CHAPTER 1

Configuring EtherChannels

This chapter describes how to configure EtherChannels and to apply and configure the Link Aggregation Control Protocol (LACP) for more efficient use of EtherChannels in Cisco NX-OS.

This chapter includes the following sections:

Information About EtherChannels

An EtherChannel bundles up to eight individual interfaces into a group to provide increased bandwidth and redundancy. Port channeling also load balances traffic across these physical interfaces. The EtherChannel stays operational as long as at least one physical interface within the EtherChannel is operational.

You create an EtherChannel by bundling compatible interfaces. You can configure and run either static EtherChannels or EtherChannels running the Link Aggregation Control Protocol (LACP). (See "Understanding LACP" section on page 1-4 for information on LACP.)

Any configuration changes that you apply to the EtherChannel are applied to each member interface of that EtherChannel. For example, if you configure Spanning Tree Protocol (STP) parameters on the EtherChannel, the Cisco NX-OS applies those parameters to each interface in the EtherChannel.

You can use static EtherChannels, with no associated protocol, for a simplified configuration. For more efficient use of the EtherChannel, you can use the Link Aggregation Control Protocol (LACP), which is defined in IEEE 802.3ad. When you use LACP, the link passes protocol packets.

This section includes the following topics:

Understanding EtherChannels

Using EtherChannels, Cisco NX-OS provides wider bandwidth, redundancy, and load balancing across the channels.

You can collect up to eight ports into a static EtherChannel or you can enable the Link Aggregation Control Protocol (LACP). Configuring EtherChannels with LACP requires slightly different steps than configuring static EtherChannels (see the "Configuring EtherChannels" section on page 1-7).

Note Cisco NX-OS does not support Port Aggregation Protocol (PAgP) for EtherChannels.

An EtherChannel bundles individual links into a channel group to create a single logical link that provides the aggregate bandwidth of up to eight physical links. If a member port within an EtherChannel fails, traffic previously carried over the failed link switches to the remaining member ports within the EtherChannel.

Each port can be in only one EtherChannel. All the ports in an EtherChannel must be compatible; they must use the same speed and operate in full-duplex mode (see the "Compatibility Requirements" section on page 1-2). When you are running static EtherChannels, without LACP, the individual links are all in the on channel mode; you cannot change this mode without enabling LACP (see the "Port-Channel Modes" section on page 1-6).

Note You cannot change the mode from ON to Active or from ON to Passive.

You can create an EtherChannel directly by creating the port-channel interface, or you can create a channel group that acts to aggregate individual ports into a bundle. When you associate an interface with a channel group, Cisco NX-OS creates a matching EtherChannel automatically if the EtherChannel does not already exist. You can also create the EtherChannel first. In this instance, Cisco NX-OS creates an empty channel group with the same channel number as the EtherChannel and takes the default configuration.

Note The EtherChannel is operationally up when at least one of the member ports is up and that port's status is channeling. The EtherChannel is operationally down when all member ports are operationally down.

Compatibility Requirements

When you add an interface to a channel group, Cisco NX-OS checks certain interface attributes to ensure that the interface is compatible with the channel group. Cisco NX-OS also checks a number of operational attributes for an interface before allowing that interface to participate in the port-channel aggregation.

The compatibility check includes the following operational attributes:

- Port mode
- Access VLAN
- Trunk native VLAN
- Allowed VLAN list
- Speed

- 802.3x flow control setting
- MTU

  The Cisco Nexus 5000 Series switch only supports system level MTU. This attribute cannot be changed on an individual port basis.
- Broadcast/Unicast/Multicast Storm Control setting
- Priority-Flow-Control
- Untagged CoS

Use the **show port-channel compatibility-parameters** command to see the full list of compatibility checks that Cisco NX-OS uses.

You can only add interfaces configured with the channel mode set to **on** to static EtherChannels. You can also only add interfaces configured with the channel mode as **active** or **passive** to EtherChannels that are running LACP. (See the "Port-Channel Modes" section on page 1-6 for information on port-channel modes.) You can configure these attributes on an individual member port.

When the interface joins an EtherChannel, the following individual parameters are replaced with the values on the EtherChannel:

- Bandwidth
- MAC address
- Spanning Tree Protocol

The following interface parameters remain unaffected when the interface joins an EtherChannel:

- Description
- CDP
- LACP port priority
- Debounce

Load Balancing Using EtherChannels

Cisco NX-OS load balances traffic across all operational interfaces in an EtherChannel 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. EtherChannels provide load balancing by default and the basic configuration uses the following criteria to select the link:

- For a Layer 2 frame, it uses the source and destination MAC addresses.
- For a Layer 3 frame, it uses the source and destination MAC addresses and the source and destination IP addresses.
- For a Layer 4 frame, it uses the source and destination MAC addresses, the source and destination IP addresses, and the source and destination port number.

You can configure the switch to use one of the following methods to load balance across the EtherChannel:

- Destination MAC address
- Source MAC address
- Source and destination MAC address
- Destination IP address

- Source IP address
- Source and destination IP address
- Destination TCP/UDP port number
- Source TCP/UDP port number
- Source and destination TCP/UDP port number

Table 1-1 shows the criteria used for each configuration:

Table 1-1 EtherChannel Load-Balancing Criteria

Configuration	Layer 2 Criteria	Layer 3 Criteria	Layer 4 Criteria
Destination MAC	Destination MAC	Destination MAC	Destination MAC
Source MAC	Source MAC	Source MAC	Source MAC
Source and destination MAC	Source and destination MAC	Source and destination MAC	Source and destination MAC
Destination IP	Destination MAC	Destination MAC, destination IP	Destination MAC, destination IP
Source IP	Source MAC	Source MAC, source IP	Source MAC, source IP
Source and destination IP	Source and destination MAC	Source and destination MAC, source and destination IP	Source and destination MAC, source and destination IP
Destination TCP/UDP port	Destination MAC	Destination MAC, destination IP	Destination MAC, destination IP, destination port
Source TCP/UDP port	Source MAC	Source MAC, source IP	Source MAC, source IP, source port
Source and destination TCP/UDP port	Source and destination MAC	Source and destination MAC, source and destination IP	Source and destination MAC, source and destination IP, source and destination port

Use the option that provides the balance criteria with the greatest variety in your configuration. For example, if the traffic on an EtherChannel is going only to a single MAC address and you use the destination MAC address as the basis of port-channel load balancing, the EtherChannel always chooses the same link in that EtherChannel; using source addresses or IP addresses might result in better load balancing.

Understanding LACP

LACP allows you to configure up to 8 interfaces into an EtherChannel.

This section includes the following topics:

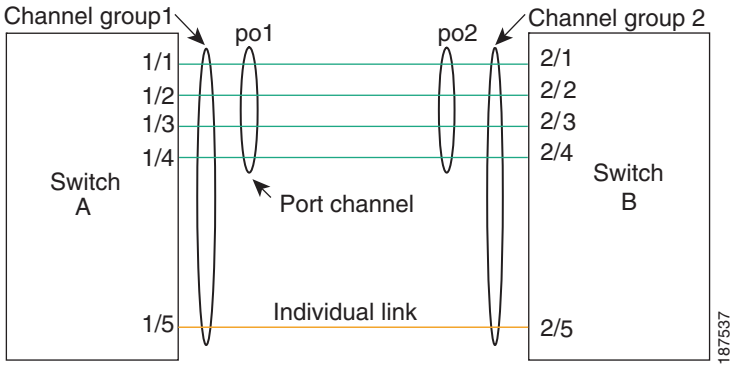
- LACP-Enabled and Static EtherChannels Differences, page 1-7

LACP Overview

Note You must enable LACP before the feature functions.

Figure 1-1 shows how individual links can be combined into LACP EtherChannels and channel groups as well as function as individual links.

Figure 1-1 Individual Links Combined into an EtherChannel



With LACP, you can bundle up to eight interfaces in a channel group.

Note When you delete the EtherChannel, Cisco NX-OS automatically deletes the associated channel group. All member interfaces revert to their previous configuration.

You cannot disable LACP while any LACP configurations are present.

LACP ID Parameters

LACP uses the following parameters:

- LACP system priority—Each system that runs LACP has an LACP system priority value. You can accept the default value of 32768 for this parameter, or you can configure a value between 1 and 65535. LACP uses the system priority with the MAC address to form the system ID and also uses the system priority during negotiation with other devices. A higher system priority value means a lower priority.

  Note The LACP system ID is the combination of the LACP system priority value and the MAC address.

- LACP port priority—Each port configured to use LACP has an LACP port priority. You can accept the default value of 32768 for the LACP port priority, or you can configure a value between 1 and 65535. LACP uses the port priority with the port number to form the port identifier. LACP uses the port priority to decide which ports should be put in standby mode when there is a limitation that prevents all compatible ports from aggregating and which ports should be put into active mode. A

higher port priority value means a lower priority for LACP. You can configure the port priority so that specified ports have a lower priority for LACP and are most likely to be chosen as active links, rather than hot-standby links.

- LACP administrative key—LACP automatically configures an administrative key value equal to the channel-group number on each port configured to use LACP. The administrative key defines the ability of a port to aggregate with other ports. A port's ability to aggregate with other ports is determined by these factors:
  - Port physical characteristics, such as the data rate, the duplex capability, and the point-to-point or shared medium state
  - Configuration restrictions that you establish

Port-Channel Modes

Individual interfaces in EtherChannels are configured with channel modes. When you run static EtherChannels, with no protocol, the channel mode is always set to **on**. After you enable LACP globally on the device, you enable LACP for each channel by setting the channel mode for each interface to **active** or **passive**. You can configure either channel mode for individual links in the LACP channel group.

Note You must enable LACP globally before you can configure an interface in either the **active** or **passive** channel mode.

Table 1-2 describes the channel modes.

Table 1-2 Channel Modes for Individual Links in an EtherChannel

Channel Mode	Description
passive	LACP mode that places a port into a passive negotiating state, in which the port responds to LACP packets that it receives but does not initiate LACP negotiation.
active	LACP mode that places a port into an active negotiating state, in which the port initiates negotiations with other ports by sending LACP packets.
on	All static EtherChannels, that is, that are not running LACP, remain in this mode. If you attempt to change the channel mode to active or passive before enabling LACP, the device returns an error message. You enable LACP on each channel by configuring the interface in that channel for the channel mode as either **active** or **passive**. When an LACP attempts to negotiate with an interface in the **on** state, it does not receive any LACP packets and becomes an individual link with that interface; it does not join the LACP channel group.

Both the passive and active modes allow LACP to negotiate between ports to determine if they can form an EtherChannel, based on criteria such as the port speed and the trunking state. The passive mode is useful when you do not know whether the remote system, or partner, supports LACP.

Ports can form an LACP EtherChannel when they are in different LACP modes as long as the modes are compatible as in the following examples:

- A port in active mode can form an EtherChannel successfully with another port that is in active mode.
- A port in active mode can form an EtherChannel with another port in passive mode.

- A port in passive mode cannot form an EtherChannel with another port that is also in passive mode because neither port will initiate negotiation.
- A port in on mode is not running LACP.

LACP Marker Responders

Using EtherChannels, data traffic may be dynamically redistributed due to either a link failure or load balancing. LACP uses the Marker Protocol to ensure that frames are not duplicated or reordered because of this redistribution. Cisco NX-OS supports only Marker Responders.

LACP-Enabled and Static EtherChannels Differences

Table 1-3 provides a brief summary of major differences between EtherChannels with LACP enabled and static EtherChannels.

Table 1-3 EtherChannels with LACP Enabled and Static EtherChannels

Configurations	EtherChannels with LACP Enabled	Static EtherChannels
Protocol applied	Enable globally.	Not applicable.
Channel mode of links	Can be either: • Active • Passive	Can only be On.
Maximum number of links in channel	8	8

Configuring EtherChannels

You can configure multiple EtherChannels on a device.

This section includes the following topics:

Creating an EtherChannel

You can create an EtherChannel before creating a channel group. Cisco NX-OS automatically creates the associated channel group.

Note If you want LACP-based EtherChannels, you need to enable LACP (see the "Enabling LACP" section on page 1-10).

To create an EtherChannel, perform this task:

	Command	Purpose
Step 1	`switch# configure terminal`	Enters configuration mode.
Step 2	`switch(config)# interface port-channel channel-number`	Specifies the port-channel interface to configure, and enters the interface configuration mode. The range is from 1 to 4096. Cisco NX-OS automatically creates the channel group if it does not already exist.

This example shows how to create an EtherChannel:

```
switch# configure terminal
switch (config)# interface port-channel 1
```

To remove the EtherChannel and delete the associated channel group, perform this task:

Command	Purpose
`switch(config)# no interface port-channel channel-number`	Removes the EtherChannel and deletes the associated channel group. See the "Compatibility Requirements" section on page 1-2 for details on how the interface configuration changes when you delete the EtherChannel.

Adding a Port to an EtherChannel

You can add a port to a new channel group or to a channel group that already contains ports. Cisco NX-OS creates the EtherChannel associated with this channel group if the EtherChannel does not already exist.

Note If you want LACP-based EtherChannels, you need to enable LACP (see the "Enabling LACP" section on page 1-10).

To configure an EtherChannel, perform this task:

	Command	Purpose
Step 1	`switch# configure terminal`	Enters configuration mode.
Step 2	`switch(config)# interface type slot/port`	Specifies the interface that you want to add to a channel group and enters the interface configuration mode.
Step 3	`switch(config-if)# switchport mode trunk`	(Optional) Configures the interface as a trunk port.

	Command	Purpose
Step 4	`switch(config-if)# switchport trunk {allowed vlan vlan-id | native vlan vlan-id}`	(Optional) Configures necessary parameters for a trunk port.
Step 5	`switch(config-if)# channel-group channel-number`	Configures the port in a channel group and sets the mode. The channel-number range is from 1 to 4096. Cisco NX-OS creates the EtherChannel associated with this channel group if the EtherChannel does not already exist[1].

1. This is called implicit EtherChannel creation.

To remove the port from the channel group, perform this task:

Command	Purpose
`switch(config)# no channel-group`	Removes the port from the channel group. The port reverts to its original configuration.

This example shows how to add an Ethernet interface 1/4 to channel group 1:

```
switch# configure terminal
switch (config)# interface ethernet 1/4
switch(config-if)# switchport mode trunk
switch(config-if)# channel-group 1
```

Configuring Load Balancing Using EtherChannels

You can configure the load-balancing algorithm for EtherChannels that applies to the entire device.

Note If you want LACP-based EtherChannels, you need to enable LACP (see the "Enabling LACP" section on page 1-10).

To configure load balancing using EtherChannels, perform this task:

	Command	Purpose
Step 1	`switch# configure terminal`	Enters configuration mode.
Step 2	`switch(config)# port-channel load-balance ethernet {destination-ip | destination-mac | destination-port | source-dest-ip | source-dest-mac | source-dest-port | source-ip | source-mac | source-port}`	Specifies the load-balancing algorithm for the device. The range depends on the device. The default is **source-dest-mac.**
Step 3	`switch(config-router)# show port-channel load-balance`	(Optional) Displays the port-channel load-balancing algorithm.

This example shows how to configure source IP load balancing for EtherChannels:

```
switch# configure terminal
switch (config)# port-channel load-balance ethernet source-ip
```

To restore the default load-balancing algorithm of source-dest-mac for non-IP traffic and source-dest-ip for IP traffic, perform this task:

Command	Purpose
`switch(config)# no port-channel load-balance ethernet`	Restores the default load-balancing algorithm.

Note Before Release 4.0(1a)N1 of Cisco NX-OS, the **source-dest-ip**, **source-dest-mac**, and **source-dest-port** keywords were **source-destination-ip**, **source-destination-mac**, and **source-destination-port**, respectively.

Enabling LACP

LACP is disabled by default; you must enable LACP before you begin LACP configuration. You cannot disable LACP while any LACP configuration is present.

LACP learns the capabilities of LAN port groups dynamically and informs the other LAN ports. Once LACP identifies correctly matched Ethernet links, it facilitates grouping the links into an EtherChannel. The EtherChannel is then added to the spanning tree as a single bridge port.

To enable LACP, perform this task:

	Command	Purpose
Step 1	`switch# configure terminal`	Enters configuration mode.
Step 2	`switch(config)# feature lacp`	Enables LACP on the switch.
Step 3	`switch(config)# show system internal clis feature`	(Optional) Displays enabled features.

This example shows how to enable LACP:

```
switch# configure terminal
switch (config)# feature lacp
```

Configuring Port-Channel Port Modes

After you enable LACP, you can configure the channel mode for each individual link in the LACP EtherChannel as **active** or **passive**. This channel configuration mode allows the link to operate with LACP.

When you configure EtherChannels with no associated protocol, all interfaces on both sides of the link remain in the **on** channel mode.

To configure the LACP link mode, perform this task:

	Command	Purpose
Step 1	`switch# configure terminal`	Enters configuration mode.
Step 2	`switch(config)# interface` *type slot/port*	Specifies the interface to configure, and enters the interface configuration mode.
Step 3	`switch(config-if)# channel-group` *number* `mode {active | on | passive}`	Specifies the port mode for the link in an EtherChannel. After LACP is enabled, you configure each link or the entire channel as active or passive. When you run EtherChannels with no associated protocol, the port-channel mode is always on. The default port-channel mode is on.
	`switch(config-if)# no channel-group` *number* `mode`	Returns the port mode to on for the specified interface.

This example shows how to set the LACP-enabled interface to active port-channel mode for Ethernet interface 1/4 in channel group 5:

```
switch# configure terminal
switch (config)# interface ethernet 1/4
switch(config-if)# channel-group 5 mode active
```

Configuring the LACP System Priority and System ID

The LACP system ID is the combination of the LACP system priority value and the MAC address.

To configure the LACP system priority, perform this task:

	Command	Purpose
Step 1	`switch# configure terminal`	Enters configuration mode.
Step 2	`switch(config)# lacp system-priority` *priority*	Configures the system priority for use with LACP. Valid values are 1 through 65535, and higher numbers have lower priority. The default value is 32768.
Step 3	`switch(config-if)# show lacp system-identifier`	Displays the LACP system identifier.

This example shows how to set the LACP system priority to 2500:

```
switch# configure terminal
switch(config)# lacp system-priority 2500
```

Configuring the LACP Port Priority

When you enable LACP, you can configure each link in the LACP EtherChannel for the port priority.

To configure the LACP link mode and port priority, perform this task:

	Command	Purpose
Step 1	`switch# configure terminal`	Enters configuration mode.
Step 2	`switch(config)# interface` *type slot/port*	Specifies the interface to configure, and enters the interface configuration mode.
Step 3	`switch(config-if)# lacp port-priority` *priority*	Configures the port priority for use with LACP. Valid values are 1 through 65535, and higher numbers have lower priority. The default value is 32768.

This example shows how to set the LACP port priority for Ethernet interface 1/4 to 40000:

```
switch# configure terminal
switch (config)# interface ethernet 1/4
switch(config-if)# lacp port priority 40000
```

Verifying Port-Channel Configuration

To display port-channel configuration information, perform one of the following tasks:

Command	Purpose
`switch# show interface port-channel` *channel-number*	Displays the status of a port-channel interface.
`switch# show system internal clis feature`	Displays enabled features.
`switch# show lacp {counters | interface` *type slot/port* `| neighbor | port-channel | system-identifier}`	Displays LACP information.
`switch# show port-channel compatibility-parameters`	Displays the parameters that must be the same among the member ports in order to join an EtherChannel.
`switch# show port-channel database [interface port-channel` *channel-number*`]`	Displays the aggregation state for one or more port-channel interfaces.
`switch# show port-channel load-balance`	Displays the type of load balancing in use for EtherChannels.
`switch# show port-channel summary`	Displays a summary for the port-channel interfaces.
`switch# show port-channel traffic`	Displays the traffic statistics for EtherChannels.
`switch# show port-channel usage`	Displays the range of used and unused channel numbers.
`switch# show port-channel database`	Displays information on current running of the EtherChannel feature.