
# EtherChannel Configuration and Link State Tracking

This chapter describes how to configure EtherChannels on Layer 2 and Layer 3 ports on the CGR 2010 ESM. 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. This chapter also describes how to configure link-state tracking.

For information about configuring the backplane PortChannel48 interface, which provides communication between the host router and the switch module, see Chapter 9, "EtherChannel Configuration Between the Switch Module and the Host Router."

**Note** For complete syntax and usage information for the commands used in this chapter, see the command reference for this release.

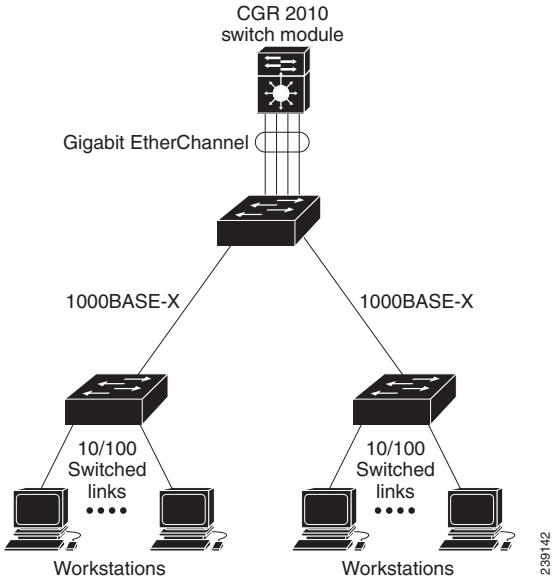


## Understanding EtherChannels

# EtherChannel Overview

An EtherChannel consists of individual Fast Ethernet or Gigabit Ethernet links bundled into a single logical link as shown in Figure 15-1.

***Figure 15-1 Typical EtherChannel Configuration***




The EtherChannel provides full-duplex bandwidth of up to 800 Mbps between your switch module and another switch module or host for Fast EtherChannel on a switch module with 24 Fast Ethernet ports. For Gigabit EtherChannel, you can configure up to 8 Gbps (8 ports of 1 Gbps), depending on the number of supported Gigabit Ethernet interfaces.

**Note** Only network node interfaces (NNIs) and enhanced network interfaces (ENIs) support Link Aggregation Control Protocol (LACP). Use the **port-type** {**eni** | **nni**} interface configuration command to configure a port as an ENI or NNI. The switch module must be running the IP services image to allow configuring of more than four ports as NNIs.

Each EtherChannel can consist of up to eight compatibly configured Ethernet ports. All ports in each EtherChannel must be configured as either Layer 2 or Layer 3 ports. The number of EtherChannels is limited to 48. For more information, see the "EtherChannel Configuration Guidelines" section on page 15-8. The EtherChannel Layer 3 ports are made up of routed ports. Routed ports are physical ports configured to be in Layer 3 mode by using the **no switchport** interface configuration command. For more information, see Chapter 8, "Interface Configuration."

You can configure an EtherChannel in one of these modes: Link Aggregation Control Protocol (LACP) or On mode. LACP is available only on NNIs and ENIs. Configure both ends of the EtherChannel in the same mode:

- When you configure one end of an EtherChannel inr LACP mode, the system negotiates with the other end of the channel to determine which ports should become active. Incompatible ports are suspended.

- When you configure an EtherChannel in the **on** mode, no negotiations take place. The switch module forces all compatible ports to become active in the EtherChannel. The other end of the channel (on the other switch module) must also be configured in the **on** mode; otherwise, packet loss can occur.

  The local port is put into an independent state and continues to carry data traffic as would any other single link. The port configuration does not change, but the port does not participate in the 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 module, 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.

# Port-Channel Interfaces

When you create an EtherChannel, a port-channel logical interface is involved:

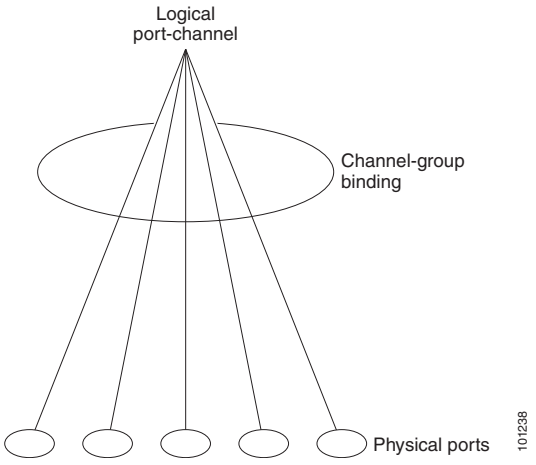
- With Layer 2 ports, use the **channel-group** interface configuration command to dynamically create the port-channel logical interface.

  You also can use the **interface port-channel** *port-channel-number* global configuration command to manually create the port-channel logical interface, but then you must use the **channel-group** *channel-group-number* command to bind the logical interface to a physical port. The *channel-group-number* can be the same as the *port-channel-number,* or you can use a new number. If you use a new number, the **channel-group** command dynamically creates a new port channel.
- With Layer 3 ports, you should manually create the logical interface by using the **interface port-channel** global configuration command followed by the **no switchport** interface configuration command. Then you manually assign an interface to the EtherChannel by using the **channel-group** interface configuration command.

For both Layer 2 and Layer 3 ports, the **channel-group** command binds the physical port and the logical interface together as shown in Figure 15-2.

Each EtherChannel has a port-channel logical interface numbered from 1 to 48. This port-channel interface number corresponds to the one specified with the **channel-group** interface configuration command.

***Figure 15-2 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 ports assigned to the port-channel interface. Configuration changes applied to the physical port affect only the port to which you apply the configuration. To change the parameters of all ports in an EtherChannel, apply the configuration commands to the port-channel interface.

# Link Aggregation Control Protocol

The LACP is defined in IEEE 802.3ad standard and enables Cisco switches to manage Ethernet channels between switches that conform to the standard. LACP facilitates the automatic creation of EtherChannels by exchanging LACP packets between Ethernet ports.

**Note** LACP is available only on NNIs and ENIs.

By using LACP, the switch module learns the identity of partners capable of supporting LACP and the capabilities of each port. It then dynamically groups similarly configured ports into a single logical link (channel or aggregate port). Similarly configured ports are grouped based on hardware, administrative, and port parameter constraints. For example, LACP groups the ports with the same speed, duplex mode, native VLAN, VLAN range, and trunking status and type. After grouping the links into an EtherChannel, LACP adds the group to the spanning tree as a single switch module port.

## LACP Modes

Table 15-1 shows the user-configurable EtherChannel LACP modes for the **channel-group** interface configuration command on an NNI or ENI.

*Table 15-1 EtherChannel LACP Modes*

| Mode | Description |
|---|---|
| **active** | Places a port into an active negotiating state in which the port starts negotiations with other ports by sending LACP packets. |
| **passive** | Places a port into a passive negotiating state in which the port responds to LACP packets that it receives, but does not start LACP packet negotiation. This setting minimizes the transmission of LACP packets. |

Both the **active** and **passive LACP** modes enable ports to negotiate with partner ports to an EtherChannel based on criteria such as port speed and, for Layer 2 EtherChannels, trunking state and VLAN numbers.

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

- A port in the **active** mode can form an EtherChannel with another port that is in the **active** or **passive** mode.
- A port in the **passive** mode cannot form an EtherChannel with another port that is also in the **passive** mode because neither port starts LACP negotiation.

### LACP Interaction with Other Features

The CDP sends and receives packets over the physical ports in the EtherChannel. Trunk ports send and receive LACP PDUs on the lowest numbered VLAN.

In Layer 2 EtherChannels, the first port in the channel that comes up provides its MAC address to the EtherChannel. If this port is removed from the bundle, one of the remaining ports in the bundle provides its MAC address to the EtherChannel.

LACP sends and receives LACP PDUs only from ports that are up and have LACP enabled for the active or passive mode.

## EtherChannel On Mode

EtherChannel **on** mode can be used to manually configure an EtherChannel. The **on** mode forces a port to join an EtherChannel without negotiations. It can be useful if the remote device does not support LACP. With the **on** mode, a usable EtherChannel exists only when both ends of the link are configured in the **on** mode.

**Note** For UNIs, the only available mode is **on**.

Ports that are configured in the **on** mode in the same channel group must have compatible port characteristics, such as speed and duplex. Ports that are not compatible are suspended, even though they are configured in the **on** mode.

**Caution** You should use care when using the **on** mode. This is a manual configuration, and ports on both ends of the EtherChannel must have the same configuration. If the group is misconfigured, packet loss or spanning-tree loops can occur.

## 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 MAC addresses or IP addresses, source or destination addresses, or both source and destination addresses. The selected mode applies to all EtherChannels configured on the switch module. You configure the load balancing and forwarding method by using the **port-channel load-balance** global configuration command.

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. 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.

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 MAC address of the incoming packet. 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.

On the CGR 2010 ESM, load distribution based on the destination host MAC address supports only four ports per EtherChannel. When you configure EtherChannel destination-MAC address load balancing, the traffic is balanced only among four ports in the channel group.If you configure more than four ports in an EtherChannel with destination host MAC address load distribution, only four of the ports receive distributed traffic. This limitation does not apply to the other load distribution methods.

With source-and-destination MAC address forwarding, when packets are forwarded to an EtherChannel, they are distributed across the ports in the channel based on both the source and destination MAC addresses. This forwarding method, a combination source-MAC and destination-MAC address forwarding methods of load distribution, can be used if it is not clear whether source-MAC or destination-MAC address forwarding is better suited on a particular switch module. With source-and-destination MAC-address forwarding, packets sent from host A to host B, host A to host C, and host C to host B could all use different ports in the channel.

With source-IP-address-based forwarding, when packets are forwarded to an EtherChannel, they are distributed across the ports in the EtherChannel based on the source-IP address of the incoming packet. To provide load-balancing, packets from different IP addresses use different ports in the channel, but packets from the same IP address use the same port in the channel.

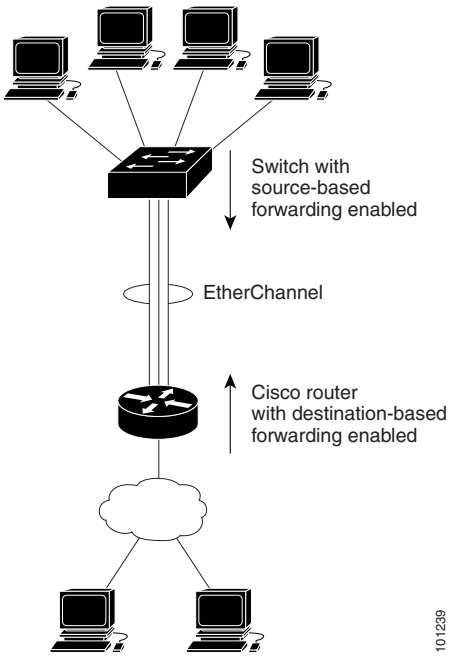
With destination-IP-address-based forwarding, when packets are forwarded to an EtherChannel, they are distributed across the ports in the EtherChannel based on the destination-IP address of the incoming packet. To provide load-balancing, packets from the same IP source address sent to different IP destination addresses could be sent on different ports in the channel. But packets sent from different source IP addresses to the same destination IP address are always sent on the same port in the channel.

With source-and-destination IP address-based forwarding, when packets are forwarded to an EtherChannel, they are distributed across the ports in the EtherChannel based on both the source and destination IP addresses of the incoming packet. This forwarding method, a combination of source-IP and destination-IP address-based forwarding, can be used if it is not clear whether source-IP or destination-IP address-based forwarding is better suited on a particular switch module. In this method, packets sent from the IP address A to IP address B, from IP address A to IP address C, and from IP address C to IP address B could all use different ports in the channel.

Different load-balancing methods have different advantages, and the choice of a particular load-balancing method should be based on the position of the switch module in the network and the kind of traffic that needs to be load-distributed. In Figure 15-3, an EtherChannel of four workstations communicates with a router. Because the router is a single-MAC-address device, source-based forwarding on the switch module EtherChannel ensures that the switch module 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 15-3 Load Distribution and Forwarding Methods*




# Configuring EtherChannels



**Note** Make sure that the ports are correctly configured. For more information, see the "EtherChannel Configuration Guidelines" section on page 15-8.

**Note** After you configure an EtherChannel, configuration changes applied to the port-channel interface apply to all the physical ports assigned to the port-channel interface, and configuration changes applied to the physical port affect only the port to which you apply the configuration.

## Default EtherChannel Configuration

Table 15-2 shows the default EtherChannel configuration.

*Table 15-2 Default EtherChannel Configuration*

| Feature | Default Setting |
|---|---|
| Channel groups | None assigned. |
| Port-channel logical interface | None defined. |
| LACP mode | No default. |
| LACP learn method | Aggregate-port learning on all NNIs and ENIs. |
| LACP port priority | 32768 on all NNIs and ENIs. |
| LACP system priority | 32768. |
| LACP system ID | LACP system priority and the switch module MAC address. |
| Load balancing | Load distribution on the switch module is based on the source-MAC address of the incoming packet. |

# EtherChannel Configuration Guidelines

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

- Do not try to configure more than 48 EtherChannels on the switch module.
- Configure a LACP EtherChannel including only NNIs or only ENIs.
- Configure all ports in an EtherChannel to operate at the same speeds and duplex modes.
- All ports in an EtherChannel must be the same type, either UNI, NNI, or ENI. You cannot mix port types in an EtherChannel.
- On UNIs, the EtherChannel mode must always be configured to **on**.
- Enable all ports in an EtherChannel. A port 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 ports in the EtherChannel. UNIs and ENIs are disabled by default. NNIs are enabled by default.
- 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

  **Note** Spanning Tree Protocol is only supported on NNIs or ENIs on which it has been specifically enabled.

- Do not configure a port to be a member of more than one EtherChannel group.

- Do not configure an EtherChannel in LACP mode. EtherChannel groups running LACP can coexist on the same switch module. Individual EtherChannel groups can run LACP, but they cannot interoperate.

**Note** LACP is only available on NNIs and ENIs.

- If the switch module is running the CGR 2010 LAN base image, you can have only four NNIs on the switch module at the same time; only four ports in an EtherChannel can support LACP at the same time.If the switch module is running the IP services image, there is no limit to the number of NNIs that can be configured on the switch module.
- Do not configure a Switched Port Analyzer (SPAN) destination port as part of an EtherChannel.
- Do not configure a secure port as part of an EtherChannel or the reverse.
- Do not configure a private-VLAN port as part of an EtherChannel.
- Do not configure a port that is an active or a not-yet-active member of an EtherChannel as an 802.1x port. If you try to enable 802.1x on an EtherChannel port, an error message appears, and 802.1x is not enabled.
- If EtherChannels are configured on switch module interfaces, remove the EtherChannel configuration from the interfaces before globally enabling 802.1x on a switch module by using the **dot1x system-auth-control** global configuration command.
- Do not enable link-state tracking on individual interfaces that will be part of a downstream Etherchannel interface.
- For Layer 2 EtherChannels:
  - Assign all ports in the EtherChannel to the same VLAN, or configure them as trunks. Ports with different native VLANs cannot form an EtherChannel.
  - If you configure an EtherChannel from trunk ports, verify that the trunking mode is the same on all the trunks. Inconsistent trunk modes on EtherChannel ports can have unexpected results.
  - An EtherChannel supports the same allowed range of VLANs on all the ports in a trunking Layer 2 EtherChannel.
  - NNIs or ENIs 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 ports 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 ports in the channel.

# Configuring Layer 2 EtherChannels

You configure Layer 2 EtherChannels by assigning ports to a channel group with the **channel-group** interface configuration command. This command automatically creates the port-channel logical interface.

Beginning in privileged EXEC mode, follow these steps to assign a Layer 2 Ethernet port to a Layer 2 EtherChannel. This procedure is required.

| | Step | Command |
|---|---|---|
| **Step 1** | Enter global configuration mode. | **configure terminal** |
| **Step 2** | Specify a physical port, and enter interface configuration mode.<br>Valid interfaces include physical ports.<br>For a LACP EtherChannel, you can configure up to 16 Ethernet ports of the same type. Up to eight ports can be active, and up to eight ports can be in standby mode.<br>**Note** If the interface is a UNI, you must enter the **port-type** {**eni** \| **nni**} interface configuration command before configuring LACP. | **interface** *interface-id* |
| **Step 3** | Enable the port, if necessary. By default, UNIs and ENIs are disabled, and NNIs are enabled. | **no shutdown** |
| **Step 4** | Assign all ports as static-access ports in the same VLAN, or configure them as trunks.<br>If you configure the port as a static-access port, assign it to only one VLAN. The range is 1 to 4094. | **switchport mode** {**access** \| **trunk**}<br>**switchport access vlan** *vlan-id* |
| **Step 5** | Assign the port to a channel group, and specify the LACP mode.<br>For *channel-group-number*, the range is 1 to 48.<br>**Note** For UNIs, the only available mode is **on**.<br>For **mode**, select one of these keywords:<br>• **on**—Forces the port to channel without LACP. With the **on** mode, a usable EtherChannel exists only when a port group in the **on** mode is connected to another port group in the **on** mode.<br>• **active**—Enables LACP only if a LACP device is detected. It places the port into an active negotiating state in which the port starts negotiations with other ports by sending LACP packets.<br>• **passive**—Enables LACP on the port and places it into a passive negotiating state in which the port responds to LACP packets that it receives, but does not start LACP packet negotiation. | **channel-group** *channel-group-number* **mode** {**auto** [**non-silent**] \| **desirable** [**non-silent**] \| **on**} \| {**active** \| **passive**} |
| **Step 6** | Return to privileged EXEC mode. | **end** |

| | Step | Command |
|---|---|---|
| **Step 7** | Verify your entries. | **show running-config** |
| **Step 8** | (Optional) Save your entries in the configuration file. | **copy running-config startup-config** |

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

This example shows how to configure an EtherChannel. It assigns two ports as static-access ports in VLAN 10 to channel 5 with the LACP mode **active**:

```
Switch# configure terminal
Switch(config)# interface range gigabitethernet0/1 -2
Switch(config-if-range)# switchport mode access
Switch(config-if-range)# switchport access vlan 10
Switch(config-if-range)# channel-group 5 mode active
Switch(config-if-range)# end
```

# Configuring Layer 3 EtherChannels

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

## Creating Port-Channel Logical Interfaces

When configuring Layer 3 EtherChannels, you should first manually create the port-channel logical interface by using the **interface port-channel** global configuration command. Then you put the logical interface into the channel group by using the **channel-group** interface configuration command.

**Note** To move an IP address from a physical port to an EtherChannel, you must delete the IP address from the physical port 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. This procedure is required.

| | Step | Command |
|---|---|---|
| **Step 1** | Enter global configuration mode. | **configure terminal** |
| **Step 2** | Specify the port-channel logical interface, and enter interface configuration mode.<br>For *port-channel-number*, the range is 1 to 48. | **interface port-channel** *port-channel-number* |
| **Step 3** | Put the port-channel interface into Layer 3 mode. | **no switchport** |
| **Step 4** | Assign an IP address and subnet mask to the EtherChannel. | **ip address** *ip-address mask* |
| **Step 5** | Return to privileged EXEC mode. | **end** |

| | Step | Command |
|---|---|---|
| **Step 6** | Verify your entries. | **show etherchannel** *channel-group-number* **detail** |
| **Step 7** | (Optional) Save your entries in the configuration file. | **copy running-config startup-config** |
| **Step 8** | Assign an Ethernet port to the Layer 3 EtherChannel. For more information, see the "Configuring the Physical Interfaces" section on page 15-12. | |

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 port to a Layer 3 EtherChannel. This procedure is required.

| | Step | Command |
|---|---|---|
| **Step 1** | Enter global configuration mode. | **configure terminal** |
| **Step 2** | Specify a physical port, and enter interface configuration mode.<br>Valid interfaces include physical ports.<br>For a LACP EtherChannel, you can configure up to 16 Ethernet ports of the same type. Up to eight ports can be active, and up to eight ports can be in standby mode.<br>**Note** If the interface is a UNI, you must enter the **port-type** {**eni** \| **nni**} interface configuration command before configuring LACP. | **interface** *interface-id* |
| **Step 3** | Enable the port, if necessary. By default, UNIs and ENIs are disabled, and NNIs are enabled. | **no shutdown** |
| **Step 4** | Ensure that there is no IP address assigned to the physical port. | **no ip address** |
| **Step 5** | Put the port into Layer 3 mode. | **no switchport** |

| | Step | Command |
|---|---|---|
| **Step 6** | Assign the port to a channel group, and specify the LACP mode.<br><br>For *channel-group-number*, the range is 1 to 48. This number must be the same as the *port-channel-number* (logical port) configured in the "Creating Port-Channel Logical Interfaces" section on page 15-11.<br><br>**Note** For UNIs, the only available mode is **on**.<br><br>For **mode**, select one of these keywords:<br>• **on**—Forces the port to channel without LACP. With the **on** mode, a usable EtherChannel exists only when a port group in the **on** mode is connected to another port group in the **on** mode.<br>• **active**—Enables LACP only if a LACP device is detected. It places the port into an active negotiating state in which the port starts negotiations with other ports by sending LACP packets.<br>• **passive**—Enables LACP on the port and places it into a passive negotiating state in which the port responds to LACP packets that it receives, but does not start LACP packet negotiation.<br><br>For information on compatible modes for the switch and its partner, see the"LACP Modes" section on page 15-4. | **channel-group** *channel-group-number* **mode** {**auto** [**non-silent**] \| **desirable** [**non-silent**] \| **on**} \| {**active** \| **passive**} |
| **Step 7** | Return to privileged EXEC mode. | **end** |
| **Step 8** | Verify your entries. | **show running-config** |
| **Step 9** | (Optional) Save your entries in the configuration file. | **copy running-config startup-config** |

This example shows how to configure an EtherChannel. It assigns two ports to channel 5 with the LACP mode **active**:

```
Switch# configure terminal
Switch(config)# interface range gigabitethernet0/1 -2
Switch(config-if-range)# no ip address
Switch(config-if-range)# no switchport
Switch(config-if-range)# channel-group 5 mode active
Switch(config-if-range)# 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 "Load Balancing and Forwarding Methods" section on page 15-5.

Beginning in privileged EXEC mode, follow these steps to configure EtherChannel load balancing. This procedure is optional.

| | Step | Command |
|---|---|---|
| **Step 1** | Enter global configuration mode. | **configure terminal** |
| **Step 2** | Configure an EtherChannel load-balancing method.<br><br>The default is **src-mac**.<br><br>Select one of these load-distribution methods:<br>• **dst-ip**—Load distribution is based on the destination-host IP address.<br>• **dst-mac**—Load distribution is based on the destination-host MAC address of the incoming packet.<br><br>**Note** When you enter the **dst-mac** keyword, the traffic is balanced only among four ports in the channel group. If you configure more than four ports in an EtherChannel with destination host MAC address load distribution, only four of the ports receive distributed traffic.This limitation does not apply to the other load distribution methods.<br><br>• **src-dst-ip**—Load distribution is based on the source-and-destination host-IP address.<br>• **src-dst-mac**—Load distribution is based on the source-and-destination host-MAC address.<br>• **src-ip**—Load distribution is based on the source-host IP address.<br>• **src-mac**—Load distribution is based on the source-MAC address of the incoming packet. | **port-channel load-balance** {**dst-ip** \| **dst-mac** \| **src-dst-ip** \| **src-dst-mac** \| **src-ip** \| **src-mac**} |
| **Step 3** | Return to privileged EXEC mode. | **end** |
| **Step 4** | Verify your entries. | **show etherchannel load-balance** |
| **Step 5** | (Optional) Save your entries in the configuration file. | **copy running-config startup-config** |

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

# Configuring LACP Hot-Standby Ports

When enabled, LACP tries to configure the maximum number of LACP-compatible ports in a channel, up to a maximum of 16 ports. Only eight LACP links can be active at one time. The software places any additional links in a hot-standby mode. If one of the active links becomes inactive, a link that is in the hot-standby mode becomes active in its place.

**Note** LACP is only available on NNIs and ENIs.

If you configure more than eight links for an EtherChannel group, the software automatically decides which of the hot-standby ports to make active based on the LACP priority. The software assigns to every link between systems that operate LACP a unique priority made up of these elements (in priority order):

- LACP system priority
- System ID (a combination of the LACP system priority and the switch module MAC address)
- LACP port priority
- Port number

In priority comparisons, numerically lower values have higher priority. The priority decides which ports should be put in standby mode when there is a hardware limitation that prevents all compatible ports from aggregating.

Ports are considered for active use in aggregation in link-priority order starting with the port attached to the highest priority link. Each port is selected for active use if the preceding higher priority selections can also be maintained. Otherwise, the port is selected for standby mode.

You can change the default values of the LACP system priority and the LACP port priority to affect how the software selects active and standby links. For more information, see the "Configuring the LACP System Priority" section on page 15-15 and the "Configuring the LACP Port Priority" section on page 15-16.

## Configuring the LACP System Priority

You can configure the system priority for all of the EtherChannels that are enabled for LACP by using the **lacp system-priority** global configuration command. You cannot configure a system priority for each LACP-configured channel. By changing this value from the default, you can affect how the software selects active and standby links.

You can use the **show etherchannel summary** privileged EXEC command to see which ports are in the hot-standby mode (denoted with an H port-state flag).

Beginning in privileged EXEC mode, follow these steps to configure the LACP system priority. This procedure is optional.

| | Step | Command |
|---|---|---|
| **Step 1** | Enter global configuration mode. | **configure terminal** |
| **Step 2** | Configure the LACP system priority.<br>For *priority*, the range is 1 to 65535. The default is 32768.<br>The lower the value, the higher the system priority. | **lacp system-priority** *priority* |

| | Step | Command |
|---|---|---|
| Step 3 | Return to privileged EXEC mode. | **end** |
| Step 4 | Verify your entries. | **show running-config**<br>or<br>**show lacp sys-id** |
| Step 5 | (Optional) Save your entries in the configuration file. | **copy running-config startup-config** |

To return the LACP system priority to the default value, use the **no lacp system-priority** global configuration command.

## Configuring the LACP Port Priority

By default, all ports use the same port priority. If the local system has a lower value for the system priority and the system ID than the remote system, you can affect which of the hot-standby links become active first by changing the port priority of LACP EtherChannel ports to a lower value than the default. The hot-standby ports that have lower port numbers become active in the channel first. You can use the **show etherchannel summary** privileged EXEC command to see which ports are in the hot-standby mode (denoted with an H port-state flag).

**Note** If LACP is not able to aggregate all the ports that are compatible (for example, the remote system might have more restrictive hardware limitations), all the ports that cannot be actively included in the EtherChannel are put in the hot-standby state and are used only if one of the channeled ports fails.

Beginning in privileged EXEC mode, follow these steps to configure the LACP port priority. This procedure is optional.

| | Step | Command |
|---|---|---|
| Step 1 | Enter global configuration mode. | **configure terminal** |
| Step 2 | Specify the port to be configured, and enter interface configuration mode.<br>**Note** If the interface is a UNI, you must enter the **port-type** {**eni** \| **nni**} interface configuration command before configuring LACP. | **interface** *interface-id* |
| Step 3 | Configure the LACP port priority.<br>For *priority*, the range is 1 to 65535. The default is 32768. The lower the value, the more likely that the port will be used for LACP transmission. | **lacp port-priority** ***priority*** |
| Step 4 | Return to privileged EXEC mode. | **end** |

| | Step | Command |
|---|---|---|
| **Step 5** | Verify your entries. | **show running-config**<br>or<br>**show lacp** [*channel-group-number*] **internal** |
| **Step 6** | (Optional) Save your entries in the configuration file. | **copy running-config startup-config** |

To return the LACP port priority to the default value, use the **no lacp port-priority** interface configuration command.

# Displaying EtherChannel and LACP Status

To display EtherChannel and LACP status information, use the privileged EXEC commands described in Table 15-3:

***Table 15-3 Commands for Displaying EtherChannel and LACP Status***

| Command | Description |
|---|---|
| **show etherchannel** [*channel-group-number* {**detail** \| **port** \| **port-channel** \| **protocol** \| **summary**}] {**detail** \| **load-balance** \| **port** \| **port-channel** \| **protocol** \| **summary**} | Displays EtherChannel information in a brief, detailed, and one-line summary form. Also displays the load-balance or frame-distribution scheme, port, port-channel, and protocol information. |
| **show lacp** [*channel-group-number*] {**counters** \| **internal** \| **neighbor**} | Displays LACP information such as traffic information, the internal LACP configuration, and neighbor information. |

You can clear LACP channel-group information and traffic counters by using the **clear lacp** {*channel-group-number* **counters** | **counters**} privileged EXEC command.

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

# Understanding Link-State Tracking

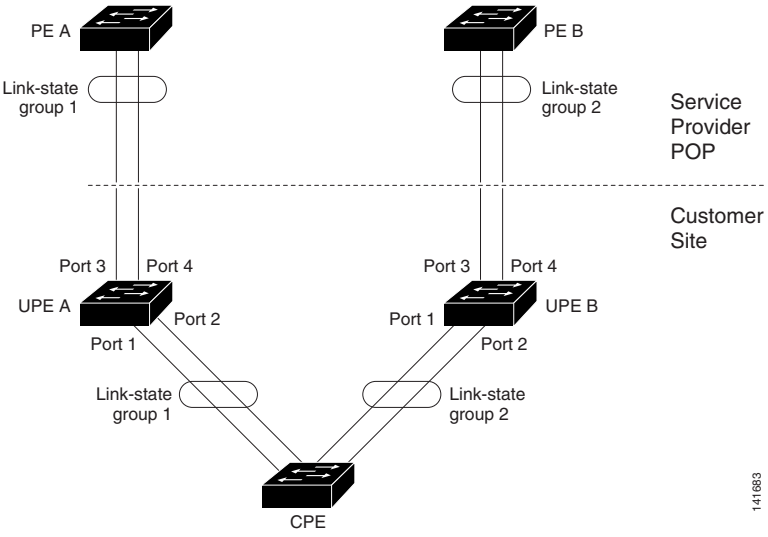
Link-state tracking, also known as trunk failover, is a feature that binds the link state of multiple interfaces. For example, link-state tracking provides redundancy in the network when used with Flex Links. If the link is lost on the primary interface, connectivity is transparently switched to the secondary interface.

As shown in Figure 15-4, switches that could be Cisco ME 3400CGS 2520 switches are used as user-facing provider edge (UPE) switches in a customer site at the edge of the provider network connected to a Customer Premises Equipment (CPE) switch. The UPE switches are connected to the provider edge (PE) switches in the service provider (SP) network. Customer devices, such as clients, connected to the CPE switch have multiple connections to the SP network. This configuration ensures

that the traffic flow is balanced from the customer site to the SP and the reverse. Ports connected to the CPE are referred to as downstream ports, and ports connected to PE switches are referred to as upstream ports.

- UPE switch A provides links to the CPE through link-state group 1. Port 1 and port 2 are connected to the CPE. Port 3 and port 4 are connected to PE switch A through link-state group 1.
- UPE switch B provides links to the CPE through link-state group 2. Port 1 and port 2 are connected to CPE. Port 3 and 4 are connected to PE switch A through link-state group 2.

***Figure 15-4 Typical Link-State Tracking Configuration***




When you enable link-state tracking on the switch, the link state of the downstream ports is bound to the link state of one or more of the upstream ports. After you associate a set of downstream ports to a set of upstream ports, if all of the upstream ports become unavailable, link-state tracking automatically puts the associated downstream ports in an error-disabled state. This causes the CPE primary interface to failover to the secondary interface.

If the PE switch fails, the cables are disconnected, or the link is lost, the upstream interfaces can lose connectivity. When link-state tracking is not enabled and the upstream interfaces lose connectivity, the link states of the downstream interfaces remain unchanged. The CPE is not aware that upstream connectivity has been lost and does not failover to the secondary interface.

An interface can be an aggregation of ports (an EtherChannel), a single physical port in access or trunk mode, or routed ports. These interfaces can be bundled together, and each downstream interface can be associated with a single group consisting of multiple upstream interfaces, referred to as a link-state group.

In a link-state group, the link state of the downstream interfaces is dependent on the link state of the upstream interfaces. If all of the upstream interfaces in a link-state group are in the link-down state, the associated downstream interfaces are forced into the link-down state. If any one of the upstream interfaces in the link-state group in the link-up state, the associated downstream interfaces can change to or remain in a link-up state.

For example, in Figure 14-4, downstream interfaces 1 and 2 on UPE switch A are defined in link-state group 1 with upstream interfaces 3 and 4. Similarly, downstream interfaces 1 and 2 on UPE switch B are defined in link-state group 2 with upstream interfaces 3 and 4.

If the link is lost on upstream interface 3, the link states of downstream interfaces 1 and 2 do not change. If upstream interface 4 also loses link, downstream interfaces 1 and 2 change to the link-down state. The CPE switch stops forwarding traffic to PE switch A and starts to forward traffic to PE switch B.

You can recover a downstream interface link-down condition by removing the failed downstream port from the link-state group. To recover multiple downstream interfaces, disable the link-state group.

# Configuring Link-State Tracking



## Default Link-State Tracking Configuration

There are no link-state groups defined, and link-state tracking is not enabled for any group.

## Link-State Tracking Configuration Guidelines

- An interface that is defined as an upstream interface cannot also be defined as a downstream interface in the same or a different link-state group. The reverse is also true.
- An interface cannot be a member of more than one link-state group.
- You can configure only two link-state groups per switch module.

## Configuring Link-State Tracking

Beginning in privileged EXEC mode, follow these steps to configure a link-state group and to assign an interface to a group:

| | Step | Command |
|---|---|---|
| **Step 1** | Enter global configuration mode. | **configure terminal** |
| **Step 2** | Create a link-state group, and enable link-state tracking. The group number can be 1 to 2; the default is 1. | **link state track** *number* |
| **Step 3** | Specify a physical interface or range of interfaces to configure, and enter interface configuration mode. | **interface** *interface-id* |

| | Step | Command |
|---|---|---|
| | Valid interfaces include switch ports in access or trunk mode (IEEE 802.1q), routed ports, or multiple ports bundled into an upstream EtherChannel interface (static or LACP), also in trunk mode.<br>Do not enable link-state tracking on individual interfaces that will be part of a downstream Etherchannel interface. | |
| **Step 4** | Enable the port, if necessary. By default, UNIs and ENIs are disabled, and NNIs are enabled. | **no shutdown** |
| **Step 5** | Specify a link-state group, and configure the interface as either an **upstream** or **downstream** interface in the group.The group number can be 1 to 2; the default is 1. | **link state group** [*number*] {**upstream** \| **downstream**} |
| **Step 6** | Return to privileged EXEC mode. | **end** |
| **Step 7** | Verify your entries. | **show running-config** |
| **Step 8** | (Optional) Save your entries in the configuration file. | **copy running-config startup-config** |

This example shows how to create a link-state group and configure the interfaces:

```
Switch# configure terminal
Switch(config)# link state track 1
Switch(config)# interface range fastethernet/0/9 -10
Switch(config-if)# link state group 1 upstream
Switch(config-if)# interface fastethernet0/1
Switch(config-if)# link state group 1 downstream
Switch(config-if)# interface fastethernet0/3
Switch(config-if)# link state group 1 downstream
Switch(config-if)# interface fastethernet0/5
Switch(config-if)# link state group 1 downstream
Switch(config-if)# end
```

To disable a link-state group, use the **no link state track** *number* global configuration command.

# Displaying Link-State Tracking Status

Use the **show link state group** command to display the link-state group information. Enter this command without keywords to display information about all link-state groups. Enter the group number to display information specific to the group. Enter the detail keyword to display detailed information about the group.

This is an example of output from the **show link state group 1** command:

```
Switch> show link state group 1

Link State Group: 1      Status: Enabled, Down
```

This is an example of output from the **show link state group detail** command:

```
Switch> show link state group detail

(Up):Interface up   (Dwn):Interface Down   (Dis):Interface disabled

Link State Group: 1 Status: Enabled, Down
Upstream Interfaces : Fa0/15(Dwn) Fa0/16(Dwn)
Downstream Interfaces : Fa0/11(Dis) Fa0/12(Dis) Fa0/13(Dis) Fa0/14(Dis)

Link State Group: 2 Status: Enabled, Down
Upstream Interfaces : Fa0/15(Dwn) Fa0/16(Dwn) Fa0/17(Dwn)
Downstream Interfaces : Fa0/11(Dis) Fa0/12(Dis) Fa0/13(Dis) Fa0/14(Dis)
(Up):Interface up (Dwn):Interface Down (Dis):Interface disabled
```

For detailed information about the fields in the display, see the command reference for this release.