CHAPTER 3

LAN Aggregation

Objectives

Upon completion of this chapter, you will be able to answer the following questions:

- What is link aggregation?
- What is EtherChannel technology?
- What are the commands to configure EtherChannel?
- What are the methods to troubleshoot link aggregation with EtherChannel?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

Port Aggregation Protocol (PAgP) *page 122*

Link Aggregation Control Protocol (LACP) *page 122*

PAgP desirable *page 127*

PAgP auto *page 127*

LACP active *page 129*

LACP passive *page 129*

Introduction (3.0.1.1)

Link aggregation is the ability to create one logical link using multiple physical links between two devices. This allows load sharing among the physical links, rather than having STP block one or more of the links. EtherChannel is a form of link aggregation used in switched networks.

This chapter describes EtherChannel and the methods used to create an EtherChannel. An EtherChannel can be manually configured or can be negotiated by using the Cisco-proprietary protocol *Port Aggregation Protocol (PAgP)* or the IEEE 802.3ad–defined protocol *Link Aggregation Control Protocol (LACP)*. The configuration, verification, and troubleshooting of EtherChannel are discussed.

Class Activity 3.0.1.2: Imagine This

It is the end of the work day. In your small- to medium-sized business, you are trying to explain to the network engineers about EtherChannel and how it looks when it is physically set up. The network engineers have difficulty envisioning how two switches could possibly be connected through several links that collectively act as one channel or connection. Your company is definitely considering implementing an EtherChannel network.

Therefore, you end the meeting with an assignment for the engineers. To prepare for the next day's meeting, they are to perform some research and bring to the meeting one graphic representation of an EtherChannel network connection. They are tasked with explaining how an EtherChannel network operates to the other engineers.

When researching EtherChannel, a good question to search for is "What does EtherChannel look like?" Prepare a few slides to demonstrate your research that will be presented to the network engineering group. These slides should provide a solid grasp of how EtherChannels are physically created within a network topology. Your goal is to ensure that everyone leaving the next meeting will have a good idea as to why he or she would consider moving to a network topology using EtherChannel as an option.

Link Aggregation Concepts (3.1)

In this section, we discuss link aggregation and EtherChannel, a Layer 2 link aggregation technology.

Link Aggregation (3.1.1)

Link aggregation is the process of using multiple redundant links as one logical link in order to take advantage of underutilized links to increase bandwidth.

Introduction to Link Aggregation (3.1.1.1)

In Figure 3-1, traffic coming from several links (usually 100 or 1000 Mb/s) aggregates on the access switch and must be sent to distribution switches. Because of the traffic aggregation, links with higher bandwidth must be available between the access and distribution switches.

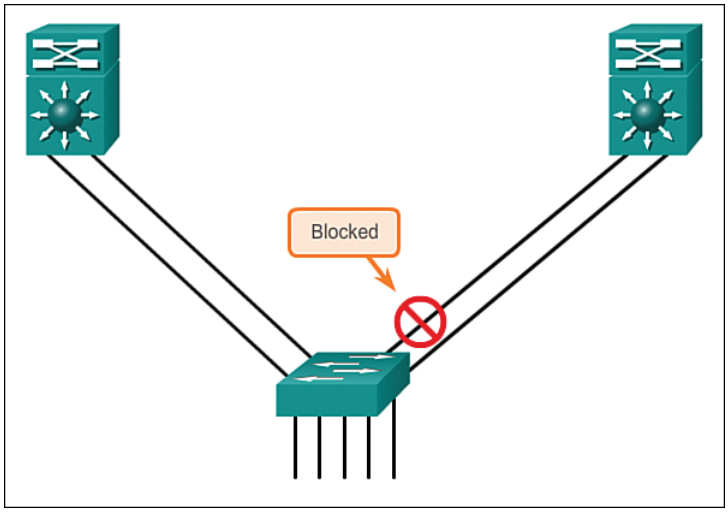

Figure 3-1 Redundant Links with STP

It might be possible to use faster links, such as 10 Gb/s, on the aggregated link between the access and distribution layer switches. However, adding faster links is expensive. Additionally, as the speed increases on the access links, even the fastest possible port on the aggregated link is no longer fast enough to aggregate the traffic coming from all access links.

It is also possible to multiply the number of physical links between the switches to increase the overall speed of switch-to-switch communication. However, by default, STP is enabled on switch devices. STP will block redundant links to prevent routing loops.

For these reasons, the best solution is to implement an EtherChannel configuration.

Advantages of EtherChannel (3.1.1.2)

Figure 3-2 shows a conceptual view of links aggregated using EtherChannel.

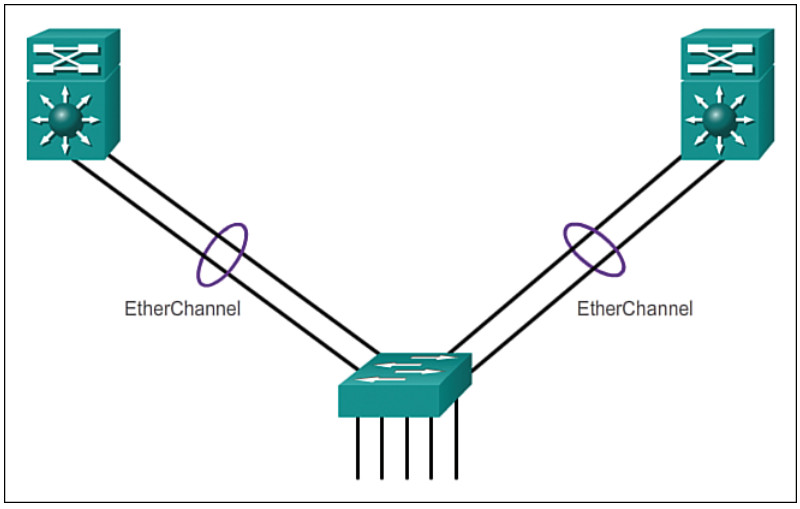

Figure 3-2 EtherChannel Topology Example

EtherChannel technology was originally developed by Cisco as a LAN switch-to-switch technique of grouping several Fast Ethernet or Gigabit Ethernet ports into one logical channel. When an EtherChannel is configured, the resulting virtual interface is called a port channel. The physical interfaces are bundled together into a port channel interface.

EtherChannel technology has many advantages:

- Most configuration tasks can be done on the EtherChannel interface instead of on each individual port, ensuring configuration consistency throughout the links.
- EtherChannel relies on existing switch ports. There is no need to upgrade the link to a faster and more expensive connection to have more bandwidth.
- Load balancing takes place between links that are part of the same EtherChannel. Depending on the hardware platform, one or more load-balancing methods can be implemented. These methods include source MAC to destination MAC load balancing, or source IP to destination IP load balancing, across the physical links.
- EtherChannel creates an aggregation that is seen as one logical link. When several EtherChannel bundles exist between two switches, STP can block one of the bundles to prevent switching loops. When STP blocks one of the redundant links, it blocks the entire EtherChannel. This blocks all the ports belonging to

that EtherChannel link. Where there is only one EtherChannel link, all physical links in the EtherChannel are active because STP sees only one (logical) link.

- EtherChannel provides redundancy because the overall link is seen as one logical connection. Additionally, the loss of one physical link within the channel does not create a change in the topology; therefore a spanning tree recalculation is not required. Assuming that at least one physical link is present, the EtherChannel remains functional, even if its overall throughput decreases because of a lost link within the EtherChannel.

EtherChannel Operation (3.1.2)

This section reviews the restrictions to implementing EtherChannel and the two EtherChannel protocols.

Implementation Restrictions (3.1.2.1)

EtherChannel can be implemented by grouping multiple physical ports into one or more logical EtherChannel links.

Note

Interface types cannot be mixed. For example, Fast Ethernet and Gigabit Ethernet cannot be mixed within a single EtherChannel.

The EtherChannel provides full-duplex bandwidth up to 800 Mb/s (Fast EtherChannel) or 8 Gb/s (Gigabit EtherChannel) between one switch and another switch or host. Currently each EtherChannel can consist of up to eight compatibly configured Ethernet ports. The Cisco IOS switch can currently support six EtherChannels. However, as new IOSs are developed and platforms change, some cards and platforms can support increased numbers of ports within an EtherChannel link, as well as support an increased number of Gigabit EtherChannels. The concept is the same no matter the speeds or number of links that are involved. When configuring EtherChannel on switches, be aware of the hardware platform boundaries and specifications.

The original purpose of EtherChannel was to increase speed capability on aggregated links between switches. However, this concept was extended as EtherChannel technology became more popular, and now many servers also support link aggregation with EtherChannel. EtherChannel creates a one-to-one relationship; that is, one EtherChannel link connects only two devices. An EtherChannel link can be created between two switches, or an EtherChannel link can be created between an EtherChannel-enabled server and a switch. However, traffic cannot be sent to two different switches through the same EtherChannel link.

The individual EtherChannel group member port configuration must be consistent on both devices. If the physical ports of one side are configured as trunks, the physical ports of the other side must also be configured as trunks within the same native VLAN. Additionally, all ports in each EtherChannel link must be configured as Layer 2 ports.

Note

Layer 3 EtherChannels can be configured on Cisco Catalyst multilayer switches, such as the Catalyst 3560, but these are not explored in this course. A Layer 3 EtherChannel has a single IP address associated with the logical aggregation of switch ports in the EtherChannel.

Each EtherChannel has a logical port channel interface, shown in Figure 3-3. A configuration applied to the port channel interface affects all physical interfaces that are assigned to that interface.

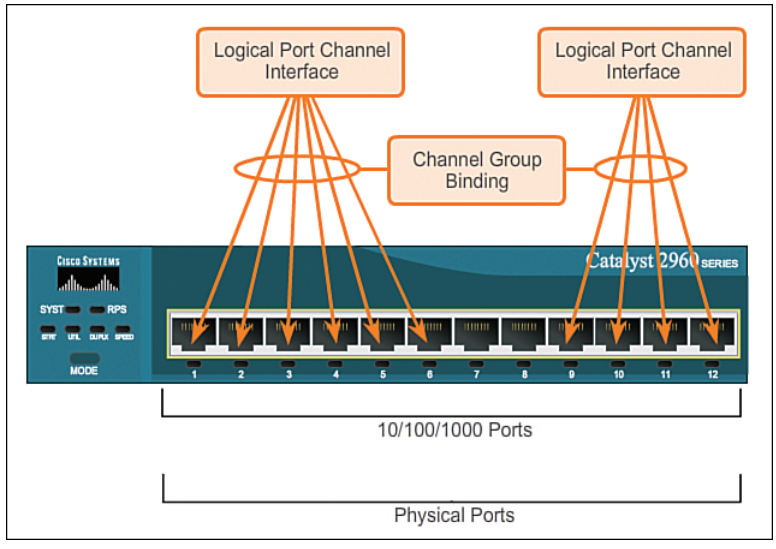

Figure 3-3 EtherChannel Logical Groupings

Port Aggregation Protocol (3.1.2.2)

EtherChannels can be formed through negotiation using one of two protocols, PAgP or LACP. These protocols allow ports with similar characteristics to form a channel through dynamic negotiation with adjoining switches.

Note

It is also possible to configure a static or unconditional EtherChannel without PAgP or LACP.

PAgP

PAgP is a Cisco-proprietary protocol that aids in the automatic creation of EtherChannel links, as shown in Figure 3-4.

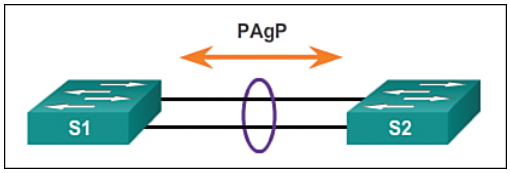

Figure 3-4 PAgP Topology

When an EtherChannel link is configured using PAgP, PAgP packets are sent between EtherChannel-capable ports to negotiate the forming of a channel. When PAgP identifies matched Ethernet links, it groups the links into an EtherChannel. The EtherChannel is then added to the spanning tree as a single port.

When enabled, PAgP also manages the EtherChannel. PAgP packets are sent every 30 seconds. PAgP checks for configuration consistency and manages link additions and failures between two switches. It ensures that when an EtherChannel is created, all ports have the same type of configuration.

Note

In EtherChannel, it is mandatory that all ports have the same speed, duplex setting, and VLAN information. Any port modification after the creation of the channel also changes all other channel ports.

PAgP helps create the EtherChannel link by detecting the configuration of each side and ensuring that links are compatible so that the EtherChannel link can be enabled when needed.

- **On:** This mode forces the interface to channel without PAgP. Interfaces configured in the on mode do not exchange PAgP packets.
- ***PAgP desirable***: This PAgP mode places an interface in an active negotiating state in which the interface initiates negotiations with other interfaces by sending PAgP packets.
- ***PAgP auto***: This PAgP mode places an interface in a passive negotiating state in which the interface responds to the PAgP packets that it receives, but does not initiate PAgP negotiation.

Table 3-1 summarizes the result for PAgP channel establishment based on the configuration of each side of a link in Figure 3-4.

Table 3-1 PAgP Channel Establishment

S1	S2	Established?
On	On	Yes
Auto/Desirable	Desirable	Yes
On/Auto/Desirable	Not Configured	No
On	Desirable	No
Auto/On	Auto	No

The modes must be compatible on each side. If one side is configured to be in auto mode, it is placed in a passive state, waiting for the other side to initiate the EtherChannel negotiation. If the other side is also set to auto, the negotiation never starts and the EtherChannel does not form. If all modes are disabled by using the **no** command, or if no mode is configured, the EtherChannel is disabled.

The on mode manually places the interface in an EtherChannel, without any negotiation. It works only if the other side is also set to on. If the other side is set to negotiate parameters through PAgP, no EtherChannel forms, because the side that is set to on mode does not negotiate.

Link Aggregation Control Protocol (3.1.2.3)

LACP is part of an IEEE specification (802.3ad) that allows several physical ports to be bundled to form a single logical channel, as shown in Figure 3-5.

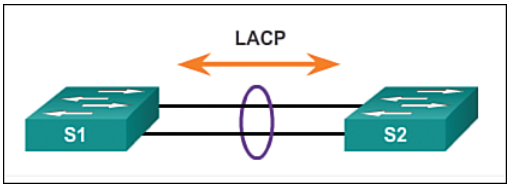

Figure 3-5 LACP Topology

LACP allows a switch to negotiate an automatic bundle by sending LACP packets to the peer. It performs a function similar to PAgP with Cisco EtherChannel. Because LACP is an IEEE standard, it can be used to facilitate EtherChannels in multivendor environments. On Cisco devices, both protocols are supported.

Note

LACP was originally defined as IEEE 802.3ad. However, LACP is now defined in the newer IEEE 802.1AX standard for local and metropolitan-area networks.

LACP provides the same negotiation benefits as PAgP. LACP helps create the EtherChannel link by detecting the configuration of each side and making sure that they are compatible so that the EtherChannel link can be enabled when needed. Figure 3-5 shows the modes for LACP.

- **On:** This mode forces the interface to channel without LACP. Interfaces configured in the on mode do not exchange LACP packets.
- ***LACP active*:** This LACP mode places a port in an active negotiating state. In this state, the port initiates negotiations with other ports by sending LACP packets.
- ***LACP passive*:** This LACP mode places a port in a passive negotiating state. In this state, the port responds to the LACP packets that it receives, but does not initiate LACP packet negotiation.

Just as with PAgP, modes must be compatible on both sides for the EtherChannel link to form. The on mode is repeated, because it creates the EtherChannel configuration unconditionally, without PAgP or LACP dynamic negotiation. Table 3-2 summarizes the results for LACP channel establishment based on the configuration of each side of a link in Figure 3-5.

Table 3-2 LACP Channel Establishment

S1	S2	Established?
On	On	Yes
Active/Passive	Active	Yes
On/Active/Passive	Not Configured	No
On	Active	No
Passive/On	Passive	No

Interactive Graphic

Activity 3.1.2.4: Identify the PAgP and LACP Modes

Go to the course online to perform this practice activity.

Link Aggregation Configuration (3.2)

This section discusses EtherChannel configuration, verification, and troubleshooting.

Configuring EtherChannel (3.2.1)

Configuring EtherChannel is simple enough as long as the network administrator is aware of the limitations.

Configuration Guidelines (3.2.1.1)

The following guidelines and restrictions are useful for configuring EtherChannel:

- **EtherChannel support:** All Ethernet interfaces on all modules must support EtherChannel with no requirement that interfaces be physically contiguous, or on the same module.
- **Speed and duplex:** Configure all interfaces in an EtherChannel to operate at the same speed and in the same duplex mode, as shown in Figure 3-6.
- **VLAN match:** All interfaces in the EtherChannel bundle must be assigned to the same VLAN, or be configured as a trunk (also shown in Figure 3-6).
- **Range of VLANs:** An EtherChannel supports the same allowed range of VLANs on all the interfaces in a trunking EtherChannel. If the allowed range of VLANs is not the same, the interfaces do not form an EtherChannel, even when set to auto or desirable mode.

Figure 3-6 shows example topologies. In the top topology, a channel is established because none of the restrictions apply. In the bottom topology, the duplex mode doesn't match, so a channel is not established.

If these settings must be changed, configure them in port channel interface configuration mode. After the port channel interface is configured, any configuration that is applied to the port channel interface also affects individual interfaces. However, configurations that are applied to the individual interfaces do not affect the port channel interface. Therefore, making configuration changes to an interface that is part of an EtherChannel link can cause interface compatibility issues.

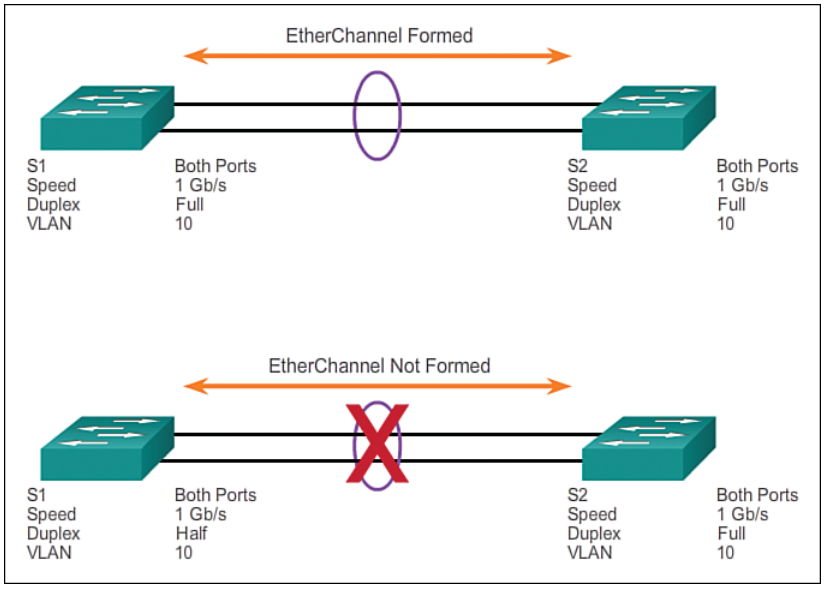

Figure 3-6 EtherChannel Configuration Restrictions Example

Configuring Interfaces (3.2.1.2)

Configuring EtherChannel with LACP is based on two steps:

Step 1. Specify the interfaces that compose the EtherChannel group using the **interface range** *interface* global configuration mode command. The **range** keyword allows you to select several interfaces and configure them all together. A good practice is to start by shutting down those interfaces so that any incomplete configuration does not create activity on the link.

Step 2. Create the port channel interface with the **channel-group** *identifier* **mode active** command in interface range configuration mode. The identifier specifies a channel group number. The **mode active** keywords identify this as an LACP EtherChannel configuration.

Note

EtherChannel is disabled by default.

Figure 3-7 shows the topology that is used for the configuration, verification, and troubleshooting examples in this section.

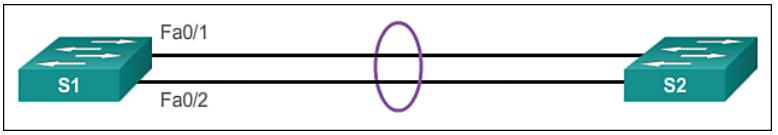

Figure 3-7 EtherChannel Configuration Topology

In Example 3-1, the FastEthernet0/1 and FastEthernet0/2 interfaces are bundled into EtherChannel interface port channel 1. To change Layer 2 settings on the port channel interface, enter port channel interface configuration mode using the interface **port-channel** command, followed by the interface identifier. In the example, the EtherChannel is configured as a trunk interface with allowed VLANs specified. Interface port channel 1 is configured as a trunk with allowed VLANs 1, 2, and 20.

Example 3-1 Configuring EtherChannel with LACP

```
S1(config)# interface range FastEthernet0/1 - 2
S1(config-if-range)# channel-group 1 mode active
S1(config-if-range)# interface port-channel 1
S1(config-if)# switchport mode trunk
S1(config-if)# switchport trunk allowed vlan 1,2,20
```

Packet Tracer Activity

Packet Tracer Activity 3.2.1.3: Configuring EtherChannel

Three switches have just been installed. There are redundant uplinks between the switches. Usually, only one of these links could be used; otherwise, a bridging loop might occur. However, using only one link utilizes only half of the available bandwidth. EtherChannel allows up to eight redundant links to be bundled together into one logical link. In this lab, you will configure Port Aggregation Protocol (PAgP), a Cisco EtherChannel protocol, and Link Aggregation Control Protocol (LACP), an IEEE 802.3ad open standard version of EtherChannel.

Lab 3.2.1.4: Configuring EtherChannel

In this lab, you will complete the following objectives:

- Part 1: Configure Basic Switch Settings
- Part 2: Configure PAgP
- Part 3: Configure LACP

Verifying and Troubleshooting EtherChannel (3.2.2)

This topic discusses several useful commands available for verifying and troubleshooting EtherChannel.

Verifying EtherChannel (3.2.2.1)

There are a number of commands to verify an EtherChannel configuration. First, the **show interface port-channel** command displays the general status of the port channel interface. In Example 3-2, the Port Channel 1 interface is up.

Example 3-2 show interface port-channel Command

```
S1# show interface Port-channel1
Port-channel1 is up, line protocol is up (connected)
  Hardware is EtherChannel, address is 0cd9.96e8.8a01 (bia 0cd9.96e8.8a01)
  MTU 1500 bytes, BW 200000 Kbit/sec, DLY 100 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
<output omitted>
```

When several port channel interfaces are configured on the same device, use the **show etherchannel summary** command to simply display one line of information per port channel. In Example 3-3, the switch has one EtherChannel configured; group 1 uses LACP.

Example 3-3 show etherchannel summary Command

```
S1# show etherchannel summary
Flags:  D - down        P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator

        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port


Number of channel-groups in use:  1
Number of aggregators:            1
```

```
Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1      Po1(SU)         LACP      Fa0/1(P)    Fa0/2(P)
```

The interface bundle consists of the FastEthernet0/1 and FastEthernet0/2 interfaces. Group 1 is a Layer 2 EtherChannel and is in use, as indicated by the letters SU next to the port channel number.

Use the **show etherchannel port-channel** command to display information about a specific port channel interface, as shown in Example 3-4.

Example 3-4 show etherchannel port-channel Command

```
S1# show etherchannel Port-channel
        Channel-group listing:
        ----------------------

Group: 1
----------
        Port-channels in the group:
        ---------------------------

Port-channel: Po1    (Primary Aggregator)

------------

Age of the Port-channel   = 0d:00h:25m:17s
Logical slot/port   = 2/1          Number of ports = 2
HotStandBy port = null
Port state          = Port-channel Ag-Inuse
Protocol            =   LACP
Port security       = Disabled

Ports in the Port-channel:

Index   Load   Port     EC state        No of bits
------+------+------+------------------+-----------
  0     00     Fa0/1    Active             0
  0     00     Fa0/2    Active             0

Time since last port bundled:    0d:00h:05m:41s    Fa0/2
Time since last port Un-bundled: 0d:00h:05m:48s    Fa0/2
```

In the example, the Port Channel 1 interface consists of two physical interfaces, FastEthernet0/1 and FastEthernet0/2. It uses LACP in active mode. It is properly connected to another switch with a compatible configuration, which is why the port channel is said to be in use.

On any physical interface member of an EtherChannel bundle, the **show interfaces etherchannel** command can provide information about the role of the interface in the EtherChannel, as shown in Example 3-5. The interface FastEthernet 0/1 is part of the EtherChannel bundle 1. The protocol for this EtherChannel is LACP.

Example 3-5 show interfaces f0/1 etherchannel Command

```
S1# show interfaces f0/1 etherchannel
Port state    = Up Mstr Assoc In-Bndl
Channel group = 1           Mode = Active          Gcchange = -
Port-channel  = Po1         GC   =   -             Pseudo port-channel = Po1
Port index    = 0           Load = 0x00            Protocol =   LACP

Flags:  S - Device is sending Slow LACPDUs   F - Device is sending fast LACPDUs.
        A - Device is in active mode.        P - Device is in passive mode.

Local information:
                            LACP port     Admin     Oper    Port         Port
Port      Flags   State     Priority      Key       Key     Number       State
Fa0/1     SA      bndl      32768         0x1       0x1     0x102        0x3D

Partner's information:

                  LACP port                         Admin  Oper   Port     Port
Port      Flags   Priority  Dev ID          Age     key    Key    Number   State
Fa0/1     SA      32768     0cd9.96d2.4000   4s     0x0    0x1    0x102    0x3D
```

Troubleshooting EtherChannel (3.2.2.2)

All interfaces within an EtherChannel must have the same configuration of speed and duplex mode, native and allowed VLANs on trunks, and access VLAN on access ports:

- Assign all ports in the EtherChannel to the same VLAN, or configure them as trunks. Ports with different native VLANs cannot form an EtherChannel.
- When configuring an EtherChannel from trunk ports, verify that the trunking mode is the same on all the trunks. Inconsistent trunk modes on EtherChannel ports can cause EtherChannel not to function and ports to be shut down (errdisable state).

- An EtherChannel supports the same allowed range of VLANs on all the ports. If the allowed range of VLANs is not the same, the ports do not form an EtherChannel, even when PAgP is set to the auto or desirable mode.
- The dynamic negotiation options for PAgP and LACP must be compatibly configured on both ends of the EtherChannel.

Note

It is easy to confuse PAgP or LACP with the Dynamic Trunking Protocol (DTP), because they are protocols used to automate behavior on trunk links. PAgP and LACP are used for link aggregation (EtherChannel). DTP is used for automating the creation of trunk links. When an EtherChannel trunk is configured, typically EtherChannel (PAgP or LACP) is configured first and then DTP.

In Example 3-6, interfaces F0/1 and F0/2 on switches S1 and S2 are connected with an EtherChannel. The output indicates that the EtherChannel is down.

Example 3-6 Troubleshooting Scenario 1

```
S1# show etherchannel summary
Flags:  D - down        P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator
        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1      Po1(SD)           -        Fa0/1(D)     Fa0/2(D)
```

In Example 3-7, more detailed output indicates that there are incompatible PAgP modes configured on S1 and S2.

Example 3-7 Troubleshooting Scenario 2

```
S1# show run | begin interface Port-channel
interface Port-channel1
 switchport mode trunk
!
interface FastEthernet0/1
 switchport mode trunk
 channel-group 1 mode on
!
interface FastEthernet0/2
 switchport mode trunk
 channel-group 1 mode on
!
<output omitted>
S2# show run | begin interface Port-channel
interface Port-channel1
 switchport mode trunk
!
interface FastEthernet0/1
 switchport mode trunk
 channel-group 1 mode desirable
!
interface FastEthernet0/2
 switchport mode trunk
 channel-group 1 mode desirable
!
<output omitted>
```

In Example 3-8, the PAgP mode on the EtherChannel is changed to desirable and the EtherChannel becomes active.

Example 3-8 Troubleshooting Scenario 3

```
S1(config)# no interface Port-channel 1
S1(config)# interface range f0/1 - 2
S1(config-if-range)# channel-group 1 mode desirable
Creating a port-channel interface Port-channel 1
S1(config-if-range)# no shutdown
S1(config-if-range)# interface Port-channel 1
S1(config-if)# switchport mode trunk
S1(config-if)# end
S1# show etherchannel summary
```

```
Flags:  D - down        P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator
        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1      Po1(SU)         PAgP      Fa0/1(P)    Fa0/2(P)
```

Note

EtherChannel and spanning tree must interoperate. For this reason, the order in which EtherChannel-related commands are entered is important, which is why (in Example 3-8) you see interface Port-Channel 1 removed and then re-added with the **channel-group** command, as opposed to directly changed. If one tries to change the configuration directly, spanning tree errors cause the associated ports to go into the blocking or errdisabled state.

Packet Tracer Activity

Packet Tracer Activity 3.2.2.3: Troubleshooting EtherChannel

Four switches were recently configured by a junior technician. Users are complaining that the network is running slowly and would like you to investigate.

Lab 3.2.2.4: Troubleshooting EtherChannel

In this lab, you will complete the following objectives:

- Part 1: Build the Network and Load Device Configurations
- Part 2: Troubleshoot EtherChannel

Summary (3.3)

Class Activity 3.3.1.1: Linking Up

Many bottlenecks occur on your small- to medium-sized business network, even though you have configured VLANs, STP, and other network traffic options on the company's switches.

Instead of keeping the switches as they are currently configured, you would like to try EtherChannel as an option for, at least, part of the network to see whether it will decrease traffic congestion between your access and distribution layer switches.

Your company uses Catalyst 3560 switches at the distribution layer and Catalyst 2960 and 2950 switches at the access layer of the network. To verify whether these switches can perform EtherChannel, you visit the site "The System Requirements to Implement EtherChannel on Catalyst Switches." This site allows you to gather more information to determine whether EtherChannel is a good option for the equipment and network currently in place.

After researching the models, you decide to use a simulation software program to practice configuring EtherChannel before implementing it live on your network. As a part of this procedure, you ensure that the equipment simulated in Packet Tracer will support these practice configurations.

Packet Tracer Activity

Packet Tracer Activity 3.3.1.2: Skills Integration Challenge

In this activity, two routers are configured to communicate with each other. You are responsible for configuring subinterfaces to communicate with the switches. You will configure VLANs, trunking, and EtherChannel with PVST. The Internet devices are all preconfigured.

EtherChannel aggregates multiple switched links together to load-balance over redundant paths between two devices. All ports in one EtherChannel must have the same speed, duplex setting, and VLAN information on all interfaces on the devices at both ends. Settings configured in the port channel interface configuration mode will also be applied to the individual interfaces in that EtherChannel. Settings configured on individual interfaces will not be applied to the EtherChannel or to the other interfaces in the EtherChannel.

PAgP is a Cisco-proprietary protocol that aids in the automatic creation of EtherChannel links. PAgP modes are on, PAgP desirable, and PAgP auto. LACP is part of an IEEE specification that also allows multiple physical ports to be bundled into one logical channel. The LACP modes are on, LACP active, and LACP passive. PAgP

and LACP do not interoperate. The on mode is repeated in both PAgP and LACP because it creates an EtherChannel unconditionally, without the use of PAgP or LACP. The default for EtherChannel is that no mode is configured.

Practice

The following activities provide practice with the topics introduced in this chapter. The Labs and Class Activities are available in the companion *Scaling Networks Lab Manual* (ISBN 978-1-58713-325-1). The Packet Tracer Activities PKA files are found in the online course.

Class Activities

- Class Activity 3.0.1.2: Imagine This
- Class Activity 3.3.1.1: Linking Up

Labs

- Lab 3.2.1.4: Configuring EtherChannel
- Lab 3.2.2.4: Troubleshooting EtherChannel

Packet Tracer Activities

- Packet Tracer Activity 3.2.1.3: Configuring EtherChannel
- Packet Tracer Activity 3.2.2.3: Troubleshooting EtherChannel
- Packet Tracer Activity 3.3.1.2: Skills Integration Challenge

Check Your Understanding Questions

Complete all the review questions listed here to test your understanding of the topics and concepts in this chapter. The appendix "Answers to 'Check Your Understanding' Questions" lists the answers.

1. Which statement is true about EtherChannel technology?

   A. EtherChannel relies on existing switch ports.

   B. STP does not run on EtherChannel links.

   C. Configuration tasks must be done on individual ports.

   D. Links must be upgraded to support EtherChannel.

2. What are advantages of using EtherChannel technology? (Choose three.)

   A. EtherChannel uses multiple logical links to provide redundancy.

   B. Load balancing is not needed with EtherChannel.

   C. The Spanning Tree Protocol shuts down the unused interfaces in the bundle to avoid loops.

   D. A spanning tree recalculation is not required when a single link within the channel goes down.

   E. There is no need to upgrade links to faster connections to increase bandwidth.

   F. Configuration tasks can be done on the EtherChannel interface.

3. Refer to Figure 3-8. An administrator tried to implement an EtherChannel between two switches by grouping the six physical ports as shown. However, the administrator was not successful. What is the reason for that?

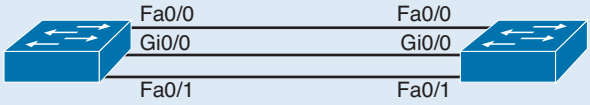

Figure 3-8 Question 3 Exhibit

   A. An EtherChannel link can only be implemented on Fast Ethernet interfaces.

   B. An EtherChannel link can only be implemented on Gigabit Ethernet interfaces.

   C. An EtherChannel link can only be formed by grouping interfaces of the same type.

   D. An EtherChannel link can only be created between Layer 3 switches.

4. Refer to Figure 3-9. An administrator wants to form an EtherChannel between the two switches by using the Port Aggregation Protocol. If switch S1 is configured to be in auto mode, which mode should be configured on S2 to form the EtherChannel?

Figure 3-9 Question 4 Exhibit

A. On
B. Auto
C. Desirable
D. Off

5. When a range of ports is being configured for EtherChannel, which mode will configure PAgP so that it initiates the EtherChannel negotiation?

A. Active
B. Auto
C. Desirable
D. Passive

6. Which of the following protocols are used to implement EtherChannel? (Choose two.)

A. Spanning Tree Protocol
B. Rapid Spanning Tree Protocol
C. Port Aggregation Protocol
D. Link Aggregation Control Protocol
E. Cisco Discovery Protocol

7. What will happen if a network administrator puts a port that is part of an EtherChannel bundle into a different VLAN than the other ports in that bundle?

A. The EtherChannel bundle will stay up only if PAgP is used.
B. The EtherChannel bundle will stay up only if LACP is used.
C. The EtherChannel bundle will stay up if either PAgP or LACP is used.
D. The EtherChannel bundle will stay up if the ports were configured with no negotiation between the switches to form the EtherChannel.
E. The EtherChannel will fail.

8. Refer to Example 3-9. On the basis of the output that is shown, what can be determined about the EtherChannel bundle?

Example 3-9 Question 8 Exhibit

```
S1# show etherchannel summary
Flags:  D - down        P - bundled in port-channel
        I - stand-alone s - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator
        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1      Po1(SU)          PAgP      Fa0/1(P)    Fa0/2(P)
```

A. Two Gigabit Ethernet ports are used to form the EtherChannel.
B. A Cisco-proprietary protocol was used to negotiate the EtherChannel link.
C. The EtherChannel bundle is down.
D. The EtherChannel bundle is operating at both Layer 2 and Layer 3.

9. Which of the following interface parameters must match for an EtherChannel to form? (Choose three.)

A. Trunking mode
B. Native VLAN
C. EtherChannel mode
D. Spanning-tree state
E. Allowed VLANs
F. PortFast mode

10. Which command displays only one line of information per port channel?

_____