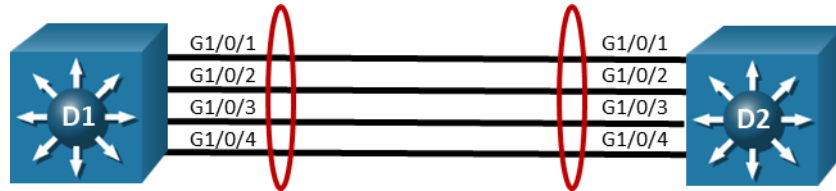


## Lab - Tune and Optimize EtherChannel Operations Topology



### Objectives

**Part 1: Build the Network and Configure Basic Device Settings**

**Part 2: Tune LACP-based EtherChannels**

**Part 3: Explore EtherChannel Load Balancing**

### Background / Scenario

The open standard Link Aggregation Control Protocol (LACP) is extremely flexible and offers robust options for maintaining an EtherChannel bundle. By default, LACP allows up to 8 active members and as many as 8 standby members in a single bundle. The minimum and maximum number of links can be controlled through configuration. In addition, the timing of LACP packets can be modified.

Both LACP and Cisco's Port Aggregation Protocol (PAgP) support a wide variety of load-balancing algorithms, which help to maintain even distribution of the traffic load across an EtherChannel bundle.

In this lab, you will explore the tuning options for LACP, as well as the load-balancing options for EtherChannel in general.

**Note:** This lab is an exercise in tuning and optimizing EtherChannel and does not necessarily reflect networking best practices.

**Note:** The switches used with CCNP hands-on labs are Cisco 3650 with Cisco IOS XE release 16.9.4 (universalk9 image). Other routers and Cisco IOS versions can be used. Depending on the model and Cisco IOS version, the commands available and the output produced might vary from what is shown in the labs.

**Note:** Ensure that the switches have been erased and have no startup configurations. If you are unsure contact your instructor.

### Required Resources

- 2 Switches (Cisco 3650 with Cisco IOS XE release 16.9.4 universal image or comparable)
- 1 PC (Windows with a terminal emulation program, such as Tera Term)
- Console cables to configure the Cisco IOS devices via the console ports
- Ethernet cables as shown in the topology

### Part 1: Build the Network and Configure Basic Device Settings

In Part 1, you will set up the network topology and then tune and optimize EtherChannel.

#### Step 1: Cable the network as shown in the topology.

Attach the devices as shown in the topology diagram, and cable as necessary.

### Step 2: Configure basic settings for each switch.

- a. Console into each switch, enter global configuration mode, and apply the basic settings using the startup configurations below for each device.

#### Switch D1

```
hostname D1
banner motd # D1, Tuning EtherChannel #
spanning-tree mode rapid-pvst
line con 0
  exec-timeout 0 0
  logging synchronous
exit
interface range g1/0/1-24, g1/1/1-4, g0/0
  shutdown
exit
interface range g1/0/1-4
  switchport mode trunk
  no shutdown
exit
```

#### Switch D2

```
hostname D2
banner motd # D2, Tuning EtherChannel #
spanning-tree mode rapid-pvst
line con 0
  exec-timeout 0 0
  logging synchronous
exit
interface range g1/0/1-24, g1/1/1-4, g0/0
  shutdown
exit
interface range g1/0/1-4
  switchport mode trunk
  no shutdown
exit
```

- b. Set the clock on each switch to UTC time.
- c. Save the running configuration to startup-config.

## Part 2: Tune LACP-based EtherChannels

An EtherChannel bundle using LACP as its negotiation protocol can have as many as 16 assigned members, with 8 active ports passing traffic, and the other 8 ports on standby. The switches involved in a LACP bundle negotiate a master/slave relationship and the designated master switch makes the decisions on which members are active and which are in "hot standby" mode when the number of members in the bundle exceeds 8.

The minimum and maximum number of ports allowed to be involved in a port channel can be managed through configuration as well.

In this part of the lab, you will do just that. For the group of links connecting D1 and D2, you will set up an EtherChannel bundle using LACP as the negotiation protocol, with a minimum of 2 links and a maximum of 3. As a part of this configuration, you will control which switch is the master. Next, you will enable LACP fast packets, reducing the time out period from 30 seconds to 1 second.

### Step 1: Configure master switch criteria.

Each switch connected using LACP has a system ID value. Those numbers are compared, and the switch with the lowest number is considered the master. The system ID value is a combination of a system priority that defaults to 32768 and the base MAC address. Unlike spanning tree, the priority value for LACP does not have to be scaled by multiples of 4096.

- a. Use the **show lacp sys-id** privileged EXEC command to see what the sys-id value is for D1 and D2. Based on the output shown below, we can deduce that D1 would be the bundle master if all default values remained unchanged.

```
D1# show lacp sys-id
32768, d8b1.9028.af80
```

```
D2# show lacp sys-id
32768, d8b1.905d.c300
```

- b. On D2, modify the lacp sys-id by changing the system priority. Use the **lacp system-priority** *value* global configuration command to set the value to 1, and then verify that the value has been changed.

```
D2# config t
Enter configuration commands, one per line. End with CNTL/Z.
D2(config)# lacp system-priority 1
D2(config)# exit
```

```
D2# show lacp sys-id
1, d8b1.905d.c300
```

### Step 2: Configure bundle size and member preferences.

By default, interfaces are selected to be included in the active bundle based on their interface id. For a given configuration, the lower numbered interfaces are added to the bundle until the bundle has reached its maximum size. Any interfaces that remain are put in hot standby mode.

- a. Issue the **shutdown** command for the interfaces connecting D1 and D2.

```
D2# config t
Enter configuration commands, one per line. End with CNTL/Z.
D2(config)# interface range g1/0/1-4
D2(config-if-range)# shutdown
```

- b. Configure the connections between D1 and D2 into a single LACP EtherChannel bundle. Use Channel Group number 12 and the Active mode. Configure the interfaces for LACP Fast.

```
D2(config-if-range)# channel-group 12 mode active
Creating a port-channel interface Port-channel 12
```

```
D2(config-if-range)# lacp rate fast
```

- c. Issue the **no shutdown** command for the interfaces connecting D1 and D2.

```
D2(config-if-range)# no shutdown
D2(config-if-range)# exit
```

- d. On D1 and D2, configure the port-channel 12 interface with a LACP minimum bundle size of 2 interfaces, and the maximum bundle size of 3 interfaces.

**Note:** The maximum value is only required on the master switch. Configuring it on both sides of the bundle is a best practice that may help with troubleshooting.

```
D2(config)# interface port-channel 12
D2(config-if)# port-channel min-links 2
D2(config-if)# lacp max-bundle 3
D2(config-if)# end
```

- e. Verify that the EtherChannel bundle has formed and take note of the ports that are included versus the port that is in hot standby mode.

```
D2# 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

        A - formed by Auto LAG
```

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

| Group | Port-channel | Protocol | Ports                                       |
|-------|--------------|----------|---|
| 12    | Po12(SU)     | LACP     | Gi1/0/1(P) Gi1/0/2(P) Gi1/0/3(P) Gi1/0/4(H) |

- f. Verify the mode, state and rate of LACPDU being sent for port members.

```
D2# show lacp internal

Flags:  S - Device is requesting Slow LACPDU
        F - Device is requesting Fast LACPDU
        A - Device is in Active mode      P - Device is in Passive mode
```

Channel group 12

| Port    | Flags | State   | LACP port<br>Priority | Admin<br>Key | Oper<br>Key | Port<br>Number | Port<br>State |
|---------|-------|---------|-----------------------|--------------|-------------|----------------|---------------|
| Gi1/0/1 | FA    | bndl    | 32768                 | 0xC          | 0xC         | 0x102          | 0x3F          |
| Gi1/0/2 | FA    | bndl    | 32768                 | 0xC          | 0xC         | 0x103          | 0x3F          |
| Gi1/0/3 | FA    | bndl    | 32768                 | 0xC          | 0xC         | 0x104          | 0x3F          |
| Gi1/0/4 | FA    | hot-sby | 32768                 | 0xC          | 0xC         | 0x105          | 0xF           |

### Part 3: Explore EtherChannel Load Balancing

The load balancing method used to send traffic through an EtherChannel is a global setting on the switch. All EtherChannels on a given switch will use the method selected for that switch. The load balancing methods used at either end of an EtherChannel bundle do not have to match.

The available methods, as well as the default method used, varies by hardware platform. By default, Cisco Catalyst 3650 and Catalyst 2960 switches load-balance using the source MAC address.

```
D2# show etherchannel load-balance
```

```
EtherChannel Load-Balancing Configuration:
```

```
src-mac
```

```
EtherChannel Load-Balancing Addresses Used Per-Protocol:
```

```
Non-IP: Source MAC address
```

```
IPv4: Source MAC address
```

```
IPv6: Source MAC address
```

The full form of the command to show what interface the load-balancing algorithm will choose is **show platform software fed etherchannel [switch switch-number] channel-group-number {group-mask | load-balance mac src-mac dst-mac [ip src-ip dst-ip [port src-port dst-port]]}**. Select a channel-group and specify the source and destination address (in the form of a MAC, IP, or Port number) and the switch tells you what the exit port will be. The example that follows shows that traffic with the same source MAC always exits using the same interface.

```
D1# show platform software fed switch 1 etherchannel 12 load-balance mac  
0050.0040.00af 0050.0040.00fa
```

```
Dest Port: : GigabitEthernet1/0/1
```

```
D1# show platform software fed switch 1 etherchannel 12 load-balance mac  
0050.0040.00af 0050.0040.00fb
```

```
Dest Port: : GigabitEthernet1/0/1
```

```
D1# show platform software fed switch 1 etherchannel 12 load-balance mac  
0050.0040.00bf 0050.0040.00fb
```

```
Dest Port: : GigabitEthernet1/0/2
```

Use this command on your switches to verify how the default load-balancing scheme is working, and then try out the other load-balancing mechanisms to see how the behavior changes.