2.3 Lab 3: Ethernet Link Aggregation

2.3.1 Introduction

2.3.1.1 About This Lab

As networks grow in scale, users require Ethernet backbone networks to provide higher bandwidth and availability. In the past, the only way to increase bandwidth was to upgrade the network with high-speed LPUs, which is costly and inflexible.

In contrast, link aggregation increases bandwidth by bundling a group of physical port into a single logical port, without the need to upgrade hardware. In addition, link aggregation provides link backup mechanisms, greatly improving link availability. Link aggregation has the following advantages:

- Improving bandwidth: The maximum bandwidth of a link aggregation group (LAG) is the combined bandwidth of all member links.
- Improving availability: If a link is faulty, the traffic can be switched to other available member links.
- Load balancing: The traffic load can be balanced among the active member links in a LAG.

  In this lab activity, you will learn how to configure Ethernet link aggregation in manual and LACP modes.

2.3.1.2 Objectives

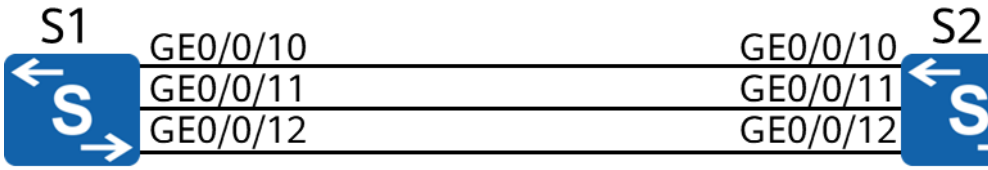
Upon completion of this task, you will be able to:

- Learn how to manually configure link aggregation
- Learn how to configure link aggregation in static LACP mode
- Learn how to determine active links in static LACP mode
- Learn how to configure some static LACP features

2.3.1.3 Networking Topology

In the spanning tree lab activity, the two links between S1 and S2 cannot be in the data forwarding state at the same time. To make full use of the bandwidth of the two links, you need to configure Ethernet link aggregation between S1 and S2.

Figure 2-1 Lab topology for configuring Ethernet link aggregation



2.3.2 Lab Configuration

2.3.2.1 Configuration Roadmap

1. Configure link aggregation manually.
2. Configure link aggregation in LACP mode.
3. Modify parameters to determine active links.
4. Change the load balancing mode.

2.3.2.2 Configuration Procedure

Step 1 Configure link aggregation manually.

Create an Eth-Trunk.

```
[S1]interface Eth-Trunk 1
```

The **interface eth-trunk** command displays the view of an existing Eth-Trunk or creates an Eth-Trunk and displays its view. The number **1** in this example indicates the port number.

```
[S2]interface Eth-Trunk 1
```

Configure the link aggregation mode of the Eth-Trunk.

```
[S1-Eth-Trunk1]mode manual load-balance
```

The **mode** command configures the working mode of the Eth-Trunk, which can be LACP or manual load balancing. By default, the manual load balancing mode is used. Therefore, the preceding operation is unnecessary and is provided for demonstration purpose only.

Add a port to the Eth-Trunk.

```
[S1]interface GigabitEthernet 0/0/10
[S1-GigabitEthernet0/0/10]eth-trunk 1
Info: This operation may take a few seconds. Please wait for a moment...done.
[S1-GigabitEthernet0/0/10]quit
[S1]interface GigabitEthernet 0/0/11
[S1-GigabitEthernet0/0/11]eth-trunk 1
Info: This operation may take a few seconds. Please wait for a moment...done.
[S1-GigabitEthernet0/0/11]quit
[S1]interface GigabitEthernet 0/0/12
[S1-GigabitEthernet0/0/12]eth-trunk 1
Info: This operation may take a few seconds. Please wait for a moment...done.
[S1-GigabitEthernet0/0/12]quit
```

You can enter the interface view of an individual port and add it to an Eth-Trunk. You can also run the **trunkport** command in the Eth-Trunk interface view to add multiple ports to the Eth-Trunk.

```
[S2]interface Eth-Trunk 1
[S2-Eth-Trunk1]trunkport GigabitEthernet 0/0/10 to 0/0/12
Info: This operation may take a few seconds. Please wait for a moment...done.
```

Note the following points when adding physical ports to an Eth-Trunk:

- An Eth-Trunk contains a maximum of 8 member ports.
- An Eth-Trunk cannot be added to another Eth-Trunk.
- An Ethernet port can be added to only one Eth-Trunk. To add an Ethernet port to another Eth-Trunk, delete it from the original one first.
- The remote ports directly connected to the local Eth-Trunk member ports must also be added to an Eth-Trunk; otherwise, the two ends cannot communicate.

- Both endpoints of an Eth-Trunk must use the same number of physical ports, port rate, and duplex mode.

Display the status of an Eth-Trunk.

```
[S1]display eth-trunk 1
Eth-Trunk1's state information is:
WorkingMode: NORMAL                 Hash arithmetic: According to SIP-XOR-DIP
Least Active-linknumber: 1          Max Bandwidth-affected-linknumber: 32
Operate status: up                  Number Of Up Port In Trunk: 3
--------------------------------------------------------------------------------
PortName                  Status     Weight
GigabitEthernet0/0/10     Up         1
GigabitEthernet0/0/11     Up         1
GigabitEthernet0/0/12     Up         1
```

Step 2 Configure link aggregation in LACP mode.

Delete member ports from an Eth-Trunk.

```
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]undo trunkport GigabitEthernet 0/0/10 to 0/0/12
Info: This operation may take a few seconds. Please wait for a moment...done.
```

```
[S2]interface Eth-Trunk 1
[S2-Eth-Trunk1]undo trunkport GigabitEthernet 0/0/10 to 0/0/12
Info: This operation may take a few seconds. Please wait for a moment...done.
```

Before changing the working mode of an Eth-Trunk, ensure that the Eth-Trunk has no member port.

Change the aggregation mode.

```
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]mode lacp
```

The **mode lacp** command sets the working mode of an Eth-Trunk to LACP.

Note: The command is **mode lacp-static** in some versions.

```
[S2]interface Eth-Trunk 1
[S2-Eth-Trunk1]mode lacp
```

Add a port to the Eth-Trunk.

```
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]trunkport GigabitEthernet 0/0/10 to 0/0/12
Info: This operation may take a few seconds. Please wait for a moment...done.
```

```
[S2]interface Eth-Trunk 1
[S2-Eth-Trunk1]trunkport GigabitEthernet 0/0/10 to 0/0/12
Info: This operation may take a few seconds. Please wait for a moment...done.
```

Display the status of the Eth-Trunk.

```
[S1]display eth-trunk 1
Eth-Trunk1's state information is:
Local:
LAG ID: 1                           WorkingMode: STATIC
Preempt Delay: Disabled             Hash arithmetic: According to SIP-XOR-DIP
System Priority: 32768              System ID: 4c1f-cc33-7359
Least Active-linknumber: 1          Max Active-linknumber: 8
Operate status: up                  Number Of Up Port In Trunk: 3
--------------------------------------------------------------------------------
ActorPortName        Status   PortType  PortPri PortNo PortKey PortState Weight
GigabitEthernet0/0/10   Selected 1GE     32768   11     305     10111100  1
```

```
GigabitEthernet0/0/11   Selected  1GE     32768   12    305    10111100  1
GigabitEthernet0/0/12   Selected  1GE     32768   13    305    10111100  1

Partner:
--------------------------------------------------------------------------------
ActorPortName       SysPri          SystemID              PortPri  PortNo PortKey   PortState
GigabitEthernet0/0/10  32768   4c1f-ccc1-4a02   32768   11    305    10111100
GigabitEthernet0/0/11  32768   4c1f-ccc1-4a02   32768   12    305    10111100
GigabitEthernet0/0/12  32768   4c1f-ccc1-4a02   32768   13    305    10111100
```

Step 3 In normal cases, only GigabitEthernet0/0/11 and GigabitEthernet0/0/12 need to be in the forwarding state, and GigabitEthernet0/0/10 is used as the backup. When the number of active ports falls bellow 2, the Eth-Trunk is shut down.

Set the LACP priority of S1 to make S1 an active device.

```
[S1]lacp priority 100
```

Configure port priorities so that GigabitEthernet0/0/11 and GigabitEthernet0/0/12 can have a higher priority.

```
[S1]interface GigabitEthernet 0/0/10
[S1-GigabitEthernet0/0/10]lacp priority 40000
```

Link Aggregation Control Protocol data units (LACPDUs) are sent and received by both endpoints of a link aggregation group in LACP mode.

First, the actor is elected.

1. The system priority field is compared. The default priority value is 32768, and a lower value indicates a higher priority. The endpoint with a higher priority is elected as the LACP actor.
2. If there is a tie in priority, the endpoint with a smaller MAC address becomes the actor.

After the actor is elected, the devices at both ends select active ports according to the port priority settings on the actor.

Set the upper and lower thresholds of active ports.

```
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]max active-linknumber 2
[S1-Eth-Trunk1]least active-linknumber 2
```

The bandwidth and status of an Eth-Trunk depend on the number of active ports. The bandwidth of an Eth-Trunk is the total bandwidth of all member ports in Up state. You can set the following thresholds to stabilize an Eth-Trunk's status and bandwidth as well as reduce the impact brought by frequent changes of member link status.

- Lower threshold: When the number of active ports falls below this threshold, the Eth-Trunk goes Down. This threshold determines the minimum bandwidth of an Eth-Trunk and is configured using the **least active-linknumber** command.
- Upper threshold: When the number of active ports reaches this threshold, the bandwidth of the Eth-Trunk will not increase even if more member links go Up. The upper threshold ensures network availability and is configured using the **max active-linknumber** command.

Enable the preemption function.

```
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]lacp preempt enable
```

In LACP mode, when an active link fails, the system selects the backup link with the highest priority to replace the faulty one. If the faulty link is recovered and has a higher priority than the backup link, the recovered link can restore the active status if preemption is enabled. The

lacp preempt enable command enables LACP preemption. By default, this function is disabled.

Display the status of the current Eth-Trunk.

```
[S1]display eth-trunk 1
Eth-Trunk1's state information is:
Local:
LAG ID: 1                       WorkingMode: STATIC
Preempt Delay Time: 30          Hash arithmetic: According to SIP-XOR-DIP
System Priority: 100            System ID: 4c1f-cc33-7359
Least Active-linknumber: 2              Max Active-linknumber: 2
Operate status: up              Number Of Up Port In Trunk: 2
--------------------------------------------------------------------------------
ActorPortName                   Status    PortType      PortPri  PortNo  PortKey          PortState  Weight
GigabitEthernet0/0/10           Unselect  1GE           40000    11      305      10100000  1
GigabitEthernet0/0/11           Selected  1GE           32768    12      305      10111100  1
GigabitEthernet0/0/12           Selected  1GE           32768    13      305      10111100  1

Partner:
--------------------------------------------------------------------------------
ActorPortName        SysPri                            SystemID              PortPri  PortNo  PortKey  PortState
GigabitEthernet0/0/10   32768    4c1f-ccc1-4a02   32768    11      305      10110000
GigabitEthernet0/0/11   32768    4c1f-ccc1-4a02   32768    12      305      10111100
GigabitEthernet0/0/12   32768    4c1f-ccc1-4a02   32768    13      305      10111100
GigabitEthernet0/0/11 and GigabitEthernet0/0/12 are in active state.
```

Shut down GigabitEthernet0/0/12 to simulate a link fault.

```
[S1]interface GigabitEthernet 0/0/12
[S1-GigabitEthernet0/0/12]shutdown
[S1]display eth-trunk 1
Eth-Trunk1's state information is:
Local:
LAG ID: 1                       WorkingMode: STATIC
Preempt Delay Time: 30          Hash arithmetic: According to SIP-XOR-DIP
System Priority: 100            System ID: 4c1f-cc33-7359
Least Active-linknumber: 2              Max Active-linknumber: 2
Operate status: up              Number Of Up Port In Trunk: 2
--------------------------------------------------------------------------------
ActorPortName                   Status    PortType      PortPri PortNo  PortKey          PortState Weight
GigabitEthernet0/0/10           Selected  1GE           40000   11      305      10111100 1
GigabitEthernet0/0/11           Selected  1GE           32768   12      305      10111100 1
GigabitEthernet0/0/12           Unselect  1GE           32768   13      305      10100010 1

Partner:
--------------------------------------------------------------------------------
ActorPortName        SysPri          SystemID               PortPri     PortNo      PortKey     PortState
GigabitEthernet0/0/10   32768    4c1f-ccc1-4a02  32768          11          305         10111100
GigabitEthernet0/0/11   32768    4c1f-ccc1-4a02  32768          12          305         10111100
GigabitEthernet0/0/12   0        0000-0000-0000  0              0           0           10100011
GigabitEthernet 0/0/10 has become active.
```

Shut down GigabitEthernet 0/0/11 to simulate a link fault.

```
[S1]interface GigabitEthernet 0/0/11
[S1-GigabitEthernet0/0/11]shutdown
```

```
[S1]display eth-trunk 1
Eth-Trunk1's state information is:
Local:
LAG ID: 1                       WorkingMode: STATIC
Preempt Delay Time: 30          Hash arithmetic: According to SIP-XOR-DIP
System Priority: 100            System ID: 4c1f-cc33-7359
Least Active-linknumber: 2              Max Active-linknumber: 2
Operate status: down            Number Of Up Port In Trunk: 0
--------------------------------------------------------------------------------
ActorPortName                   Status   PortType  PortPri  PortNo  PortKey  PortState Weight
GigabitEthernet0/0/10           Unselect 1GE       40000    11      305      10100000  1
```

```
GigabitEthernet0/0/11        Unselect 1GE     32768   12    305     10100010  1
GigabitEthernet0/0/12        Unselect 1GE     32768   13    305     10100010  1

Partner:
--------------------------------------------------------------------------------
ActorPortName       SysPri                SystemID        PortPri PortNo  PortKey     PortState
GigabitEthernet0/0/10  32768    4c1f-ccc1-4a02      32768   11      305     10110000
GigabitEthernet0/0/11  0        0000-0000-0000 0            0       0       10100011
GigabitEthernet0/0/12  0        0000-0000-0000 0            0       0       10100011
```

The lower threshold for the number of active links is set to 2. Therefore, the Eth-Trunk is shut down. Although GigabitEthernet0/0/10 is Up, it is still in Unselect state.

Step 4 Change the load balancing mode.

Enable the ports disabled in the previous step.

```
[S1]inter GigabitEthernet 0/0/11
[S1-GigabitEthernet0/0/11]undo shutdown
[S1-GigabitEthernet0/0/11]quit
[S1]inter GigabitEthernet 0/0/12
[S1-GigabitEthernet0/0/12]undo shutdown
```

Wait about 30 seconds and check the status of Eth-Trunk 1.

```
[S1]display eth-trunk 1
Eth-Trunk1's state information is:
Local:
LAG ID: 1                       WorkingMode: STATIC
Preempt Delay Time: 30          Hash arithmetic: According to SIP-XOR-DIP
System Priority: 100            System ID: 4c1f-cc33-7359
Least Active-linknumber: 2              Max Active-linknumber: 2
Operate status: down            Number Of Up Port In Trunk: 0
--------------------------------------------------------------------------------
ActorPortName       Status   PortType  PortPri PortNo  PortKey  PortState  Weight
GigabitEthernet0/0/10  Unselect  1GE     40000   11    305     10100000  1
GigabitEthernet0/0/11  Selected  1GE     32768   12    305     10100010  1
GigabitEthernet0/0/12  Selected  1GE     32768   13    305     10100010  1

Partner:
--------------------------------------------------------------------------------
ActorPortName       SysPri                SystemID        PortPri         PortNo  PortKey     PortState
GigabitEthernet0/0/10  32768    4c1f-ccc1-4a02      32768           11      305     10110000
GigabitEthernet0/0/11  0        0000-0000-0000  0       0       0       10100011
GigabitEthernet0/0/12  0        0000-0000-0000  0       0       0       10100011
```

The preemption function is enabled on the Eth-Trunk. Therefore, when GigabitEthernet0/0/11 and GigabitEthernet0/0/12 enter the Up state, GigabitEthernet0/0/11 and GigabitEthernet0/0/12 have a higher priority than GigabitEthernet0/0/10. As a result, GigabitEthernet0/0/10 enters the Unselect state. In addition, to ensure link stability, the default preemption hold time is 30 seconds. Therefore, preemption occurs 30 seconds after the ports are enabled.

Change the load balancing mode of the Eth-Trunk to destination IP address-based load balancing.

```
[S1]interface Eth-Trunk 1
[S1-Eth-Trunk1]load-balance dst-ip
```

To ensure proper load balancing between physical links of an Eth-Trunk and avoid link congestion, use the **load-balance** command to set the load balancing mode of the Eth-Trunk. Load balancing is valid only for outgoing traffic; therefore, the load balancing modes for the ports at both ends can be different.

----End

2.3.3 Verification

The details are not provided here.

2.3.4 Configuration Reference

Configuration on S1

```
#
sysname S1
#
lacp priority 100
#
interface Eth-Trunk1
 mode lacp
 least active-linknumber 2
 load-balance dst-ip
 lacp preempt enable
 max active-linknumber 2
#
interface GigabitEthernet0/0/10
 eth-trunk 1
 lacp priority 40000
#
interface GigabitEthernet0/0/11
 eth-trunk 1
#
interface GigabitEthernet0/0/12
 eth-trunk 1
#
return
```

Configuration on S2

```
#
sysname S2
#
interface Eth-Trunk1
 mode lacp
#
interface GigabitEthernet0/0/10
 eth-trunk 1
#
interface GigabitEthernet0/0/11
 eth-trunk 1
#
interface GigabitEthernet0/0/12
 eth-trunk 1
#
return
```

2.3.5 Quiz

1. What are the requirements for the values of **least active-linknumber** and **max active-linknumber?**