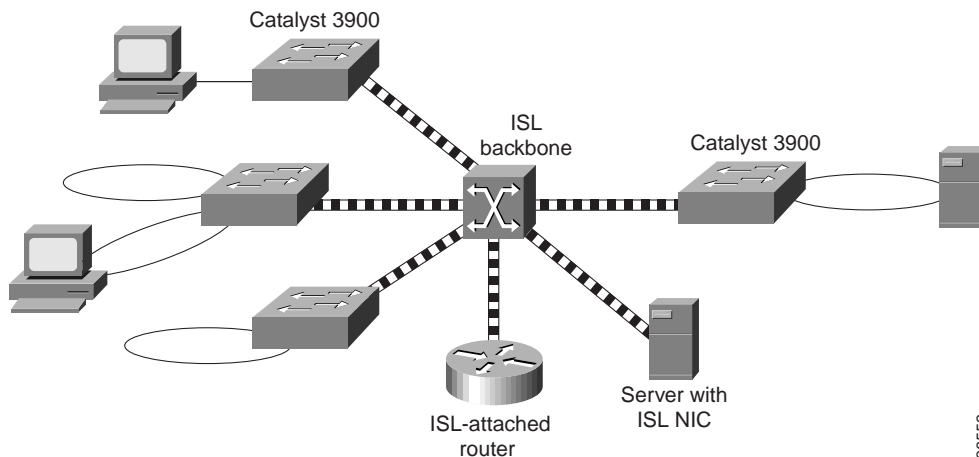
ISL was originally developed for Ethernet switches. It uses a Fast Ethernet interface to provide connectivity between switches and extends the VLAN capabilities of the switch by tagging the standard Fast Ethernet frame with the necessary VLAN information. Like ATM, ISL can provide a high-speed link between switches. Unlike ATM, ISL forwards the data across the high-speed link without breaking the frames into cells. The entire frame is sent intact across the ISL connection.

An ISL port is considered a trunk port. A *trunk* is a physical link that carries the traffic of multiple VLANs between two switches or between a switch and a router, thereby allowing the VLANs to be extended across switches. Trunks use high-speed interfaces such as Fast Ethernet, FDDI, or ATM.

The ISL protocol is a packet tagging protocol that contains a standard Ethernet or Token Ring frame and the VLAN information associated with that frame. Some additional information is also present in the frame. For more information about the ISL frame format, see the “Frame Formats” appendix.

The ISL backbone design looks much like an ATM design; however, ISL is less expensive than ATM and avoids the need for LAN emulation (LANE) services. It is primarily intended for network managers who do not want an ATM backbone for the campus. Routing between Token Ring VLANs is provided via an ISL-attached router or the Catalyst 5000 series Route Switch Module (RSM). Figure 3-1 shows an example of the ISL backbone design.

Figure 3-1 ISL Backbone Design



The Catalyst 5000 family of switches should be used to provide the ISL backbone. The Catalyst 3900 switch can then be connected to this backbone via the dual 100-Mbps ISL expansion module. In addition, vendors provide ISL network interface cards (NICs) that support both Token Ring and Ethernet VLANs. These NICs can be used for high-speed attachment to servers.

For the Catalyst 5000, any of the ports on many of its Fast Ethernet modules can be configured as trunk ports that use ISL.

The Catalyst 3900 2-port 100-Mbps Token Ring ISL module supports the encapsulation of Token Ring frames on a standard Fast Ethernet link to allow VLANs to be distributed across multiple platforms and devices. The module is available with a fiber or UTP copper media interface. The ports of the ISL module can be connected to the ports of another ISL module in another router or switch.

If you want to attach the Catalyst 3900 ISL port to the ISL port of a Catalyst 5000, you must manually configure the ISL port on the Catalyst 5000 for 100 Mbps (using the `set port speed` command) and full-duplex (using the `set port duplex` command).

Note: The ISL module does not support MAC or protocol filtering.

Using ISL in Parallel Configurations

While your Catalyst 3900 can contain both an ATM expansion module and an ISL expansion module, use caution when using ISL in a parallel configuration with ATM or Token Ring. Because the Catalyst 3900 supports the propagation of VLAN trunking information via ISL connections only, it is important that the ISL connection be the active path in an ISL-ATM parallel connection.

If the ISL module is configured in parallel connections with ATM or Token Ring, the STP allows only one active port at a time. When using the default Catalyst 3900 STP values, the path cost is calculated based on a 200-Mbps connection that results in a path cost of 5 and causes the STP to place the ISL port in forwarding mode and the ATM port or the Token Ring port in blocked mode.

However, modifying the Catalyst 3900 port STP values or using devices from other vendors that use different STP values can block the ISL port. If an ISL port becomes blocked in an ISL-ATM parallel connection, traffic passes via the ATM link, but VLAN trunking data is not passed. Also, if your STP configuration makes an ATM or Token Ring port the forwarding path to the root switch instead of the ISL link, the switch on the other end of a blocked ISL port might incorrectly limit AREs to the incoming TrCRE.

Therefore, when modifying STP values, always ensure that the STP port path costs are configured so that the ISL port is the preferred path. In an ISL parallel configuration, a Token Ring or ATM link should never have a lower cost to the root bridge than the ISL link.