Link Aggregation

Link Aggregation Configuration
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Introduction

This Technical Configuration Guide (TCG) describes how to configure Link Aggregation under Comware OS. The intended audience is HP solution architects and technical consultants.

What is Link Aggregation?

When two or more Ethernet links are directly connected between two switches, the Multiple Spanning Tree Protocol (MSTP) blocks all but one of the links in each MSTP instance to avoid loops. The full bandwidth potential of the multiple links may not be achieved.

Link Aggregation binds multiple Ethernet links into one aggregate link and shares the traffic load onto the multiple links in a manner that avoids looping. MSTP is unaware of the components of the aggregate link and treats the aggregate link as a single spanning tree link with a cost representative of the aggregate link.

The configuration of Link Aggregation consists of creating a logical interface that represents the aggregate link and then binding the physical interfaces to the logical interface. Finally, the desired characteristics of the link are configured on the logical interface.

Background Information

This section provides some background information related to this TCG.

Requirements

Readers of this document should be familiar with the basic Comware data-link layer configuration commands including Virtual Local Area Networks (VLANs), access ports, and trunk ports.

Considerations:

- Link Aggregation is configured on two switches. Both switches must be configured.
- All physical interfaces that are part of the Link Aggregation must function at the same speed.
- Link Aggregation is designed for point-to-point Ethernet links.
- All physical interfaces that are part of the Link Aggregation will be configured similarly.

The following hardware is required:

- Manageable switches or routers with bridged interfaces under Comware OS.

The following software is required:

- Comware 5.20
**Configure**

Configuration Example – Link-Aggregation of 802.1q trunk ports with LACP

Network diagram

Figure 1 Link aggregation with LACP on two Ten-Gigabit Ethernet links

**Configuration steps**

To configure Link Aggregation of 802.1q trunk ports with Link Aggregation Control Protocol, LACP, follow these steps:

- Create a logical Bridge-Aggregation interface.
- Enable Link Aggregation Control Protocol.
- Assign physical interfaces to the logical Bridge-Aggregation interface.
- Configure the Bridge-Aggregate interface as a trunk port.
- Permit desired VLANs on the Bridge-Aggregate interface.

**Step 1 – Create a logical Bridge-Aggregation interface**

Create a logical Bridge-Aggregation interface. Choose an interface number that is not already in use on the switch as part of any other Link Aggregation.

The Bridge-Aggregation group number is locally significant to a switch. This number does not need to match the Bridge-Aggregation group number on the connecting switch.

```bash
# Switch-A
interface bridge-aggregation 3

# Switch-B
interface bridge-aggregation 1
```

**Step 2 – Enable the Link Aggregation Control Protocol**

Enable LACP on the Bridge-Aggregation interface of both switches.

LACP must be configured prior to assigning physical interfaces to the Bridge Group (Step 3).

```bash
# Switch-A
interface bridge-aggregation 3
  link-aggregation mode dynamic
```

---

Technical Configuration Guide – Link Aggregation
Step 3 – Assign physical interfaces to the Bridge Aggregation Group

Assign the physical interfaces that are to be part of this link aggregation to the Bridge Aggregation group. The group-member number used in this step must match the Bridge Aggregation number used in the previous step.

```
# Switch-A
interface Ten-GigabitEthernet1/0/25
link-aggregation group-member 3

interface Ten-GigabitEthernet1/0/26
link-aggregation group-member 3

# Switch-B
interface Ten-GigabitEthernet1/0/27
link-aggregation group-member 1

interface Ten-GigabitEthernet1/0/28
link-aggregation group-member 1
```

Step 4 – Configure the Bridge-Aggregation interface as a trunk port

Configure the Bridge-Aggregate interface as an 802.1q trunk interface.

Do not configure trunk commands on the physical interfaces. The trunk configuration will be placed on the physical link interfaces automatically.

```
# Switch-A
interface bridge-aggregation 3
port link-type trunk

# Switch-B
interface bridge-aggregation 1
port link-type trunk
```

Step 5 – Permit the desired VLANs on the Bridge-Aggregation interface

By default an 802.1q trunk interface permits only VLAN 1. Permit any additional VLANs required on the aggregate link and select the PVID if necessary.

```
# Switch-A
interface bridge-aggregation 3
port trunk permit vlan all

# Switch-B
interface bridge-aggregation 1
port trunk permit vlan all
```

Verify Link-Aggregation of Trunk Ports with LACP

To verify the configuration of Link-Aggregation of 802.1q trunk ports with LACP, follow these steps:

- Verify that the Bridge-Aggregation interface has selected all of the physical interfaces.
**ITEM** | **DESCRIPTION**
--- | ---
1. | Dynamic mode indicates LACP is enabled
2. | Both member ports are “selected”
- Verify that LACP is active, collecting, and distributing.
- Verify that the physical cables connect to the same peer.

```
<SwitchA> display link-aggregation verbose
```

Loadsharing Type: Shar -- Loadsharing, NonS -- Non-Loadsharing
Port Status: S -- Selected, U -- Unselected
Flags:  A -- LACP_Activity, B -- LACP_Timeout, C -- Aggregation, 
        D -- Synchronization, E -- Collecting, F -- Distributing, 
        G -- Defaulted, H -- Expired

Aggregation Interface: Bridge-Aggregation3
Aggregation Mode: Dynamic
Loadsharing Type: Share
System ID: 0x8000, 3ce5-a6cf-1219
Local:
<table>
<thead>
<tr>
<th>Port</th>
<th>Status</th>
<th>Priority</th>
<th>Oper-Key</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>XGE1/0/25</td>
<td>S</td>
<td>32768</td>
<td>1</td>
<td>{ACDEF}</td>
</tr>
<tr>
<td>XGE1/0/26</td>
<td>S</td>
<td>32768</td>
<td>1</td>
<td>{ACDEF}</td>
</tr>
</tbody>
</table>

Remote:
<table>
<thead>
<tr>
<th>Actor</th>
<th>Partner</th>
<th>Priority</th>
<th>Oper-Key</th>
<th>SystemID</th>
<th>Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>XGE1/0/25</td>
<td>83</td>
<td>32768</td>
<td>1</td>
<td>0x8000, 3ce5-a680-9cb6</td>
<td>{ACDEF}</td>
</tr>
<tr>
<td>XGE1/0/26</td>
<td>84</td>
<td>32768</td>
<td>1</td>
<td>0x8000, 3ce5-a680-9cb6</td>
<td>{ACDEF}</td>
</tr>
</tbody>
</table>

Figure 3 Verification with display link aggregation verbose command

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Both member ports are “selected”</td>
</tr>
<tr>
<td>2.</td>
<td>LACP confirms that member ports connect to the same peer</td>
</tr>
<tr>
<td>3.</td>
<td>MAC address of peer for each link</td>
</tr>
</tbody>
</table>
• Verify that the Bridge-Aggregation interface is an 802.1q trunk port.
• Verify the aggregate bandwidth represents the aggregate bandwidth of all links.

```<Switch-A> display interface Bridge-Aggregation 3

Bridge-Aggregation3 current state: UP
IP Packet Frame Type: PKTFMT_ETHNT_2, Hardware Address: 000f-e207-f2e0
Description: Bridge-Aggregation3 Interface
20Gbps-speed mode, full-duplex mode
Link speed type is autonegotiation, link duplex type is autonegotiation
PVID: 1
Port link-type: trunk
  VLAN passing : 1(default vlan), 2-100
  VLAN permitted: 1(default vlan), 2-4094
Trunk port encapsulation: IEEE 802.1q
```

![Figure 4 Verification with display interface bridge aggregation command](image)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Aggregate bandwidth</td>
</tr>
</tbody>
</table>

### Configuration Example – Static Link-Aggregation of 802.1q trunk ports (without LACP)

#### Network diagram

The network diagram below illustrates the connectivity for this configuration example.

![Figure 5 Link Aggregation with two 802.1q Ten-Gigabit Ethernet links without LACP](image)

#### Configuration steps

To configure Link Aggregation of 802.1q trunk ports, follow these steps:

• Create a logical Bridge-Aggregation interface.
• Assign physical interfaces to the logical Bridge-Aggregation interface.
• Configure the Bridge-Aggregate interface as a trunk port.
• Permit desired VLANs on the Bridge-Aggregate interface.
Step 1 – Create a logical Bridge-Aggregation interface

Create a logical Bridge-Aggregation interface. Choose an interface number that is not already in use on the switch as part of any other Link Aggregation.

The Bridge-Aggregation group number is locally significant to a switch. This number does not need to match the Bridge-Aggregation group number on the connecting switch.

# Switch-A
interface bridge-aggregation 3

# Switch-B
interface bridge-aggregation 1

Step 2 – Assign physical interfaces to the Bridge Aggregation Group

Assign the physical interfaces that are to be part of this link aggregation to the Bridge Aggregation group. The group-member number used in this step must match the Bridge Aggregation number used in the previous step.

# Switch-A
interface Ten-GigabitEthernet1/0/25
  link-aggregation group-member 3

interface Ten-GigabitEthernet1/0/26
  link-aggregation group-member 3

# Switch-B
interface Ten-GigabitEthernet1/0/27
  link-aggregation group-member 1

interface Ten-GigabitEthernet1/0/28
  link-aggregation group-member 1

Step 3 – Configure the Bridge-Aggregation interface as a trunk port

Configure the Bridge-Aggregate interface as an 802.1q trunk interface.

Do not configure trunk commands on the physical interfaces. The trunk configuration will be placed on the physical link interfaces automatically.

# Switch-A
interface bridge-aggregation 3
  port link-type trunk

# Switch-B
interface bridge-aggregation 1
  port link-type trunk

Step 4 – Permit the desired VLANs on the Bridge-Aggregation interface

By default an 802.1q trunk interface permits only VLAN 1. Permit any additional VLANs required on the aggregate link and select the PVID if necessary.

# Switch-A
interface bridge-aggregation 3
  port trunk permit vlan all

# Switch-B
interface bridge-aggregation 1
port trunk permit vlan all

Verify Static Link-Aggregation

To verify the configuration of static Link-Aggregation of 802.1q trunk ports, follow these steps:

- Verify that the Bridge-Aggregation interface has selected all of the physical interfaces.

  ```
  <SwitchA> display link-aggregation summary
  Aggregation Interface Type:
  BAGG -- Bridge-Aggregation, RAGG -- Route-Aggregation
  Aggregation Mode: S -- Static, D -- Dynamic
  Loadsharing Type: Shar -- Loadsharing, NonS -- Non-Loadsharing
  Actor System ID: 0x8000, 3ce5-a6cf-1219
  
  AGG         AGG Partner ID               Select Unselect   Share
  Interface   Mode                               Ports  Ports Type
  -------------------------------------------------------------------------
  BAGG3       S         none                     2      0          Shar
  
  Figure 6 Verification with the display link aggregation summary command
  ```

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Static mode indicates LACP is not enabled</td>
</tr>
<tr>
<td>2.</td>
<td>Partner MAC address is unknown without LACP</td>
</tr>
<tr>
<td>3.</td>
<td>Both member ports are “selected”</td>
</tr>
</tbody>
</table>
• Verify link aggregation mode is static.

```bash
<SwitchA> display link-aggregation verbose
```

Loadsharing Type: Shar -- Loadsharing, NonS -- Non-Loadsharing
Port Status: S -- Selected, U -- Unselected
Flags:  A -- LACP_Activity, B -- LACP_Timeout, C -- Aggregation,
        D -- Synchronization, E -- Collecting, F -- Distributing,
        G -- Defaulted, H -- Expired

Aggregation Interface: Bridge-Aggregation3
Aggregation Mode: Static
Loadsharing Type: Shar

<table>
<thead>
<tr>
<th>Port</th>
<th>Status</th>
<th>Priority</th>
<th>Oper-Key</th>
</tr>
</thead>
<tbody>
<tr>
<td>XGE1/0/25</td>
<td>S</td>
<td>32768</td>
<td>1</td>
</tr>
<tr>
<td>XGE1/0/26</td>
<td>S</td>
<td>32768</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 7 Verification with the display link aggregation verbose command

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Static indicates LACP is not enabled</td>
</tr>
<tr>
<td>2.</td>
<td>Both member ports are “selected”</td>
</tr>
</tbody>
</table>
Configuration Example – Link-Aggregation of multiple access ports with LACP

Network Diagram
The network diagram below illustrates the connectivity for this configuration example.

![Link aggregation diagram](image)

Figure 8 Link aggregation of two Gigabit Ethernet links – access ports with LACP

Configuration steps
To configure Link Aggregation of access ports with LACP, follow these steps:

- Create a logical Bridge-Aggregation interface.
- Enable the Link Aggregation Control Protocol.
- Assign physical interfaces to the logical Bridge-Aggregation interface.
- Configure the Bridge-Aggregate interface as an access port in the appropriate VLAN.

Step 1 – Create a logical Bridge-Aggregation interface
Create a logical Bridge-Aggregation interface. Choose an interface number that is not already in use on the switch as part of any other Link Aggregation.

```
# Switch-A
interface bridge-aggregation 3
```

Step 2 – Enable the Link Aggregation Control Protocol
Enable LACP on the Bridge-Aggregation interface of the switch.

LACP must be configured prior to assigning physical interfaces to the Bridge Group (Step 3).

```
# Switch-A
interface bridge-aggregation 3
    link-aggregation mode dynamic
```

Step 3 – Assign physical interfaces to the Bridge Aggregation Group
Assign the physical interfaces that are to be part of this link aggregation to the Bridge Aggregation group. The group-member number used in this step must match the Bridge Aggregation number used in the previous step.

```
# Switch-A
interface GigabitEthernet1/0/14
    link-aggregation group-member 3
```
interface GigabitEthernet2/0/14
    link-aggregation group-member 3

Step 4 – Configure the Bridge-Aggregation interface as an access port in the desired VLAN.

Configure the Bridge-Aggregate interface as an access port and place the Bridge Aggregate interface into the desired VLAN.

Do not configure access port commands or VLAN commands on the physical interfaces. These commands will be placed on the physical interfaces automatically.

If any physical interfaces were previously configured as trunk ports, they will be changed to access ports automatically.

    # Switch-A
    interface bridge-aggregation 3
    port link-type access
    port access vlan 100

Verify Link-Aggregation with Access Ports

To verify the configuration of Link-Aggregation of access ports with LACP, follow these steps:

- Verify that the Bridge-Aggregation interface has selected all of the physical interfaces.

    <SwitchA> display link-aggregation summary

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Dynamic mode indicates LACP is enabled</td>
</tr>
<tr>
<td>2.</td>
<td>Both member ports are “selected”</td>
</tr>
</tbody>
</table>
• Verify that the Bridge-Aggregation interface is an access port in the proper VLAN.

```plaintext
<SwitchA> display interface Bridge-Aggregation 3
Bridge-Aggregation3 current state: UP
IP Packet Frame Type: PKTFMT_ETHNT_2, Hardware Address: 000f-e207-f2e0
Description: Bridge-Aggregation3 Interface
2Gbps-speed mode, full-duplex mode
Link speed type is autonegotiation, link duplex type is autonegotiation
PVID: 100
Port link-type: access
  Tagged VLAN ID : none
  Untagged VLAN ID : 100
```

![Figure 10 Verification with the display interface bridge-aggregation command](image)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Aggregate bandwidth</td>
</tr>
<tr>
<td>2.</td>
<td>Primary VLAN ID</td>
</tr>
<tr>
<td>3.</td>
<td>Port link-type is an access port</td>
</tr>
</tbody>
</table>

**Additional Information**

**Configuration steps**

This section provides additional information on each of the steps to configure Link Aggregation.

**Create a logical Bridge-Aggregation interface**

Link-Aggregation consists of bundling several physical interfaces together. The bundle of interfaces is represented logically by a Bridge-Aggregation interface.

The first step to configure Link Aggregation is to create a Bridge-Aggregation interface.

Since a switch may have more than one aggregate link, each logical Bridge-Aggregation interface is assigned an interface number that uniquely represents a specific bundle of physical interfaces on the switch. This Bridge-Aggregation interface number is also referred to as a bridge-aggregation group number.

The Bridge-Aggregation group number is locally significant to a switch. This number does not need to match the Bridge-Aggregation group number on the connecting switch.

All interfaces that are to be part of the same bundle are assigned to the same Bridge Aggregation group.

This new interface can be configured similarly to a physical interface. Changes made to the logical interface will be propagated to the physical interfaces, ensuring a consistent configuration of the member ports.
Enable the Link Aggregation Control Protocol (optional)

The Link Aggregation Control Protocol, LACP, allows a standardized mechanism by which switches can transition to and from link aggregation status in an orderly fashion. LACP is a standard protocol defined by 802.1ax (formerly 802.3ad) and is interoperable with other vendors who support this standard.

The second step to configure Link Aggregation is to enable the LACP protocol if desired.

The use of LACP is optional. However, if one end of the aggregate link enables LACP, the other end must enable LACP too. LACP is not required for the formation of an aggregate link, but the use of LACP can make the conversion less problematic. For example, by using LACP, a switch can refrain from converting to an aggregate link if the partner switch is not properly configured.

LACP can also simplify troubleshooting cabling problems. Should there be a mistake in cabling, the administrator can inspect the status of the LACP link and observe the bridge ID of the neighbor to verify proper connectivity; this can be very useful when remotely administering equipment. Without LACP the switch does not detect the error, and despite having a correct configuration, Link Aggregation does not function because the cables are incorrectly connected. Identifying and troubleshooting these types of issues is easier with LACP.

If you choose to use LACP, it must be configured prior to assigning physical interfaces to the Bridge Aggregation Group. Once the physical interfaces are assigned, LACP cannot be enabled or disabled on the Bridge-Aggregation interface until the physical interfaces are removed from the logical Bridge-Aggregation interface.

In Comware, LACP functions in the “active” role.

Assign physical interfaces to the Bridge Aggregation Group

The third step to configure Link Aggregation is to assign the physical interfaces that are to participate in a specific link aggregation to the logical Bridge Aggregation Group.

All interfaces that are to be part of the same bundle are assigned to the same Bridge Aggregation group.

Configure the link-mode and VLANs on the Bridge-Aggregation interface

The final step to configure link aggregation is to configure the desired characteristics of the link on the logical Bridge-Aggregation interface.

The logical Bridge-Aggregation interface represents the aggregate link. Commands to change the configuration of the logical interface should be entered in the Bridge-Aggregation interface instead of the physical components.

If the aggregate link is to function as an 802.1q trunk port, configure the necessary link-mode trunk command on the Bridge-Aggregate interface.

If the aggregate link is to function as an access port, configure the necessary link-mode and VLAN commands on the Bridge-Aggregate interface.

There is no need to configure trunk, access, or VLAN commands on the physical interfaces. These configurations will be placed on the physical link interfaces automatically.

Avoid configuring trunk, access, or VLAN commands on the individual component interfaces. Doing so risks creating an inconsistency in the link-mode status among the participating interfaces causing the aggregate link to exclude certain physical interfaces from the aggregate. Only interfaces with a configuration consistent with the parent Bridge-Aggregation interface are considered for inclusion in the aggregate link.

The configurations of the physical interfaces must remain consistent among all members of the aggregate link as well as remain consistent with the parent Bridge-Aggregate interface.

Troubleshoot

If the configuration cannot be verified, follow these steps to troubleshoot:
Common Misconfigurations

The following are examples of several common misconfigurations of Link-Aggregation. The invalid configuration is shown followed by the necessary steps to correct the problem.

Problem: No Member Ports Selected

In this example, no member ports are selected as part of the Link-Aggregation interface because the link-type of the member ports does not match the link-type of the Bridge-Aggregation interface.

The link-type of the Bridge-Aggregation interface must match the link-type of the member ports.

<SwitchA>
interface Bridge-Aggregation2
   link-aggregation mode dynamic

interface Ten-GigabitEthernet4/0/1
   port link-type trunk
   port trunk permit vlan all
   port link-aggregation group 2

interface Ten-GigabitEthernet4/0/2
   port link-type trunk
   port trunk permit vlan all
   port link-aggregation group 2

<SwitchA> display link-aggregation summary

Actor System ID: 0x8000, 3ce5-a680-9cb6

<table>
<thead>
<tr>
<th>AGG</th>
<th>AGG Mode</th>
<th>Partner ID</th>
<th>Select Ports</th>
<th>Unselect Ports</th>
<th>Share Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAGG2</td>
<td>D</td>
<td>0x8000, 0000-0000-0000</td>
<td>0</td>
<td>2</td>
<td>Shar</td>
</tr>
</tbody>
</table>

Figure 11 Misconfiguration – no member ports selected

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Bridge-aggregation interface is an access port</td>
</tr>
<tr>
<td>2.</td>
<td>Member ports are 802.1q trunk ports</td>
</tr>
<tr>
<td>3.</td>
<td>No member ports are “selected”</td>
</tr>
</tbody>
</table>

To correct this problem, configure the link-type of the Bridge-Aggregation interface.

If the Link-Aggregation is to be an 802.1q trunk port, configure the Bridge-Aggregation interface as a trunk port.

If the Link-Aggregation is to be an access port, reconfigure the Bridge-Aggregation interface as an access port.
Problem: LACP mismatch

In this example, LACP is configured on one switch but not the other switch. If LACP is to be used, it must be configured on both switches.

```
<Switch-A>
  interface Bridge-Aggregation2
  port link-type trunk
  port trunk permit vlan all

<Switch-B>
  interface Bridge-Aggregation2
  port link-type trunk
  port trunk permit vlan all
  link-aggregation mode dynamic
```

```
<Switch-A> display link-aggregation summary

<table>
<thead>
<tr>
<th>AGG Interface</th>
<th>AGG Mode</th>
<th>Partner ID</th>
<th>Select Ports</th>
<th>Unselect Ports</th>
<th>Share Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAGG2</td>
<td>S</td>
<td>none</td>
<td>2</td>
<td>0</td>
<td>Shar</td>
</tr>
</tbody>
</table>

<Switch-B> display link-aggregation summary

<table>
<thead>
<tr>
<th>AGG Interface</th>
<th>AGG Mode</th>
<th>Partner ID</th>
<th>Select Ports</th>
<th>Unselect Ports</th>
<th>Share Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAGG2</td>
<td>D</td>
<td>0x8000, 0000-0000-0000</td>
<td>1</td>
<td>1</td>
<td>Shar</td>
</tr>
</tbody>
</table>
```

To correct this problem, either configure LACP on Switch-A, or remove the LACP configuration from Switch-B.
For more information

To read more about HP Networking Products, go to http://www.hp.com/go/networking