



Configuring EtherChannels

This chapter describes how to configure EtherChannel on Layer 2 interfaces. EtherChannel provides fault-tolerant high-speed links between switches, routers, and servers. You can use it to increase the bandwidth between the wiring closets and the data center, and you can deploy it anywhere in the network where bottlenecks are likely to occur. EtherChannel provides automatic recovery for the loss of a link by redistributing the load across the remaining links. If a link fails, EtherChannel redirects traffic from the failed link to the remaining links in the channel without intervention.



Note

For complete syntax and usage information for the commands used in this chapter, refer to the command reference for this release.

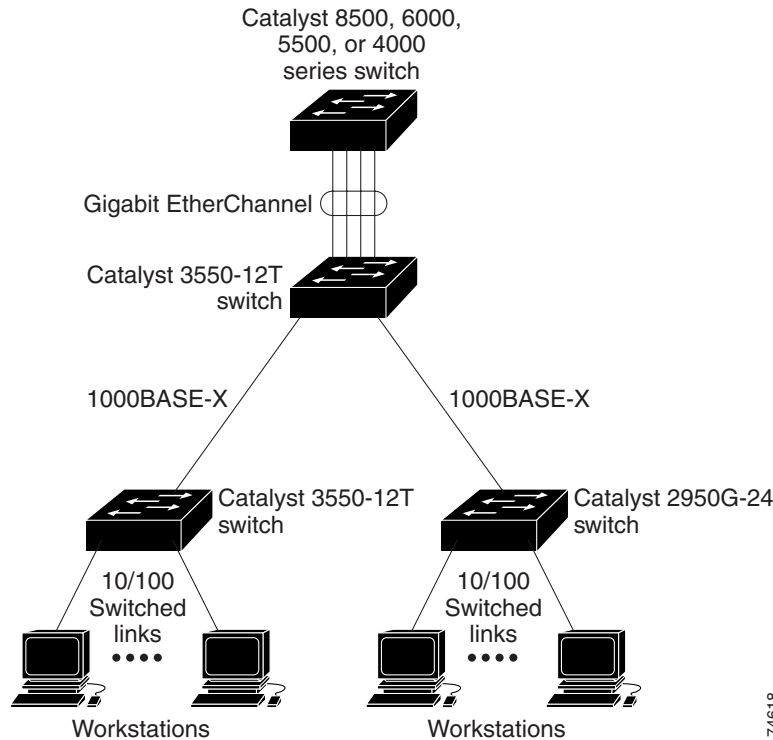
This chapter consists of these sections:

- [Understanding EtherChannels, page 26-1](#)
- [Configuring EtherChannels, page 26-7](#)
- [Displaying EtherChannel and PAgP Status, page 26-11](#)

Understanding EtherChannels

An EtherChannel consists of individual Fast Ethernet or Gigabit Ethernet links bundled into a single logical link as shown in [Figure 26-1](#). The EtherChannel provides full-duplex bandwidth up to 800 Mbps (Fast EtherChannel) or 2 Gbps (Gigabit EtherChannel) between your switch and another switch or host.

Figure 26-1 Typical EtherChannel Configuration



Each EtherChannel can consist of up to eight compatibly configured Ethernet interfaces. All interfaces in each EtherChannel must be the same speed, and all must be configured as Layer 2 interfaces.

**Note**

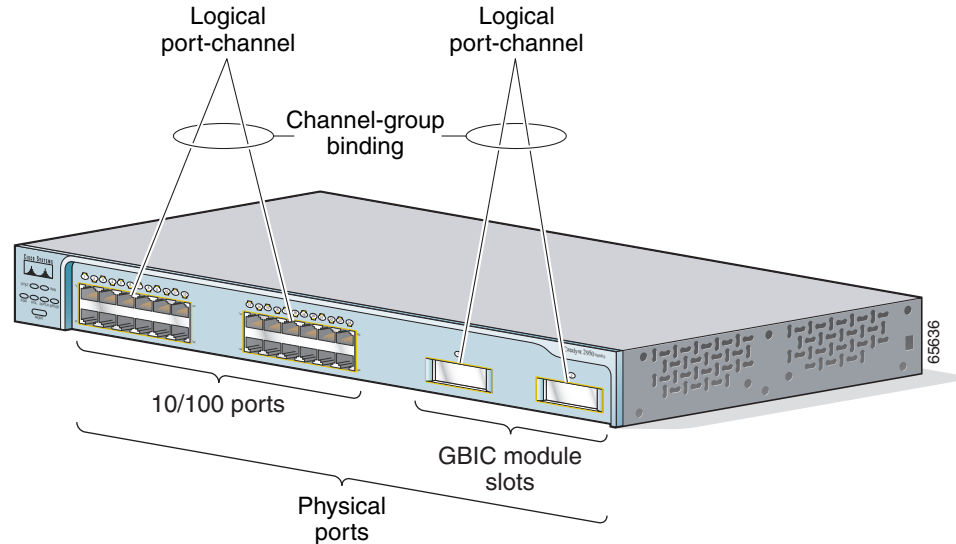
The network device to which your switch is connected can impose its own limits on the number of interfaces in the EtherChannel. For Catalyst 2950 switches, the number of EtherChannels is limited to six with eight ports per EtherChannel.

If a link within an EtherChannel fails, traffic previously carried over that failed link changes to the remaining links within the EtherChannel. A trap is sent for a failure, identifying the switch, the EtherChannel, and the failed link. Inbound broadcast and multicast packets on one link in an EtherChannel are blocked from returning on any other link of the EtherChannel.

Understanding Port-Channel Interfaces

When you create an EtherChannel for Layer 2 interfaces, a logical interface is dynamically created. You then manually assign an interface to the EtherChannel by using the **channel-group** interface configuration command as shown in [Figure 26-2](#).

Each EtherChannel has a logical port-channel interface numbered from 1 to 6.

Figure 26-2 Relationship of Physical Ports, Logical Port Channels, and Channel Groups

After you configure an EtherChannel, configuration changes applied to the port-channel interface apply to all the physical interfaces assigned to the port-channel interface. Configuration changes applied to the physical interface affect only the interface where you apply the configuration. To change the parameters of all ports in an EtherChannel, apply configuration commands to the port-channel interface, for example, spanning-tree commands or commands to configure a Layer 2 EtherChannel as a trunk.

Understanding the Port Aggregation Protocol

The Port Aggregation Protocol (PAgP) facilitates the automatic creation of EtherChannels by exchanging packets between Ethernet interfaces. By using PAgP, the switch learns the identity of partners capable of supporting PAgP and learns the capabilities of each interface. It then dynamically groups similarly configured interfaces into a single logical link (channel or aggregate port); these interfaces are grouped based on hardware, administrative, and port parameter constraints. For example, PAgP groups the interfaces with the same speed, duplex mode, native VLAN, VLAN range, and trunking status and type. After grouping the links into an EtherChannel, PAgP adds the group to the spanning tree as a single switch port.

PAgP Modes

Table 26-1 shows the user-configurable EtherChannel modes for the **channel-group** interface configuration command: **on**, **auto**, and **desirable**. Switch interfaces exchange PAgP packets only with partner interfaces configured in the **auto** or **desirable** modes; interfaces configured in the **on** mode do not exchange PAgP packets.

Table 26-1 EtherChannel Modes

Mode	Description
auto	Places an interface into a passive negotiating state, in which the interface responds to PAgP packets it receives but does not start PAgP packet negotiation. This setting minimizes the transmission of PAgP packets.
desirable	Places an interface into an active negotiating state, in which the interface starts negotiations with other interfaces by sending PAgP packets.
on	Forces the interface to channel without PAgP. With the on mode, a usable EtherChannel exists only when an interface group in the on mode is connected to another interface group in the on mode.

Both the **auto** and **desirable** modes allow interfaces to negotiate with partner interfaces to determine if they can form an EtherChannel based on criteria such as interface speed and, for Layer 2 EtherChannels, trunking state and VLAN numbers.

Interfaces can form an EtherChannel when they are in different PAgP modes as long as the modes are compatible. For example:

- An interface in the **desirable** mode can form an EtherChannel with another interface that is in the **desirable** or **auto** mode.
- An interface in the **auto** mode can form an EtherChannel with another interface in the **desirable** mode.

An interface in the **auto** mode cannot form an EtherChannel with another interface that is also in the **auto** mode because neither interface starts PAgP negotiation.

An interface in the **on** mode that is added to a port channel is forced to have the same characteristics as the already existing **on** mode interfaces in the channel.



Caution

You should exercise care when setting the mode to **on** (manual configuration). All ports configured in the **on** mode are bundled in the same group and are forced to have similar characteristics. If the group is misconfigured, packet loss or spanning-tree loops might occur.

If your switch is connected to a partner that is PAgP-capable, you can configure the switch interface for nonsilent operation by using the **non-silent** keyword. If you do not specify **non-silent** with the **auto** or **desirable** mode, silent mode is assumed.

The silent mode is used when the switch is connected to a device that is not PAgP-capable and seldom, if ever, sends packets. An example of a silent partner is a file server or a packet analyzer that is not generating traffic. In this case, running PAgP on a physical port connected to a silent partner prevents that switch port from ever becoming operational; however, the silent setting allows PAgP to operate, to attach the interface to a channel group, and to use the interface for transmission.

Physical Learners and Aggregate-Port Learners

Network devices are classified as PAgP physical learners or aggregate-port learners. A device is a physical learner if it learns addresses by physical ports and directs transmissions based on that knowledge. A device is an aggregate-port learner if it learns addresses by aggregate (logical) ports.

When a device and its partner are both aggregate-port learners, they learn the address on the logical port-channel. The device sends packets to the source by using any of the interfaces in the EtherChannel. With aggregate-port learning, it is not important on which physical port the packet arrives.

The switch uses source-MAC address distribution for a channel if it is connected to a physical learner even if the user configures destination-MAC address distribution.

These frame distribution mechanisms are possible for frame transmission:

- Port selection based on the source-MAC address of the packet
- Port selection based on the destination- MAC address of the packet

The switch supports up to eight ports in a PAgP group.

PAgP Interaction with Other Features

The Dynamic Trunking Protocol (DTP) and Cisco Discovery Protocol (CDP) send and receive packets over the physical interfaces in the EtherChannel. Trunk ports send and receive PAgP protocol data units (PDUs) on the lowest numbered VLAN.

Spanning tree sends packets over a single physical interface in the EtherChannel. Spanning tree regards the EtherChannel as one port.

PAgP sends and receives PAgP PDUs only from interfaces that are up and have PAgP enabled for the auto or desirable mode.

Understanding Load Balancing and Forwarding Methods

EtherChannel balances the traffic load across the links in a channel by reducing part of the binary pattern formed from the addresses in the frame to a numerical value that selects one of the links in the channel. EtherChannel load balancing can use either source-MAC or destination-MAC address forwarding.

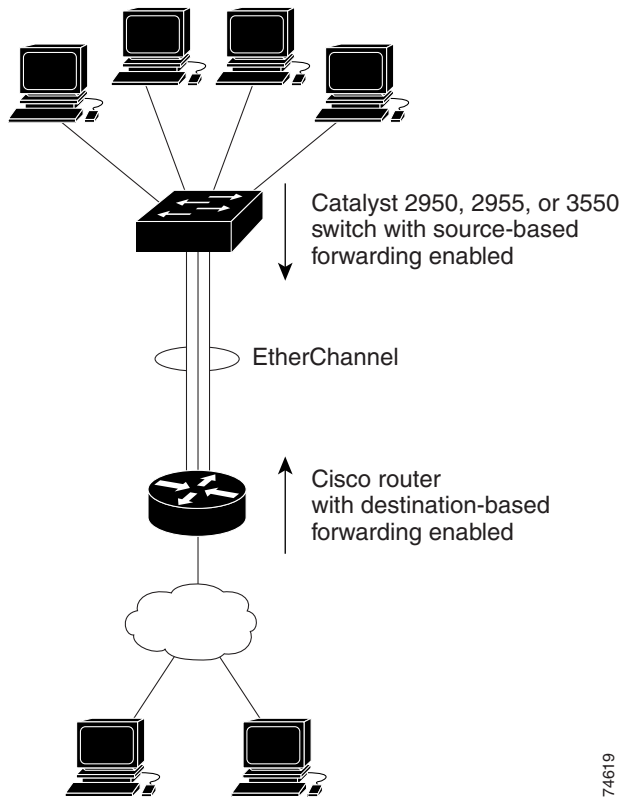
With source-MAC address forwarding, when packets are forwarded to an EtherChannel, they are distributed across the ports in the channel based on the source-MAC address of the incoming packet. Therefore, to provide load balancing, packets from different hosts use different ports in the channel, but packets from the same host use the same port in the channel (and the MAC address learned by the switch does not change).

With destination-MAC address forwarding, when packets are forwarded to an EtherChannel, they are distributed across the ports in the channel based on the destination host's MAC address of the incoming packet. Therefore, packets to the same destination are forwarded over the same port, and packets to a different destination are sent on a different port in the channel. You configure the load balancing and forwarding method by using the **port-channel load-balance** global configuration command.

In [Figure 26-3](#), an EtherChannel of four workstations communicates with a router. Because the router is a single-MAC-address device, source-based forwarding on the switch EtherChannel ensures that the switch uses all available bandwidth to the router. The router is configured for destination-based forwarding because the large number of workstations ensures that the traffic is evenly distributed from the router EtherChannel.

Use the option that provides the greatest variety in your configuration. For example, if the traffic on a channel is going only to a single MAC address, using the destination-MAC address always chooses the same link in the channel; using source addresses or IP addresses might result in better load balancing.

Figure 26-3 Load Distribution and Forwarding Methods



Configuring EtherChannels

These sections describe how to configure EtherChannel interfaces:

- [Default EtherChannel Configuration](#), page 26-7
- [EtherChannel Configuration Guidelines](#), page 26-8
- [Configuring Layer 2 EtherChannels](#), page 26-8
- [Configuring EtherChannel Load Balancing](#), page 26-10
- [Configuring the PAgP Learn Method and Priority](#), page 26-11



Note

Make sure that the interfaces are correctly configured (see the “[EtherChannel Configuration Guidelines](#)” section on page 26-8).



Note

After you configure an EtherChannel, configuration changes applied to the port-channel interface apply to all the physical interfaces assigned to the port-channel interface, and configuration changes applied to the physical interface affect only the interface where you apply the configuration.

Default EtherChannel Configuration

[Table 26-2](#) shows the default EtherChannel configuration.

Table 26-2 *Default EtherChannel Configuration*

Feature	Default Setting
Channel groups	None assigned.
PAgP mode	No default.
PAgP learn method	Aggregate-port learning on all interfaces.
PAgP priority	128 on all interfaces. (Changing this value has no effect.)
Load balancing	Load distribution on the switch is based on the source-MAC address of the incoming packet.

EtherChannel Configuration Guidelines

If improperly configured, some EtherChannel interfaces are automatically disabled to avoid network loops and other problems. Follow these guidelines to avoid configuration problems:

- Configure an EtherChannel with up to eight Ethernet interfaces of the same type.



Note Do not configure a GigaStack GBIC port as part of an EtherChannel.

- Configure all interfaces in an EtherChannel to operate at the same speeds and duplex modes.
- Enable all interfaces in an EtherChannel. An interface in an EtherChannel that is disabled by using the **shutdown** interface configuration command is treated as a link failure, and its traffic is transferred to one of the remaining interfaces in the EtherChannel.
- 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 these parameters, you must also make the changes to all ports in the group:
 - Allowed-VLAN list
 - Spanning-tree path cost for each VLAN
 - Spanning-tree port priority for each VLAN
 - Spanning-tree Port Fast setting
- If you configure Switch Port Analyzer (SPAN) on a port that is a member of the EtherChannel, it leaves the EtherChannel.
- Do not configure a port that belongs to an EtherChannel port group as a secure port.
- Before enabling 802.1X on the port, you must first remove it from the EtherChannel. If you try to enable 802.1X on an EtherChannel or on an active port in an EtherChannel, an error message appears, and 802.1X is not enabled. If you enable 802.1X on a not-yet active port of an EtherChannel, the port does not join the EtherChannel.
- Assign all interfaces in the EtherChannel to the same VLAN, or configure them as trunks.
- If you configure an EtherChannel from trunk interfaces, verify that the trunking mode (802.1Q) is the same on all the trunks. Inconsistent trunk modes on EtherChannel interfaces can have unexpected results.
- An EtherChannel supports the same allowed range of VLANs on all the interfaces in a trunking Layer 2 EtherChannel. If the allowed range of VLANs is not the same, the interfaces do not form an EtherChannel even when PAgP is set to the **auto** or **desirable** mode.
- Interfaces with different spanning-tree path costs can form an EtherChannel if they are otherwise compatibly configured. Setting different spanning-tree path costs does not, by itself, make interfaces incompatible for the formation of an EtherChannel.

Configuring Layer 2 EtherChannels

You configure Layer 2 EtherChannels by configuring the Ethernet interfaces with the **channel-group** interface configuration command, which creates the port-channel logical interface.



Note

Layer 2 interfaces must be connected and functioning for IOS to create port-channel interfaces.

Beginning in privileged EXEC mode, follow these steps to assign a Layer 2 Ethernet interface to a Layer 2 EtherChannel:

	Command	Purpose
Step 1	configure terminal	Enter global configuration mode.
Step 2	interface <i>interface-id</i>	Enter interface configuration mode, and specify a physical interface to configure. Valid interfaces include physical interfaces. Up to eight interfaces of the same type and speed can be configured for the same group.
Step 3	channel-group <i>channel-group-number</i> mode { auto [non-silent] desirable [non-silent] on }	Assign the interface to a channel group, and specify the PAgP mode. The default mode is auto silent . For <i>channel-group-number</i> , the range is 1 to 6. Each EtherChannel can have up to eight compatibly configured Ethernet interfaces. For mode , select one of these keywords: <ul style="list-style-type: none"> • auto—Enables PAgP only if a PAgP device is detected. It places an interface into a passive negotiating state, in which the interface responds to PAgP packets it receives but does not start PAgP packet negotiation. • desirable—Unconditionally enables PAgP. It places an interface into an active negotiating state, in which the interface starts negotiations with other interfaces by sending PAgP packets. • on—Forces the interface to channel without PAgP. With the on mode, a usable EtherChannel exists only when an interface group in the on mode is connected to another interface group in the on mode. • non-silent—If your switch is connected to a partner that is PAgP-capable, you can configure the switch interface for nonsilent operation. You can configure an interface with the non-silent keyword for use with the auto or desirable mode. If you do not specify non-silent with the auto or desirable mode, silent is assumed. The silent setting is for connections to file servers or packet analyzers; this setting allows PAgP to operate, to attach the interface to a channel group, and to use the interface for transmission. For information on compatible PAgP modes for the switch and its partner, see the “PAgP Modes” section on page 26-4.
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 entries in the configuration file.

To remove an interface from the EtherChannel group, use the **no channel-group** interface configuration command. If you delete the EtherChannel by using the **no interface port-channel** global configuration command without removing the physical interfaces, the physical interfaces are shutdown. If you do not want the member physical interfaces to shut down, remove the physical interfaces before deleting the EtherChannel.

This example shows how to assign Gigabit Ethernet interfaces 0/1 and 0/2 with the PAGP mode **desirable**:

```
Switch# configure terminal
Switch(config)# interface range gigabitethernet0/1 -2
Switch(config-if)# channel-group 5 mode desirable
Switch(config-if)# end
```

Configuring EtherChannel Load Balancing

This section describes how to configure EtherChannel load balancing by using source-based or destination-based forwarding methods. For more information, see the [“Understanding Load Balancing and Forwarding Methods”](#) section on page 26-5.

Beginning in privileged EXEC mode, follow these steps to configure EtherChannel load balancing:

	Command	Purpose
Step 1	<code>configure terminal</code>	Enter global configuration mode.
Step 2	<code>port-channel load-balance {dst-mac src-mac}</code>	<p>Configure an EtherChannel load-balancing method.</p> <p>The default is src-mac.</p> <p>Select one of these keywords to determine the load-distribution method:</p> <ul style="list-style-type: none"> • dst-mac—Load distribution is based on the destination-host MAC address of the incoming packet. Packets to the same destination are sent on the same port, but packets to different destinations are sent on different ports in the channel. • src-mac—Load distribution is based on the source-MAC address of the incoming packet. Packets from different hosts use different ports in the channel, but packets from the same host use the same port in the channel. <p>If the link partner to the switch is a physical learner, set the load-distribution method to one of these ways:</p> <ul style="list-style-type: none"> • If the channel-group interface configuration command is set to auto or desirable, the switch automatically uses the load distribution method based on the source-MAC address, regardless of the configured load-distribution method. • If the channel-group interface configuration command is set to on, set the load-distribution method based on the source-MAC address by using the port-channel load-balance src-mac global configuration command.
Step 3	<code>end</code>	Return to privileged EXEC mode.

	Command	Purpose
Step 4	<code>show etherchannel load-balance</code>	Verify your entries.
Step 5	<code>copy running-config startup-config</code>	(Optional) Save your entries in the configuration file.

To return EtherChannel load balancing to the default configuration, use the **no port-channel load-balance** global configuration command.

Configuring the PAgP Learn Method and Priority

Network devices are classified as PAgP physical learners or aggregate-port learners. A device is a physical learner if it learns addresses by physical ports and directs transmissions based on that knowledge. A device is an aggregate-port learner if it learns addresses by aggregate ports.

For compatibility with Catalyst 1900 series switches, configure the Catalyst 2950 switches for source-MAC load distribution.

The Catalyst 2950 switch supports address learning only on aggregate ports even though the **physical-port** keyword is provided in the command-line interface (CLI). The **pagp learn-method** and the **pagp port-priority** interface configuration command have no effect on the switch hardware.



Note

You should not set the learn method to **physical-port** because the switch is an aggregate-learning device.

If the link partner to the switch is a physical learner that has the **channel-group** interface configuration command set to **auto** or **desirable**, the switch automatically uses the load-distribution method based on the source MAC address, regardless of the configured load distribution method.

If the link partner to the Catalyst 2950 switch is a physical learner that has the **channel-group** interface configuration command set to **on**, set the load-distribution method based on the source MAC address by using the **port-channel load-balance src-mac** global configuration command.

Displaying EtherChannel and PAgP Status

You can use the privileged EXEC commands described in [Table 26-3](#) to display EtherChannel and PAgP status information:

Table 26-3 Commands for Displaying EtherChannel and PAgP Status

Command	Description
<code>show etherchannel [channel-group-number] {brief detail load-balance port port-channel summary}</code>	Displays EtherChannel information in a brief, detailed, and one-line summary form. Also displays the load-balance or frame-distribution scheme, port, and port-channel information.
<code>show pagp [channel-group-number] {counters internal neighbor}</code> ¹	Displays PAgP information such as traffic information, the internal PAgP configuration, and neighbor information.

1. You can clear PAgP channel-group information and traffic filters by using the **clear pagp [channel-group-number] [counters] | counters** privileged EXEC command.

For detailed information about the fields in the displays, refer to the command reference for this release.

