Environment

- Link aggregation explained on HPE Networking Switches

Issue

What is Link Aggregation and how is it configured on HPE Networking Switches?

Cause

- Link Aggregation Overview

Resolution

Link Aggregation:
Link aggregation is called trunking on HP E-Series switches.

E-Series switches support two trunking methods:

HPE Port Trunking - HPE has supported port trunking since its first offering of switches in the mid-1990's. The original HPE port trunking technology remains an option on ProCurve switches. HPE port trunking is the default on E-Series switches. For proper trunk operation, all links in the same trunk group must have the same speed, duplex, and flow control.

Link Aggregation Control Protocol (LACP) - The IEEE standard for link aggregation. HP's implementation of LACP supports both active and passive configuration of trunking. These link-aggregation methods impose a similar set of requirements and restrictions. However, LACP imposes an additional restriction - the links must operate in full duplex mode. This is rarely a concern because trunks consist of point-to-point links between switches, and these links will usually negotiate to full duplex operation.

HPE port trunking does not have this requirement.

Both methods for port trunking share one important limitation in the area of load sharing—they are static methods. They do not adjust to reflect traffic volume on the links or evaluate an individual conversation to determine which link would be best at a given moment. Instead, all methods distribute the conversations evenly across all links with the expectation that the load generally is balanced. The benefits of trunking are always best realized in the presence of many source and destination points on each side of the trunk.

Configuring Port Trunking on E-Series Devices

To enable static port trunking from the CLI, you use the trunk command. At the global configuration level, issue the trunk command followed by a list of the ports that will be aggregated, a name for the trunk, and the type of trunk (HPE trunk or LACP). The ports need not be contiguous. A list of ports separated by commas, for example: "\"trunk a1,a7,b1,b24 trk1 LACP\"" is ok.
Note: The 2500 series switches support only one trunk. If the trunk is statically defined, it will be named Trk1

The trunk configuration must be performed on both sides of the trunk before the redundant links are connected.

Edge_1(config)# trunk ?
[ethernet] PORT-LIST Specify the ports that are to be added to/removed from a trunk.

Edge_1(config)# trunk c1,c2?
trk1 Trunk group 1
trk2 Trunk group 2
...

Edge_1(config)# trunk c1,c2 trk1 ?
trunk Do not use any protocol to create or maintain the trunk.
LACP Use IEEE 802.1ad Link Aggregation protocol.

Edge_1(config)# trunk c1,c2 trk1 lacp

The trunk command is used to create an HP port trunk or LACP port trunk
trk1, trk2, etc. are fixed label names for trunks
On the 8100fl series, trunks are referred to as Link Aggregation Groups

Configuring Link Aggregation on A-Series Devices

Static Link Aggregation
1. Create VLAN 10 and aggregate interface 1, and assign the aggregate interface to VLAN 10.
   <DeviceA> system-view
   [DeviceA] vlan 10
   [DeviceA-vlan10] quit
   [DeviceA] interface bridge-aggregation 1
   [DeviceA-Bridge-Aggregation1] port access vlan 10
   [DeviceA-Bridge-Aggregation1] quit

2. Assign ports GE4/0/1 through GE4/0/3 to link aggregation group 1 and VLAN 10 one at a time.
   [DeviceA] interface gigabitethernet 4/0/1
   [DeviceA-Gigabitethernet4/0/1] port link-aggregation group 1
   [DeviceA-Gigabitethernet4/0/1] port access vlan 10
   Warning: This port is a member of the link aggregation group. If configuration of the whole group is required to be modified, please configure it under the aggregation interface view. Otherwise, this operation may interrupt network traffic. Continue?[Y/N]: y
   [DeviceA-Gigabitethernet4/0/1] quit
   [DeviceA] interface gigabitethernet 4/0/2
   [DeviceA-Gigabitethernet4/0/2] port link-aggregation group 1
   [DeviceA-Gigabitethernet4/0/2] port access vlan 10
   Warning: This port is a member of the link aggregation group. If configuration of the whole group is required to be modified, please configure it under the aggregation interface view. Otherwise, this operation may interrupt network traffic. Continue?[Y/N]: y
   [DeviceA-Gigabitethernet4/0/2] quit
   [DeviceA] interface gigabitethernet 4/0/3
   [DeviceA-Gigabitethernet4/0/3] port link-aggregation group 1
   [DeviceA-Gigabitethernet4/0/3] port access vlan 10
   Warning: This port is a member of the link aggregation group. If configuration of the whole group is required to be modified, please configure it under the aggregation interface view. Otherwise, this operation may interrupt network traffic. Continue?[Y/N]: y
   [DeviceA-Gigabitethernet4/0/3] quit

3. Configure Device A to perform load sharing based on source and destination MAC addresses for link aggregation groups.
   [DeviceA] link-aggregation load-sharing mode source-mac destination-mac

Dynamic Link Aggregation
1. Create VLAN 10 and aggregate interface Bridge-aggregation 1, configure the link aggregation mode as dynamic, and assign the aggregate interface to VLAN 10.
   <DeviceA> system-view
   [DeviceA] vlan 10
2. Assign ports GE4/0/1 through GE4/0/3 to link aggregation group 1 and VLAN 10 one at a time.

   [DeviceA] interface gigabitethernet 4/0/1
   [DeviceA-Gigabitethernet4/0/1] port link-aggregation group 1
   [DeviceA-Gigabitethernet4/0/1] port access vlan 10
   Warning: This port is a member of the link aggregation group. If configuration of the whole group is required to be modified, please configure it under the aggregation interface view. Otherwise, this operation may interrupt network traffic. Continue? [Y/N]: y
   [DeviceA-Gigabitethernet4/0/1] quit

   [DeviceA] interface gigabitethernet 4/0/2
   [DeviceA-Gigabitethernet4/0/2] port link-aggregation group 1
   [DeviceA-Gigabitethernet4/0/2] port access vlan 10
   Warning: This port is a member of the link aggregation group. If configuration of the whole group is required to be modified, please configure it under the aggregation interface view. Otherwise, this operation may interrupt network traffic. Continue? [Y/N]: y
   [DeviceA-Gigabitethernet4/0/2] quit

   [DeviceA] interface gigabitethernet 4/0/3
   [DeviceA-Gigabitethernet4/0/3] port link-aggregation group 1
   [DeviceA-Gigabitethernet4/0/3] port access vlan 10
   Warning: This port is a member of the link aggregation group. If configuration of the whole group is required to be modified, please configure it under the aggregation interface view. Otherwise, this operation may interrupt network traffic. Continue? [Y/N]: y
   [DeviceA-Gigabitethernet4/0/3] quit

3. Configure Device A to perform load sharing based on source and destination MAC addresses for link aggregation groups.

   [DeviceA] link-aggregation load-sharing mode source-mac destination-mac

Load Sharing Mode

   <DeviceA> system-view
   [DeviceA] vlan 10
   [DeviceA-vlan10] quit

2. Create aggregate interface Bridge-aggregation 1, configure the source MAC-based load-sharing mode for the link aggregation group, and assign the aggregate interface to VLAN 10.

   [DeviceA] interface bridge-aggregation 1
   [DeviceA-Bridge-Aggregation1] link-aggregation load-sharing mode source-mac
   [DeviceA-Bridge-Aggregation1] port access vlan 10
   [DeviceA-Bridge-Aggregation1] quit

3. Assign ports GE4/0/1 and GE4/0/2 to link aggregation group 1 and VLAN 10.

   [DeviceA] interface gigabitethernet 4/0/1
   [DeviceA-Gigabitethernet4/0/1] port link-aggregation group 1
   [DeviceA-Gigabitethernet4/0/1] port access vlan 10
   Warning: This port is a member of the link aggregation group. If configuration of the whole group is required to be modified, please configure it under the aggregation interface view. Otherwise, this operation may interrupt network traffic. Continue? [Y/N]: y
   [DeviceA-Gigabitethernet4/0/1] quit

   [DeviceA] interface gigabitethernet 4/0/2
   [DeviceA-Gigabitethernet4/0/2] port link-aggregation group 1
   [DeviceA-Gigabitethernet4/0/2] port access vlan 10
   Warning: This port is a member of the link aggregation group. If configuration of the whole group is required to be modified, please configure it under the aggregation interface view. Otherwise, this operation may interrupt network traffic. Continue? [Y/N]: y
   [DeviceA-Gigabitethernet4/0/2] quit
4. Create aggregate interface Bridge-aggregation 2, configure the destination MAC-based load sharing mode for the link aggregation group, and assign the aggregate interface to VLAN 10.

   [DeviceA] interface bridge-aggregation 2
   [DeviceA-Bridge-Aggregation2] link-aggregation load-sharing mode destination-mac
   [DeviceA-Bridge-Aggregation2] port access vlan 10
   [DeviceA-Bridge-Aggregation2] quit

5. Assign ports GE4/0/3 and GE4/0/4 to link aggregation group 2 and VLAN 10.

   [DeviceA] interface gigabitethernet 4/0/3
   [DeviceA-Gigabitethernet4/0/3] port link-aggregation group 2
   [DeviceA-Gigabitethernet4/0/3] port access vlan 10
   Warning: This port is a member of the link aggregation group. If configuration of the whole group is required to be modified, please configure it under the aggregation interface view. Otherwise, this operation may interrupt network traffic. Continue?[Y/N]: y
   [DeviceA-Gigabitethernet4/0/3] quit
   [DeviceA] interface gigabitethernet 4/0/4
   [DeviceA-Gigabitethernet4/0/4] port access vlan 10
   Warning: This port is a member of the link aggregation group. If configuration of the whole group is required to be modified, please configure it under the aggregation interface view. Otherwise, this operation may interrupt network traffic. Continue?[Y/N]: y
   [DeviceA-Gigabitethernet4/0/4] quit

LACP – Link Aggregation Control Protocol

Link Aggregation Control Protocol (LACP) is another option for creating port trunk groups on HP switches. LACP is defined by the IEEE standard 802.3ad. LACP was standardized to allow a switch to automatically recognize coterminous, full duplex, same-speed links between itself and another LACP-compliant switch.

Although LACP can automatically recognize links that are capable of aggregation, the activation of an LACP trunk requires some configuration. You can’t simply connect four links between the same two switches and expect them to act as a trunk.

When using dynamic LACP, you must define the trunk on one side, which is known as the active side. The active side sends Bridge Protocol Data Units (BPDUs) across every link that has LACP defined statically.

Although a complete description of the fields in the BPDU is beyond the scope of this article, a few BPDU fields relevant to dynamic operation are worth noting.

They are:

- A system identifier, which is the switch’s MAC address.
- A priority value, which is a permutation of the MAC address.
- A port identifier, which contains a port number.

When a switch receives BPDUs through multiple passive LACP ports that have the same system identifier, it knows that those ports are linked to the same switch. If the links are the same speed, the switch sends BPDUs to the active partners on the other side of the links, and the two switches agree to load share across the group of links. Passive LACP ports only speak when spoken to; a passive LACP port sends BPDUs only after it has received BPDUs from a connected switch.

Configurable LACP States

HP switches offer three possible options for LACP configuration:

- Passive
- Active
- Disabled - (default state)

LACP is configured on a per-port basis. When a port is configured for a passive LACP state, it will be blocked for approximately five seconds when the switch is initialized. This is appropriate for ports that are linked to active LACP partners because it provides the ports with time to discover the LACP topology before forwarding any traffic. However, this delay can be unacceptable for normal switch operation.

Consequently, HP recommends that LACP remain in the default state of disabled for all ports that will not participate in dynamic link aggregation. If you define a trunk using the trunk command described earlier in this module, the no LACP command is automatically
executed and included in the configuration for the ports specified in the trunk command’s port list. Static and dynamic port trunking cannot be simultaneously active on the same port.

Finally, is the case of 802.1X (Port-Based Access Control) being configured on a Port. To maintain security, LACP is not allowed on ports configured for 802.1X authenticator operation. If you configure port security on a port on which LACP (active or passive) is configured, the switch removes the LACP configuration, displays a notice that LACP is disabled on the port(s), and enables 802.1X on that port.

Static vs. Dynamic Link Aggregation
One important advantage of dynamic link aggregation is its ability to recognize and use trunk standby links. When two switches detect more than four coterminous, same speed links, they aggregate the four links with the lowest port numbers. The remaining links are used as standby links. While dynamic LACP is the only way to set up standby links in a trunk, its disadvantage is that in certain circumstances it can give you less control. The primary disadvantage of static link aggregation is its lack of support for standby links. Switches configured for static link aggregation cannot automatically detect new members of the trunk group and, therefore, cannot use standby links.

On the other hand, static aggregation enables administrators to retain more control of the operation of the trunk ports.