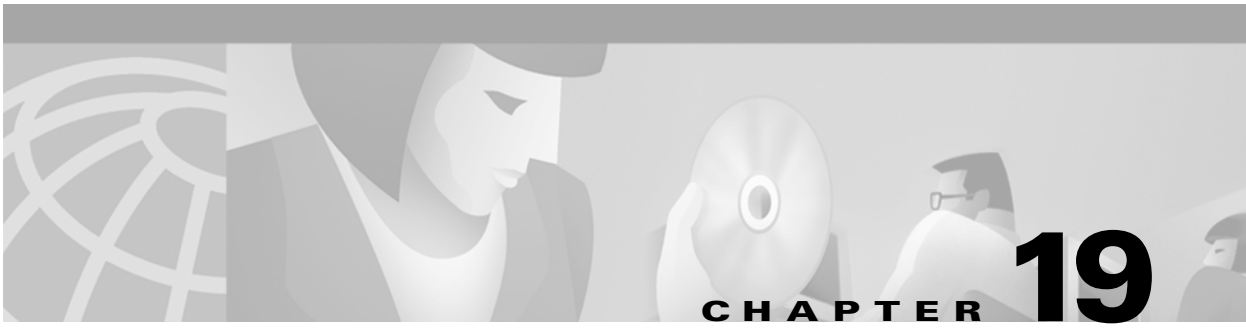


CHAPTER 19

Configuring EtherChannel

This chapter describes how to configure EtherChannel on Layer 2 and Layer 3 interfaces. To configure Layer 3 interfaces, you must have the enhanced multilayer switch image installed on your switch.

Note For complete syntax and usage information for the commands used in this chapter, refer to the *Catalyst 3550 Multilayer Switch Command Reference* for this release.

This chapter consists of these sections:

Understanding EtherChannel

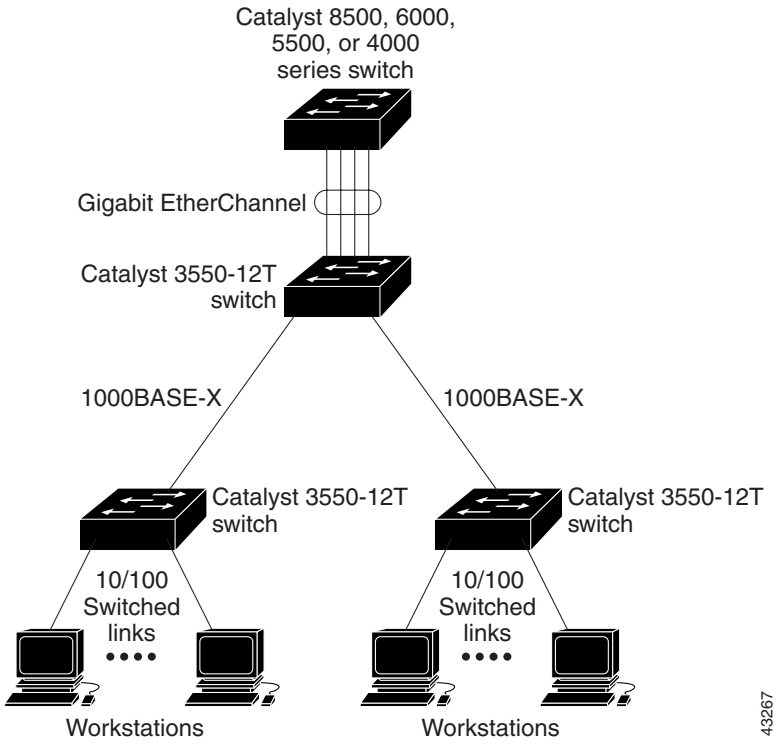
EtherChannel is composed of individual Gigabit Ethernet links bundled into a single logical link as shown in Figure 19-1. The EtherChannel provides full-duplex bandwidth up to 8 Gbps (Gigabit EtherChannel) between your switch and another switch or host.

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 either Layer 2 or Layer 3 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 3550 switches, the number of EtherChannels is limited to the number of ports of the same type.

If a link within an EtherChannel fails, traffic previously carried over the 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.

Figure 19-1 Typical EtherChannel Configuration



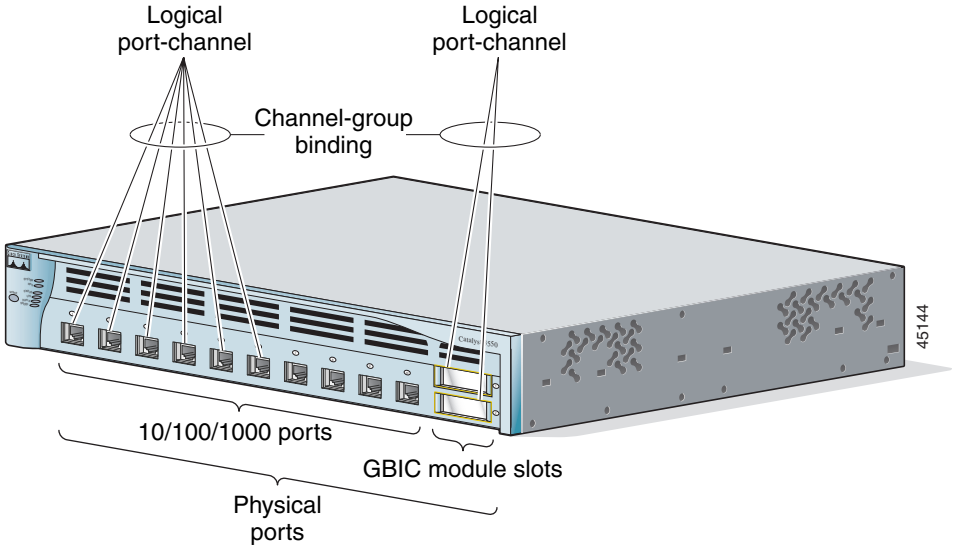
Understanding Port-Channel Interfaces

You create an EtherChannel for Layer 2 interfaces differently from Layer 3 interfaces. Both configurations involve logical interfaces.

- With Layer 3 interfaces, you manually create the logical interface by using the **interface port-channel** global configuration command.
- With Layer 2 interfaces, the logical interface is dynamically created.
- With both Layer 3 and 2 interfaces, you manually assign an interface to the EtherChannel by using the **channel-group** interface configuration command. This command binds the physical and logical ports together as shown in Figure 19-2.

Each EtherChannel has a logical port-channel interface numbered from 1 to 64. The channel groups are also numbered from 1 to 64.

Figure 19-2 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, and 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 Protocol (STP) 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, native VLAN, VLAN range, and the 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 19-1 shows the three 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 19-1 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 initiate PAgP packet negotiation. This setting minimizes the transmission of PAgP packets and is the default.
desirable	Places an interface into an active negotiating state, in which the interface initiates 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 **desirable** mode can form an EtherChannel with another interface that is in **desirable** or **auto** mode.
- An interface in **auto** mode can form an EtherChannel with another interface in **desirable** mode.
- An interface in **auto** mode cannot form an EtherChannel with another interface that is also in **auto** mode because neither interface initiates 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 STP 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 is assumed.

The silent mode is used when the switch is connected to a device that is not PAgP-capable and seldom, if ever, transmits 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 learning. 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 transmits packets to the source using any of the interfaces in the EtherChannel. With aggregate-port learning, it is not important on which physical port the packet arrives.

PAgP cannot automatically detect when the partner device is a physical learner and the local device is an aggregate-port learner. Therefore, you must manually set the learning method on the local device for source-based distribution by using the **pagp learn-method src-mac** interface configuration command. With source-based distribution, any given source MAC address is always sent on the same physical port. You can also configure a single interface within the group for all transmissions and use other interfaces for hot standby. The unused interfaces in the group can be swapped into operation in just a few seconds if the selected single interface loses hardware signal detection. You can configure which interface is always selected for packet transmission by changing its priority by using the **pagp port-priority** interface configuration command. The higher the priority, the more likely that the port will be selected.

PAgP Interaction with Other Features

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

STP sends packets over the first interface in the EtherChannel.

The MAC address of a Layer 3 EtherChannel is the MAC address of the first interface in the port-channel.

PAgP transmits 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 same MAC address learned by the switch does not change).

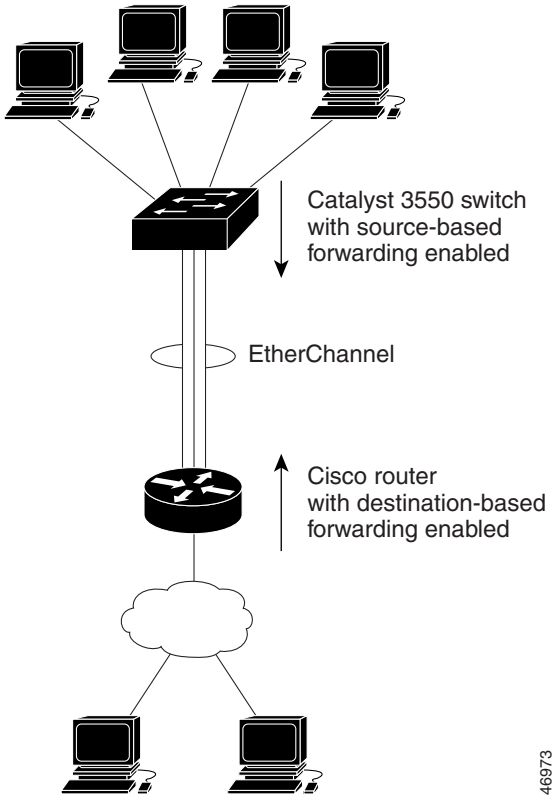
When the source MAC address forwarding method is used, load distribution based on the source and destination IP address is also enabled for routed IP traffic. All routed IP traffic chooses a port based on the source and destination IP address. Packets between two IP hosts always use the same port in the channel, and traffic between any other pair of hosts can use a different port in the channel.

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 19-3, 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 19-3 Load Distribution and Forwarding Methods



Configuring EtherChannel

This section describes these configurations for EtherChannel on Layer 2 and Layer 3 interfaces:

Note Make sure that the interfaces are correctly configured (see the "EtherChannel Configuration Guidelines" section on page 19-8).

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 19-2 shows the default EtherChannel configuration.

Table 19-2 Default EtherChannel Configuration

Feature	Default Setting
Channel groups	None assigned.
Layer 3 port-channel logical interface	None defined.
PAgP mode	Auto and silent (The interface is in a passive negotiating state; it responds to PAgP packets it receives but does not initiate PAgP packet negotiation. PAgP is enabled only if a PAgP device is detected.)
PAgP learn method	Aggregate-port learning on all interfaces.
PAgP priority	128 on all interfaces.
Load balancing	Load distribution on the switch is based on the source MAC address of the incoming packet. Load distribution based on the source and destination IP address is also enabled for routed IP traffic.

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:

- Each EtherChannel can consist of up to eight compatibly configured Ethernet interfaces.
- Configure all interfaces in an EtherChannel to operate at the same speed and duplex mode.
- Enable all interfaces in an EtherChannel. If you shut down an interface in an EtherChannel, it 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
  - STP path cost for each VLAN
  - STP port priority for each VLAN
  - STP Port Fast setting
- For Layer 2 EtherChannels:
  - Assign all interfaces in the EtherChannel to the same VLAN, or configure them as trunks. Interfaces with different native VLANs cannot form an EtherChannel.
  - If you configure an EtherChannel from trunk interfaces, verify that the trunking mode (ISL or 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 STP path costs can form an EtherChannel as long they are otherwise compatibly configured. Setting different STP path costs does not, by itself, make interfaces incompatible for the formation of an EtherChannel.
- For Layer 3 EtherChannels, assign the Layer 3 address to the port-channel logical interface, not to the physical interfaces in the channel.

Configuring Layer 2 EtherChannels

To configure Layer 2 EtherChannels, you configure 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 for Layer 2 EtherChannels.

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** *interface-id*	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	**switchport mode** {**access** | **trunk**} **switchport access vlan** *vlan-id*	Assign all interfaces as static-access ports in the same VLAN, or configure them as trunks. If you configure the interface as a static-access port, assign it to only one VLAN. The range is 1 to 1005.

	Command	Purpose
Step 4	**channel-group** *channel-group-number* **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 *channel-group-number*, the range is 1 to 64. Each EtherChannel can consist of up to eight compatibly configured Ethernet interfaces. For **mode**, select one of these keywords: • **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 initiate PAgP packet negotiation. • **desirable**—Unconditionally enables PAgP. It places an interface into an active negotiating state, in which the interface initiates 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 non-silent 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 19-4.
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 entries in the configuration file.

To remove an interface from the EtherChannel group, use the **no channel-group** interface configuration command.

This example shows how to assign Gigabit Ethernet interfaces 0/4 and 0/5 as static-access ports in VLAN 10 to channel 5 with PAgP mode **desirable**:

```
Switch# configure terminal
Switch(config)# interface range gigabitethernet0/4 -5
Switch(config-if)# switchport mode access
Switch(config-if)# switchport access vlan 10
Switch(config-if)# channel-group 5 mode desirable
Switch(config-if)# end
```

Note For information about the **range** keyword, see the "Configuring a Range of Interfaces" section on page 7-9.

Configuring Layer 3 EtherChannels

To configure Layer 3 EtherChannels, you create the port-channel logical interface and then put the Ethernet interfaces into the port-channel as described in the next two sections.

Creating Port-Channel Logical Interfaces

Note To move an IP address from a physical interface to an EtherChannel, you must delete the IP address from the physical interface before configuring it on the port-channel interface.

Beginning in privileged EXEC mode, follow these steps to create a port-channel interface for a Layer 3 EtherChannel:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface port-channel** *port-channel-number*	Enter interface configuration mode, and create the port-channel logical interface. For *port-channel-number*, the range is 1 to 64.
Step 3	**no switchport**	Put the interface into Layer 3 mode. You must have the enhanced multilayer switch image installed to use this command.
Step 4	**ip address** *ip-address mask*	Assign an IP address and subnet mask to the EtherChannel.
Step 5	**end**	Return to privileged EXEC mode.
Step 6	**show etherchannel** *channel-group-number* **detail**	Verify your entries.
Step 7	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.
Step 8		Assign an Ethernet interface to the Layer 3 EtherChannel. For more information, see the "Configuring the Physical Interfaces" section on page 19-12.

To remove the port-channel, use the **no interface port-channel** *port-channel-number* global configuration command.

This example shows how to create the logical port channel (5) and assign 172.10.20.10 as its IP address:

```
Switch# configure terminal
Switch(config)# interface port-channel 5
Switch(config-if)# no switchport
Switch(config-if)# ip address 172.10.20.10 255.255.255.0
Switch(config-if)# end
```

Configuring the Physical Interfaces

Beginning in privileged EXEC mode, follow these steps to assign an Ethernet interface to a Layer 3 EtherChannel:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	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	**no ip address**	Ensure that there is no IP address assigned to the physical interface.
Step 4	**channel-group** *channel-group-number* **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 *channel-group-number*, the range is 1 to 64. This number must be the same as the *port-channel-number* (logical port) configured in the "Creating Port-Channel Logical Interfaces" section on page 19-11. Each EtherChannel can consist of up to eight compatibly configured Ethernet interfaces. For **mode**, select one of these keywords: • **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 initiate PAgP packet negotiation. • **desirable**—Unconditionally enables PAgP. It places an interface into an active negotiating state, in which the interface initiates 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 non-silent 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 19-4.

	Command	Purpose
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 entries in the configuration file.

To remove an interface from the EtherChannel group, use the **no channel-group** interface configuration command.

This example shows how to assign Gigabit Ethernet interfaces 0/4 and 0/5 to channel 5 with PAgP mode **desirable**:

```
Switch# configure terminal
Switch(config)# interface range gigabitethernet0/4 -5
Switch(config-if)# no ip address
Switch(config-if)# channel-group 5 mode desirable
Switch(config-if)# end
```

Note For information about the **range** keyword, see the "Configuring a Range of Interfaces" section on page 7-9.

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 19-5.

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

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**port-channel load-balance** {**dst-mac** | **src-mac**}	Configure an EtherChannel load-balancing method. The default is **src-mac**. Select one of these keywords to determine the load-distribution method: • **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. When **src-mac** is used, load distribution based on the source and destination IP address is also enabled. For all IP traffic being routed, the switch chooses a port for transmission based on the source and destination IP address. Packets between two IP hosts always use the same port for packet transmission, but packets between any other pair of hosts might use a different transmission port.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show etherchannel load-balance**	Verify your entries.
Step 5	**copy running-config startup-config**	(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 learning. A device is an aggregate-port learner if it learns addresses by aggregate ports.

For compatibility with Catalyst 1900 series switches, configure the PAgP learn method on the Catalyst 3550 switches to learn source MAC addresses on the physical port. The switch then transmits packets to the Catalyst 1900 switch using the same interface in the EtherChannel from which it learned the source address.

Beginning in privileged EXEC mode, follow these steps to configure your switch as a PAgP physical-port learner and adjust the priority so that the same port in the bundle is selected for transmitting packets:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Enter interface configuration mode, and specify the interface for transmission.
Step 3	**pagp learn-method physical-port**	Select the PAgP learning method. By default, **aggregation-port** learning is selected, which means the switch transmits 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. Select **physical-port** to connect with another switch that is a physical learner. Make sure to configure the **port-channel load-balance** global configuration command to **src-mac** as described in the "Configuring EtherChannel Load Balancing" section on page 19-13. The learn method must be configured the same at both ends of the link.
Step 4	**pagp port-priority** *priority*	Assign a priority so that the selected interface is chosen for packet transmission. For *priority*, the range is 0 to 255. The default is 128. The higher the priority, the more likely that the interface will be used for PAgP transmission.
Step 5	**end**	Return to privileged EXEC mode.
Step 6	**show running-config** or **show pagp** *channel-group-number* **internal**	Verify your entries.
Step 7	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To return the priority to its default setting, use the **no pagp port-priority** interface configuration command. To return the learning method to its default setting, use the **no pagp learn-method** interface configuration command.

Displaying EtherChannel and PAgP Status

You can use the user EXEC commands described in Table 19-3 to display EtherChannel and PAgP status information:

Table 19-3 Commands for Displaying EtherChannel and PAgP Status

Command	Description
show etherchannel [*channel-group-number*] {**brief** | **detail** | **load-balance** | **port** | **port-channel** | **summary**}	Displays EtherChannel information in a brief, detailed, and one-line summary form. Also displays the load-balance or frame-distribution scheme, and port, and port-channel information.
show pagp {*channel-group-number*} {**counters** | **internal** | **neighbor**}[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**} privileged EXEC command.

For detailed information about the fields in the displays, refer to the *Catalyst 3550 Multilayer Switch Command Reference* for this release.