



## Configuring Link Bundling

This module describes the configuration of link bundle interfaces on the Cisco NCS 6000 Series Router.

A link bundle is a group of one or more ports that are aggregated together and treated as a single link. The Link Bundling feature allows you to group multiple point-to-point links together into one logical link and provide higher bidirectional bandwidth, redundancy, and load balancing between two routers. A virtual interface is assigned to the bundled link. The component links can be dynamically added and deleted from the virtual interface. The virtual interface is treated as a single interface on which you can configure an IP address and other software features used by the link bundle. Packets sent to the link bundle are forwarded to one of the links in the bundle.

Each bundle has a single MAC and shares a single Layer 3 configuration set, such as IP address, ACL, Quality of Service (QoS), and so on.



**Note** Link bundles do not have a one-to-one modular services card association. Member links can terminate on different cards.

### Feature History for Configuring Link Bundling

| Release       | Modification                               |
|---------------|--|
| Release 5.2.5 | Bundle Fast Convergence feature was added. |
| Release 5.0.0 | This feature was introduced.               |

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## Prerequisites for Configuring Link Bundling

You must be in a user group associated with a task group that includes the proper task IDs. The command reference guides include the task IDs required for each command. If you suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.

The prerequisites for link bundling depend on the platform on which you are configuring this feature. This section includes the following information:

## Prerequisites for Configuring Link Bundling

Before configuring link bundling, be sure that these tasks and conditions are met:

- You know which links should be included in the bundle you are configuring.
- If you are configuring an Ethernet link bundle, you have at least one of the following Ethernet cards installed in the router:
  - 4-Port 10-Gigabit Ethernet PLIM
  - 8-Port 10-Gigabit Ethernet PLIM
  - 10-Port Gigabit Ethernet SPA
  - 42-Port Gigabit Ethernet PLIM
  - 1-Port 100-Gigabit Ethernet PLIM

## Information About Configuring Link Bundling

To configure link bundling, you must understand the following concepts:

### Link Bundling Overview

The Link Bundling feature allows you to group multiple point-to-point links together into one logical link and provide higher bidirectional bandwidth, redundancy, and load balancing between two routers. A virtual interface is assigned to the bundled link. The component links can be dynamically added and deleted from the virtual interface.

The virtual interface is treated as a single interface on which one can configure an IP address and other software features used by the link bundle. Packets sent to the link bundle are forwarded to one of the links in the bundle.

The advantages of link bundles are as follows:

- Multiple links can span several line cards to form a single interface. Thus, the failure of a single link does not cause a loss of connectivity.
- Bundled interfaces increase bandwidth availability, because traffic is forwarded over all available members of the bundle. Therefore, traffic can if one of the links within a bundle fails. can without interrupting packet flow.

For example, a bundle can contain all Ethernet interfaces, or it can contain all POS interfaces, but it cannot contain Ethernet and POS interfaces at the same time.

Cisco IOS XR software supports the following methods of forming bundles of Ethernet interfaces:

- IEEE 802.3ad—Standard technology that employs a Link Aggregation Control Protocol (LACP) to ensure that all the member links in a bundle are compatible. Links that are incompatible or have failed are automatically removed from a bundle.

- EtherChannel or POS Channel—Cisco proprietary technology that allows the user to configure links to join a bundle, but has no mechanisms to check whether the links in a bundle are compatible. (EtherChannel applies to Ethernet interfaces, and POS Channel applies to POS interfaces.)

## Features and Compatible Characteristics of Link Bundles

Link bundles support these features:

- ACL
- Basic IP
- Basic MPLS
- MPLS VPN
- Sampled Netflow
- BGP Policy Accounting
- HSRP/VRRP
- VLAN Bundling (Ethernet only)
- Inter-AS
- WRED/MDRR per member interface.

The following list describes the properties and limitations of link bundles:

- A bundle contains links, each of which has LACP enabled or disabled. If a bundle contains links, some that have LACP enabled and some that have LACP disabled, the links with LACP disabled are not aggregated in the bundle.
- Bundle membership can span across several modular services cards that are installed in a single router and across SPAS in the same service card.
- Physical layer and link layer configuration are performed on individual member links of a bundle.
- Configuration of network layer protocols and higher layer applications is performed on the bundle itself.
- IPv4 and IPv6 addressing is supported on Ethernet link bundles.
- For Ethernet link bundling, links within a single bundle should have the same speed.
- For POS link bundling, the links within a single bundle can have varying speeds. The fastest link can be set to a maximum speed that is four times greater than the slowest link.
- Mixed bandwidth bundle member configuration is only supported when 1:1 redundancy is configured (this means that a 1 GigabitEthernet member can only be configured as the backup of the 10 GigabitEthernet interface).
- Mixed link bundle mode is supported only when active standby operation is configured (usually with the lower speed link in standby mode).
- A bundle can be administratively enabled or disabled.
- Each individual link within a bundle can be administratively enabled or disabled.
- If a MAC address is not set on the bundle, the bundle MAC address is obtained from a pool of pre-assigned MAC addresses stored in EEPROM of the chassis midplane.
- Each link within a bundle can be configured to allow different keepalive periods on different members.
- Load balancing (the distribution of data between member links) is done by flow instead of by packet.

- Upper layer protocols, such as routing updates and hellos, are sent over any member link of an interface bundle.
- All links within a single bundle must terminate on the same two systems. Both systems must be directly connected.
- Bundled interfaces are point-to-point.
- A bundle can contain physical links only. Tunnels and VLAN sub-interfaces cannot be bundle members. However, you can create VLANs as sub-interfaces of bundles.
- An IPv4 address configuration on link bundles is identical to an IPv4 address configuration on regular interfaces.
- Multicast traffic is load balanced over the members of a bundle. For a given flow, internal processes select the member link, and all traffic for that flow is sent over that member.
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## Link Aggregation Through LACP

Aggregating interfaces on different modular services cards and on SPAs within the same services cards provides redundancy, allowing traffic to be quickly redirected to other member links when an interface or modular services card failure occurs.

The optional Link Aggregation Control Protocol (LACP) is defined in the IEEE 802 standard. LACP communicates between two directly connected systems (or peers) to verify the compatibility of bundle members. The peer can be either another router or a switch. LACP monitors the operational state of link bundles to ensure the following:

- All links terminate on the same two systems.
- Both systems consider the links to be part of the same bundle.
- All links have the appropriate settings on the peer.

LACP transmits frames containing the local port state and the local view of the partner system's state. These frames are analyzed to ensure both systems are in agreement.

### IEEE 802.3ad Standard

The IEEE 802.3ad standard typically defines a method of forming Ethernet link bundles.

For each link configured as bundle member, the following information is exchanged between the systems that host each end of the link bundle:

- A globally unique local system identifier
- An identifier (operational key) for the bundle of which the link is a member
- An identifier (port ID) for the link
- The current aggregation status of the link

This information is used to form the link aggregation group identifier (LAG ID). Links that share a common LAG ID can be aggregated. Individual links have unique LAG IDs.

The system identifier distinguishes one router from another, and its uniqueness is guaranteed through the use of a MAC address from the system. The bundle and link identifiers have significance only to the router assigning them, which must guarantee that no two links have the same identifier, and that no two bundles have the same identifier.

The information from the peer system is combined with the information from the local system to determine the compatibility of the links configured to be members of a bundle.

The MAC address of the first link attached to a bundle becomes the MAC address of the bundle itself. The bundle uses this MAC address until that link (the first link attached to the bundle) is detached from the bundle, or until the user configures a different MAC address. The bundle MAC address is used by all member links when passing bundle traffic. Any unicast or multicast addresses set on the bundle are also set on all the member links.



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**Note** We recommend that you avoid modifying the MAC address, because changes in the MAC address can affect packet forwarding.

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## LACP Short Period Time Intervals

As packets are exchanged across member links of a bundled interface, some member links may slow down or time-out and fail. LACP packets are exchanged periodically across these links to verify the stability and reliability of the links over which they pass. The configuration of short period time intervals, in which LACP packets are sent, enables faster detection and recovery from link failures.

Short period time intervals are configured as follows:

- In milliseconds
- In increments of 100 milliseconds
- In the range 100 to 1000 milliseconds
- The default is 1000 milliseconds (1 second)
- Up to 64 member links
- Up to 1280 packets per second (pps)

After 6 missed packets, the link is detached from the bundle.

When the short period time interval is not configured, LACP packets are transmitted over a member link every 30 seconds by default.

When the short period time interval is configured, LACP packets are transmitted over a member link once every 1000 milliseconds (1 second) by default. Optionally, both the transmit and receive intervals can be configured to less than 1000 milliseconds, independently or together, in increments of 100 milliseconds (100, 200, 300, and so on).

When you configure a custom LACP short period transmit interval at one end of a link, you must configure the same time period for the receive interval at the other end of the link.



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**Note** You must always configure the transmit interval at both ends of the connection before you configure the receive interval at either end of the connection. Failure to configure the transmit interval at both ends first results in route flapping (a route going up and down continuously). When you remove a custom LACP short period, you must do it in reverse order. You must remove the receive intervals first and then the transmit intervals.

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## Load Balancing

Load balancing is a forwarding mechanism which distributes traffic over multiple links, based on Layer 3 routing information in the router. Per-flow load balancing is supported on all links in the bundle. This scheme achieves load sharing by allowing the router to distribute packets over one of the links in the bundle, that is determined through a hash calculation. The hash calculation is an algorithm for link selection based on certain parameters.

The standard hash calculation is a 3-tuple hashing, using the following parameters:

- IP source address
- IP destination address
- Router ID

7-tuple hashing can also be configured, based on Layer 3 and Layer 4 parameters:

- IP source address
- IP destination address
- Router ID
- Input interface
- IP protocol
- Layer 4 source port
- Layer 4 destination port

When per-flow load balancing and 3-tuple hashing is enabled, all packets for a certain source-destination pair will go through the same link, though there are multiple links available. Per-flow load balancing ensures that packets for a certain source-destination pair arrive in order.



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**Note** For multicast traffic, ingress forwarding is based on the Fabric Multicast Group Identifier (FGID). Egress forwarding over the bundle is based on the bundle load balancing.

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## VLANs on an Ethernet Link Bundle

802.1Q VLAN subinterfaces can be configured on 802.3ad Ethernet link bundles. Keep the following information in mind when adding VLANs on an Ethernet link bundle:

- The maximum number of VLANs allowed per bundle is 128.
- The maximum number of bundled VLANs allowed per router is 4000.



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**Note** The memory requirement for bundle VLANs is slightly higher than standard physical interfaces.

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To create a VLAN subinterface on a bundle, include the VLAN subinterface instance with the **interface Bundle-Ether** command, as follows:

```
interface Bundle-Ether interface-bundle-id.subinterface
```

After you create a VLAN on an Ethernet link bundle, all VLAN subinterface configuration is supported on that link bundle.

VLAN sub-interfaces can support multiple Layer 2 frame types and services, such as Ethernet Flow Points (EFPs) and Layer 3 services.

## Link Bundle Configuration Overview

The following steps provide a general overview of the link bundle configuration. Keep in mind that a link must be cleared of all previous network layer configuration before it can be added to a bundle:

1. In XR configuration mode, create a link bundle. To create an Ethernet link bundle, enter the interface Bundle-Ether command. To create a POS link bundle, enter the interface Bundle-POS command.
2. Assign an IP address and subnet mask to the virtual interface using the `ipv4` address command.
3. Add interfaces to the bundle you created in Step 1 with the **bundle id** command in the interface configuration submode. You can add up to 64 links to a single bundle.
4. You can optionally implement 1:1 link protection for the bundle by setting the **bundle maximum-active links** command to 1. Performing this configuration causes the highest-priority link in the bundle to become active and the second-highest-priority link to become the standby. (The link priority is based on the value of the **bundle port-priority** command.) If the active link fails, the standby link immediately becomes the active link.



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**Note** A link is configured as a member of a bundle from the interface configuration submode for that link.

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## Nonstop Forwarding During RP Switchover

Cisco IOS XR software supports nonstop forwarding during switchover between active and standby paired RP cards. Nonstop forwarding ensures that there is no change in the state of the link bundles when a switchover occurs.

For example, if an active RP fails, the standby RP becomes operational. The configuration, node state, and checkpoint data of the failed RP are replicated to the standby RP. The bundled interfaces will all be present when the standby RP becomes the active RP.



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**Note** You do not need to configure anything to guarantee that the standby interface configurations are maintained.

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## Link Switchover

By default, a maximum of 64 links in a bundle can actively carry traffic on a Cisco NCS 6000 Series Router. If one member link in a bundle fails, traffic is redirected to the remaining operational member links.

## Bundle Fast Convergence

The Bundle Fast Convergence (BFC) feature provides the ability to converge bundle members within sub seconds instead of multiple seconds. This feature provides faster bundle member convergence with deterministic traffic outage bounded within 50 milliseconds.

On bundle member shut, the packet drop is reduced to less than 50 milliseconds. On multiple members shut, the loss is less than  $(n*50ms)$ , where 'n' is the number of members being shut.

### BFC Functionality

The BFC feature decouples the tasks FIB is performing for bundle membership updates. This splits the FIB's bundle membership tasks into two separate threads:

- FAST Update (FRR thread): This option does In-Place-Modify (IPM) only, which guarantees deterministic outage time. FIB gets the bundle member down directly from Bundle Interface Manager (BIM) using Fast Protect Infra (similar to TE FRR update model).
- SLOW Update (Adjacency thread): Adjacency update from AIB, which is the current processing logic; does the following tasks:
  - IPM on the current hardware entries
  - Create a new set of hardware entries with new membership information

BFC tracks the bundle members that are down from FAST channel by setting a pending flag, then when SLOW update AIB is received it looks for FAST down member. If the BFC finds the FAST down member, it clears the pending flag, if it does not, it processes the SLOW update and considers the FAST down member as down and programs to the hardware.

### Condition for BFC

The bundle must contain N members (they may be of different bandwidth, belong to different slices or Line Cards) and at the most N-1 members could be shut down in a single or multiple commits.



#### Note

Shutting down bundle member link/s in single or serial commits is the only valid trigger for BFC. Bundle fast convergence time is calculated based on Frame delta and number of links affected. Convergence time < Number of links affected \* 50ms --> 0 (50ms). Convergence time must be < 50ms per flow in the traffic.

### Sample BFC Data

The following example shows convergence time data for sixteen individual flows that traffic was sent onto on dual router topology.

This data is taken for a bundle which has ten members including one 100Gig and nine 10Gig members where nine members (including 100Gig) are shut down with individual commits in order to trigger the BFC feature.

| Frame Delta | Packet Loss Duration (ms) | Direction |
|-------------|---------------------------|-----------|
| 337         | 6.667                     | Egress    |
| 61          | 1.187                     | Egress    |



|      |        |         |
|------|--------|---------|
| 254  | 4.942  | Egress  |
| 0    | 0      | Egress  |
| 255  | 4.961  | Egress  |
| 255  | 4.961  | Egress  |
| 47   | 0.914  | Egress  |
| 0    | 0      | Egress  |
| 1226 | 23.853 | Ingress |
| 866  | 16.849 | Ingress |
| 240  | 4.669  | Ingress |
| 1131 | 22.005 | Ingress |
| 0    | 0      | Ingress |
| 526  | 10.234 | Ingress |
| 1243 | 24.187 | Ingress |
| 264  | 5.136  | Ingress |

## How to Configure Link Bundling

This section contains the following procedures:

### Configuring Ethernet Link Bundles

This section describes how to configure an Ethernet link bundle.




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**Note** MAC accounting is not supported on Ethernet link bundles.

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**Note** In order for an Ethernet bundle to be active, you must perform the same configuration on both connection endpoints of the bundle.

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#### SUMMARY STEPS

1. **configure**
2. **interface Bundle-Ether** *bundle-id*
3. **ipv4 address** *ipv4-address mask*

4. **bundle minimum-active bandwidth** *kbps*
5. **bundle minimum-active links** *links*
6. **bundle maximum-active links** *links* [**hot-standby**]
7. **lacp fast-switchover**
8. **exit**
9. **interface** {TenGigE} interface-path-id
10. **bundle id** *bundle-id* [**mode** {**active** | **on** | **passive**}]
11. **bundle port-priority** *priority*
12. **no shutdown**
13. **exit**
14. **interface** {TenGigE} number
15. Do one of the following:
  - **end**
  - 
  - **commit**
16. **exit**
17. **exit**
18. Perform Step 1 through Step 15 on the remote end of the connection.
19. **show bundle Bundle-Ether** bundle-id
20. **show lacp bundle Bundle-Ether** *bundle-id*

## DETAILED STEPS

|               | Command or Action   | Purpose  |
|---------------|---|--|
| <b>Step 1</b> | <b>configure</b><br><b>Example:</b><br>RP/0/RP0/CPU0:router# configure  | Enters XR configuration mode.  |
| <b>Step 2</b> | <b>interface Bundle-Ether</b> <i>bundle-id</i><br><b>Example:</b><br>RP/0/RP0/CPU0:router#(config)# interface Bundle-Ether 3        | Creates a new Ethernet link bundle with the specified bundle-id. The range is 1 to 65535.<br><br>This <b>interface Bundle-Ether</b> command enters you into the interface configuration submode, where you can enter interface specific configuration commands are entered. Use the <b>exit</b> command to exit from the interface configuration submode back to the normal XR configuration mode. |
| <b>Step 3</b> | <b>ipv4 address</b> <i>ipv4-address mask</i><br><b>Example:</b><br>RP/0/RP0/CPU0:router(config-if)# ipv4 address 10.1.2.3 255.0.0.0 | Assigns an IP address and subnet mask to the virtual interface using the <b>ipv4 address</b> configuration subcommand.   |
| <b>Step 4</b> | <b>bundle minimum-active bandwidth</b> <i>kbps</i><br><b>Example:</b>   | (Optional) Sets the minimum amount of bandwidth required before a user can bring up a bundle.  |

|                | Command or Action   | Purpose  |
|----------------|---|--|
|                | RP/0/RP0/CPU0:router(config-if)# bundle minimum-active bandwidth 580000   |  |
| <b>Step 5</b>  | <b>bundle minimum-active links</b> <i>links</i><br><b>Example:</b><br>RP/0/RP0/CPU0:router(config-if)# bundle minimum-active links 2                                    | (Optional) Sets the number of active links required before you can bring up a specific bundle.   |
| <b>Step 6</b>  | <b>bundle maximum-active links</b> <i>links</i> [ <b>hot-standby</b> ]<br><b>Example:</b><br>RP/0/RP0/CPU0:router(config-if)# bundle maximum-active links 1 hot-standby | (Optional) Implements 1:1 link protection for the bundle, which causes the highest-priority link in the bundle to become active and the second-highest-priority link to become the standby. Also, specifies that a switchover between active and standby LACP-enabled links is implemented per a proprietary optimization.<br><br><b>Note</b> The priority of the active and standby links is based on the value of the <b>bundle port-priority</b> command. |
| <b>Step 7</b>  | <b>lacp fast-switchover</b><br><b>Example:</b><br>RP/0/RP0/CPU0:router(config-if)# lacp fast-switchover   | (Optional) If you enabled 1:1 link protection (you set the value of the <b>bundle maximum-active links</b> command to 1) on a bundle with member links running LACP, you can optionally disable the wait-while timer in the LACP state machine. Disabling this timer causes a bundle member link in standby mode to expedite its normal state negotiations, thereby enabling a faster switchover from a failed active link to the standby link.              |
| <b>Step 8</b>  | <b>exit</b><br><b>Example:</b><br>RP/0/RP0/CPU0:router(config-if)# exit   | Exits interface configuration submode for the Ethernet link bundle.  |
| <b>Step 9</b>  | <b>interface</b> { <b>TenGigE</b> } <i>interface-path-id</i><br><b>Example:</b><br>RP/0/RP0/CPU0:router(config)# interface GigabitEthernet 1/0/0/0                      | Enters interface configuration mode for the specified interface.<br><br>Enter the <b>TenGigE</b> keyword to specify the interface type. Replace the <i>interface-path-id</i> argument with the node-id in the <i>rack/slot/module</i> format.  |
| <b>Step 10</b> | <b>bundle id</b> <i>bundle-id</i> [ <b>mode</b> { <b>active</b>   <b>on</b>   <b>passive</b> }]<br><b>Example:</b><br>RP/0/RP0/CPU0:router(config-if)# bundle-id 3      | Adds the link to the specified bundle.<br><br>To enable active or passive LACP on the bundle, include the optional <b>mode active</b> or <b>mode passive</b> keywords in the command string.<br><br>To add the link to the bundle without LACP support, include the optional <b>mode on</b> keywords with the command string.  |

|                | Command or Action   | Purpose   |
|----------------|---|---|
|                |   | <b>Note</b> If you do not specify the <b>mode</b> keyword, the default mode is <b>on</b> (LACP is not run over the port).   |
| <b>Step 11</b> | <b>bundle port-priority</b> <i>priority</i><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config-if)# bundle port-priority 1</pre>  | (Optional) If you set the <b>bundle maximum-active links</b> command to 1, you must also set the priority of the active link to the highest priority (lowest value) and the standby link to the second-highest priority (next lowest value). For example, you can set the priority of the active link to 1 and the standby link to 2. |
| <b>Step 12</b> | <b>no shutdown</b><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config-if)# no shutdown</pre>  | (Optional) If a link is in the down state, bring it up. The no shutdown command returns the link to an up or down state depending on the configuration and state of the link.   |
| <b>Step 13</b> | <b>exit</b><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config-if)# exit</pre>  | Exits interface configuration submode for the Ethernet interface.   |
| <b>Step 14</b> | <b>interface</b> {TenGigE} number<br><b>Example:</b><br><pre>bundle id bundle-id [mode {active   passive   on}]</pre> <b>Example:</b><br><pre>no shutdown</pre> <b>Example:</b><br><pre>exit</pre> <b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config)# interface TenGigE 1/0/2/1</pre> <b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config-if)# bundle id 3</pre> <b>Example:</b> | (Optional) Repeat Step 8 through Step 11 to add more links to the bundle.   |

|                       | Command or Action   | Purpose   |
|-----------------------|---|---|
|                       | <pre>RP/0/RP0/CPU0:router(config-if)# bundle port-priority 2</pre> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-if)# no shutdown</pre> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-if)# exit</pre> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config)# interface TenGigE 1/0/2/3</pre> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-if)# bundle id 3</pre> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-if)# no shutdown</pre> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-if)# exit</pre> |   |
| <p><b>Step 15</b></p> | <p>Do one of the following:</p> <ul style="list-style-type: none"> <li>• <b>end</b></li> <li>•</li> <li>• <b>commit</b></li> </ul> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-if)# end</pre> <p><b>Example:</b></p> <p><b>Example:</b></p>   | <p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>• When you issue the <b>end</b> command, the system prompts you to commit changes:</li> </ul> <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>• Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to XR EXEC mode.</li> </ul> |

|                | Command or Action   | Purpose   |
|----------------|---|---|
|                | <pre>RP/0/RP0/CPU0:router(config-if)# commit</pre>  | <ul style="list-style-type: none"> <li>• Entering <b>no</b> exits the configuration session and returns the router to XR EXEC mode without committing the configuration changes.</li> <li>• Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> <li>• Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |
| <b>Step 16</b> | <b>exit</b><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config-if)# exit</pre>  | Exits interface configuration mode.   |
| <b>Step 17</b> | <b>exit</b><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config)# exit</pre>   | Exits XR configuration mode.  |
| <b>Step 18</b> | Perform Step 1 through Step 15 on the remote end of the connection.   | Brings up the other end of the link bundle.   |
| <b>Step 19</b> | <b>show bundle Bundle-Ether bundle-id</b><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router# show bundle Bundle-Ether 3</pre>           | (Optional) Shows information about the specified Ethernet link bundle.  |
| <b>Step 20</b> | <b>show lacp bundle Bundle-Ether bundle-id</b><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router# show lacp bundle Bundle-Ether 3</pre> | (Optional) Shows detailed information about LACP ports and their peers.   |

## Configuring EFP Load Balancing on an Ethernet Link Bundle

This section describes how to configure Ethernet flow point (EFP) Load Balancing on an Ethernet link bundle.

By default, Ethernet flow point (EFP) load balancing is enabled. However, the user can choose to configure all egressing traffic on the fixed members of a bundle to flow through the same physical member link. This configuration is available only on an Ethernet Bundle subinterface with Layer 2 transport (**l2transport**) enabled.



**Note** If the active members of the bundle change, the traffic for the bundle may get mapped to a different physical link that has a hash value that matches the configured value.

## SUMMARY STEPS

1. **configure**
2. **interface Bundle-Ether *bundle-id* l2transport**
3. Do one of the following:
  - **bundle load-balance hash *hash-value* [auto]**
4. Do one of the following:
  - **end**
  - 
  - **commit**

## DETAILED STEPS

|               | Command or Action   | Purpose  |
|---------------|---|--|
| <b>Step 1</b> | <b>configure</b><br><b>Example:</b><br>RP/0/RP0/CPU0:router# configure  | Enters XR configuration mode.  |
| <b>Step 2</b> | <b>interface Bundle-Ether <i>bundle-id</i> l2transport</b><br><b>Example:</b><br>RP/0/RP0/CPU0:router#(config)# interface Bundle-Ether 3 l2transport  | Creates a new Ethernet link bundle with the specified <i>bundle-id</i> and with Layer 2 transport enabled.<br>The range is 1 to 65535.   |
| <b>Step 3</b> | Do one of the following: <ul style="list-style-type: none"> <li>• <b>bundle load-balance hash <i>hash-value</i> [auto]</b></li> </ul> <b>Example:</b><br>RP/0/RP0/CPU0:router(config-subif)# bundle load-balancing hash 1<br><b>Example:</b><br>RP/0/RP0/CPU0:router(config-subif)# bundle load-balancing hash auto | Configures all egressing traffic on the fixed members of a bundle to flow through the same physical member link. <ul style="list-style-type: none"> <li>• <i>hash-value</i>—Numeric value that specifies the physical member link through which all egressing traffic in this bundle will flow. The values are 1 through 8.</li> <li>• <b>auto</b>—The physical member link through which all egressing traffic on this bundle will flow is automatically chosen.</li> </ul> |
| <b>Step 4</b> | Do one of the following: <ul style="list-style-type: none"> <li>• <b>end</b></li> <li>•</li> <li>• <b>commit</b></li> </ul> <b>Example:</b><br>RP/0/RP0/CPU0:router(config-if)# end   | Saves configuration changes. <ul style="list-style-type: none"> <li>• When you issue the <b>end</b> command, the system prompts you to commit changes:</li> </ul> <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre>   |

|  | Command or Action  | Purpose   |
|--|--|---|
|  | <p><b>Example:</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-if)# commit</pre> | <ul style="list-style-type: none"> <li>• Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to XR EXEC mode.</li> <li>• Entering <b>no</b> exits the configuration session and returns the router to XR EXEC mode without committing the configuration changes.</li> <li>• Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> </ul> <ul style="list-style-type: none"> <li>• Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |

## Configuring VLAN Bundles

This section describes how to configure a VLAN bundle. The creation of a VLAN bundle involves three main tasks:

1. Create an Ethernet bundle
2. Create VLAN subinterfaces and assign them to the Ethernet bundle.
3. Assign Ethernet links to the Ethernet bundle.

These tasks are describe in detail in the procedure that follows.



### Note

In order for a VLAN bundle to be active, you must perform the same configuration on both ends of the bundle connection.

### SUMMARY STEPS

1. **configure**
2. **interface Bundle-Ether** *bundle-id*
3. **ipv4 address** *ipv4-address mask*
4. **bundle minimum-active bandwidth** *kbps*
5. **bundle minimum-active links** *links*
6. **bundle maximum-active links** *links* [**hot-standby**]
7. **lACP fast-switchover**
8. **exit**
9. **interface Bundle-Ether** *bundle-id.vlan-id*
10. **ipv4 address** *ipv4-address mask*
11. **no shutdown**
12. **exit**
13. Repeat Step 9 through Step 12 to add more VLANs to the bundle you created in Step 2.
14. Do one of the following:
  - **end**



- or
  - **commit**
15. **exit**
  16. **exit**
  17. **configure**
  18. **interface** {TenGigE} interface-path-id
  19. **bundle id** *bundle-id* [mode {active | on | passive}]
  20. **bundle port-priority** *priority*
  21. **no shutdown**
  22. —
  23. Do one of the following:
    - **end**
    - 
    - **commit**
  24. Perform Step 1 through Step 23 on the remote end of the VLAN bundle connection.
  25. **show bundle Bundle-Ether** bundle-id
  26. **show vlan interface**
  27. **show vlan trunks** [{TenGigE | Bundle-Ether} interface-path-id] [brief | summary] [location node-id]
  28. **lacp fast-switchover**

## DETAILED STEPS

|               | Command or Action  | Purpose  |
|---------------|--|--|
| <b>Step 1</b> | <b>configure</b><br><b>Example:</b><br>RP/0/RP0/CPU0:router# configure   | Enters XR configuration mode.  |
| <b>Step 2</b> | <b>interface Bundle-Ether</b> <i>bundle-id</i><br><b>Example:</b><br>RP/0/RP0/CPU0:router#(config)# interface Bundle-Ether 3                     | Creates and names a new Ethernet link bundle.<br><br>This <b>interface Bundle-Ether</b> command enters you into the interface configuration submode, where you can enter interface-specific configuration commands. Use the <b>exit</b> command to exit from the interface configuration submode back to the normal XR configuration mode. |
| <b>Step 3</b> | <b>ipv4 address</b> <i>ipv4-address mask</i><br><b>Example:</b><br>RP/0/RP0/CPU0:router(config-if)# ipv4 address 10.1.2.3 255.0.0.0              | Assigns an IP address and subnet mask to the virtual interface using the <b>ipv4 address</b> configuration subcommand.   |
| <b>Step 4</b> | <b>bundle minimum-active bandwidth</b> <i>kbps</i><br><b>Example:</b><br>RP/0/RP0/CPU0:router(config-if)# bundle minimum-active bandwidth 580000 | (Optional) Sets the minimum amount of bandwidth required before a user can bring up a bundle.  |

|                | Command or Action  | Purpose  |
|----------------|--|--|
| <b>Step 5</b>  | <b>bundle minimum-active links</b> <i>links</i><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config-if)# bundle minimum-active links 2</pre>                                    | (Optional) Sets the number of active links required before you can bring up a specific bundle.   |
| <b>Step 6</b>  | <b>bundle maximum-active links</b> <i>links</i> [ <b>hot-standby</b> ]<br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config-if)# bundle maximum-active links 1 hot-standby</pre> | (Optional) Implements 1:1 link protection for the bundle, which causes the highest-priority link in the bundle to become active and the second-highest-priority link to become the standby. Also, specifies that a switchover between active and standby LACP-enabled links is implemented per a proprietary optimization.<br><br><b>Note</b> The priority of the active and standby links is based on the value of the <b>bundle port-priority</b> command.                                     |
| <b>Step 7</b>  | <b>lACP fast-switchover</b><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config-if)# lACP fast-switchover</pre>   | (Optional) If you enabled 1:1 link protection (you set the value of the <b>bundle maximum-active links</b> command to 1) on a bundle with member links running LACP, you can optionally disable the wait-while timer in the LACP state machine. Disabling this timer causes a bundle member link in standby mode to expedite its normal state negotiations, thereby enabling a faster switchover from a failed active link to the standby link.  |
| <b>Step 8</b>  | <b>exit</b><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config-if)# exit</pre>   | Exits the interface configuration submode.   |
| <b>Step 9</b>  | <b>interface Bundle-Ether</b> <i>bundle-id.vlan-id</i><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router#(config)# interface Bundle-Ether 3.1</pre>                                  | Creates a new VLAN, and assigns the VLAN to the Ethernet bundle you created in Step 2.<br><br>Replace the <i>bundle-id</i> argument with the <i>bundle-id</i> you created in Step 2.<br><br>Replace the <i>vlan-id</i> with a subinterface identifier. Range is from 1 to 4094 inclusive (0 and 4095 are reserved).<br><br><b>Note</b> When you include the <i>.vlan-id</i> argument with the <b>interface Bundle-Ether</b> <i>bundle-id</i> command, you enter subinterface configuration mode. |
| <b>Step 10</b> | <b>IPv4 address</b> <i>IPv4-address mask</i><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router#(config-subif)# IPv4 address 10.1.2.3/24</pre>  | Assigns an IP address and subnet mask to the subinterface.   |

|                | Command or Action   | Purpose   |
|----------------|---|---|
| <b>Step 11</b> | <p><b>no shutdown</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router#(config-subif)# no shutdown</pre>  | (Optional) If a link is in the down state, bring it up. The no shutdown command returns the link to an up or down state depending on the configuration and state of the link. |
| <b>Step 12</b> | <p><b>exit</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-subif)# exit</pre>   | Exits subinterface configuration mode for the VLAN subinterface.  |
| <b>Step 13</b> | <p>Repeat Step 9 through Step 12 to add more VLANs to the bundle you created in Step 2.</p> <p><b>Example:</b></p> <p><b>Example:</b></p> <pre>interface Bundle-Ether bundle-id.vlan-id</pre> <p><b>Example:</b></p> <pre>dot1q vlan vlan-id</pre> <p><b>Example:</b></p> <pre>ipv4 address ipv4-address mask</pre> <p><b>Example:</b></p> <pre>no shutdown</pre> <p><b>Example:</b></p> <pre>exit</pre> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-subif)# interface Bundle-Ether 3.1</pre> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-subif)# ipv4 address 20.2.3.4/24</pre> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-subif)# no shutdown</pre> <p><b>Example:</b></p> <pre>exit</pre> | (Optional) Adds more sub-interfaces to the bundle.  |
| <b>Step 14</b> | <p>Do one of the following:</p> <ul style="list-style-type: none"> <li>• <b>end</b></li> <li>• <b>or</b></li> </ul>   | <p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>• When you issue the <b>end</b> command, the system prompts you to commit changes:</li> </ul>      |

|                | Command or Action  | Purpose  |
|----------------|--|--|
|                | <p>• <b>commit</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-subif)# end</pre> <p><b>Example:</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-subif)# commit</pre> | <p>Uncommitted changes found, commit them before exiting(yes/no/cancel)?<br/>[cancel]:</p> <ul style="list-style-type: none"> <li>• Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to XR EXEC mode.</li> <li>• Entering <b>no</b> exits the configuration session and returns the router to XR EXEC mode without committing the configuration changes.</li> <li>• Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> <li>• Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |
| <b>Step 15</b> | <p><b>exit</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-subif)# end</pre>   | Exits interface configuration mode.  |
| <b>Step 16</b> | <p><b>exit</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config)# exit</pre>  | Exits XR configuration mode.   |
| <b>Step 17</b> | <p><b>configure</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router # configure</pre>   | Enters XR configuration mode.  |
| <b>Step 18</b> | <p><b>interface {TenGigE} interface-path-id</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config)# interface<br/>GigabitEthernet 1/0/0/0</pre>  | <p>Enters interface configuration mode for the Ethernet interface you want to add to the Bundle.</p> <p>Enter the <b>TenGigE</b> keyword to specify the interface type. Replace the <i>interface-path-id</i> argument with the node-id in the rack/slot/module format.</p> <p><b>Note</b> A VLAN bundle is not active until you add an Ethernet interface on both ends of the link bundle.</p>   |
| <b>Step 19</b> | <p><b>bundle id bundle-id [mode {active   on   passive}]</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-if)# bundle-id 3</pre>  | <p>Adds an Ethernet interface to the bundle you configured in Step 2 through Step 13.</p> <p>To enable active or passive LACP on the bundle, include the optional <b>mode active</b> or <b>mode passive</b> keywords in the command string.</p>  |

|                | Command or Action   | Purpose   |
|----------------|---|---|
|                |   | To add the interface to the bundle without LACP support, include the optional <b>mode on</b> keywords with the command string.<br><br><b>Note</b> If you do not specify the <b>mode</b> keyword, the default mode is <b>on</b> (LACP is not run over the port).   |
| <b>Step 20</b> | <b>bundle port-priority</b> <i>priority</i><br><br><b>Example:</b><br><br>RP/0/RP0/CPU0:router (config-if)# bundle port-priority 1  | (Optional) If you set the <b>bundle maximum-active links</b> command to 1, you must also set the priority of the active link to the highest priority (lowest value) and the standby link to the second-highest priority (next lowest value). For example, you can set the priority of the active link to 1 and the standby link to 2.   |
| <b>Step 21</b> | <b>no shutdown</b><br><br><b>Example:</b><br><br>RP/0/RP0/CPU0:router (config-if)# no shutdown  | (Optional) If a link is in the down state, bring it up. The no shutdown command returns the link to an up or down state depending on the configuration and state of the link.   |
| <b>Step 22</b> | —   | Repeat Step 19 through Step 21 to add more Ethernet interfaces to the VLAN bundle.  |
| <b>Step 23</b> | Do one of the following:<br><br>• <b>end</b><br>•<br>• <b>commit</b><br><br><b>Example:</b><br><br>RP/0/RP0/CPU0:router (config-subif)# end<br><br><b>Example:</b><br><br>RP/0/RP0/CPU0:router (config-subif)# commit | Saves configuration changes.<br><br>• When you issue the <b>end</b> command, the system prompts you to commit changes:<br><br>Uncommitted changes found, commit them before exiting (yes/no/cancel)?<br>[cancel]:<br><br>• Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to XR EXEC mode.<br>• Entering <b>no</b> exits the configuration session and returns the router to XR EXEC mode without committing the configuration changes.<br>• Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.<br><br>• Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session. |
| <b>Step 24</b> | Perform Step 1 through Step 23 on the remote end of the VLAN bundle connection.   | Brings up the other end of the link bundle.   |
| <b>Step 25</b> | <b>show bundle Bundle-Ether</b> bundle-id<br><br><b>Example:</b>  | (Optional) Shows information about the specified Ethernet link bundle.  |

|                | Command or Action   | Purpose  |
|----------------|---|--|
|                | RP/0/RP0/CPU0:router# show bundle Bundle-Ether 3  | The <b>show bundle Bundle-Ether</b> command displays information about the specified bundle. If your bundle has been configured properly and is carrying traffic, the State field in the <b>show bundle Bundle-Ether</b> command output shows the number “4,” which means the specified VLAN bundle port is “distributing.”  |
| <b>Step 26</b> | <b>show vlan interface</b><br><b>Example:</b><br>RP/0/RP0/CPU0:router# show vlan interface  | Displays the current VLAN interface and status configuration.  |
| <b>Step 27</b> | <b>show vlan trunks</b> [ {TenGigE   Bundle-Ether} interface-path-id ] [brief   summary] [location node-id]<br><b>Example:</b><br>RP/0/RP0/CPU0:router# show vlan trunk summary | (Optional) Displays summary information about each of the VLAN trunk interfaces. <ul style="list-style-type: none"> <li>The keywords have the following meanings: <ul style="list-style-type: none"> <li><b>brief</b>—Displays a brief summary.</li> <li><b>summary</b>—Displays a full summary.</li> <li><b>location</b>—Displays information about the VLAN trunk interface on the given slot.</li> <li><b>interface</b>—Displays information about the specified interface or subinterface.</li> </ul> </li> </ul> Use the <b>show vlan trunks</b> command to verify that all configured VLAN subinterfaces on an Ethernet bundle are “up.” |
| <b>Step 28</b> | <b>lACP fast-switchover</b><br><b>Example:</b><br>RP/0/RP0/CPU0:router(config-if)# lACP fast-switchover   | (Optional) If you enabled 1:1 link protection (you set the value of the <b>bundle maximum-active links</b> command to 1) on a bundle with member links running LACP, you can optionally disable the wait-while timer in the LACP state machine. Disabling this timer causes a bundle member link in standby mode to expedite its normal state negotiations, thereby enabling a faster switchover from a failed active link to the standby link.  |

## Configuring the Default LACP Short Period Time Interval

This section describes how to configure the default short period time interval for sending and receiving LACP packets on a Gigabit Ethernet interface. This procedure also enables the LACP short period.

### SUMMARY STEPS

1. **configure**
2. **interface GigabitEthernet interface-path**
3. **bundle id number mode active**
4. **lACP period short**
5. Do one of the following:

- end
- 
- commit

## DETAILED STEPS

|        | Command or Action  | Purpose   |
|--------|--|---|
| Step 1 | <b>configure</b><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router# configure</pre>  | Enters XR configuration mode.   |
| Step 2 | <b>interface GigabitEthernet <i>interface-path</i></b><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config)# interface TenGigE 0/0/0/1</pre>  | Creates a Ten Gigabit Ethernet interface and enters interface configuration mode.   |
| Step 3 | <b>bundle id <i>number</i> mode active</b><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config-if)# bundle id 1 mode active</pre>   | Specifies the bundle interface and puts the member interface in active mode.  |
| Step 4 | <b>lACP period short</b><br><b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config-if)# lACP period short</pre>   | Configures a short period time interval for the sending and receiving of LACP packets, using the default time period of 1000 milliseconds or 1 second.  |
| Step 5 | Do one of the following: <ul style="list-style-type: none"> <li>• end</li> <li>•</li> <li>• commit</li> </ul> <b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config-if)# end</pre> <b>Example:</b><br><pre>RP/0/RP0/CPU0:router(config-if)# commit</pre> | Saves configuration changes. <ul style="list-style-type: none"> <li>• When you issue the <b>end</b> command, the system prompts you to commit changes:               <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>• Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to XR EXEC mode.</li> <li>• Entering <b>no</b> exits the configuration session and returns the router to XR EXEC mode without committing the configuration changes.</li> <li>• Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> </ul> </li> </ul> |

|  | Command or Action | Purpose  |
|--|-------------------|--|
|  |                   | <ul style="list-style-type: none"> <li>Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |

## Configuring Custom LACP Short Period Time Intervals

This section describes how to configure custom short period time intervals (less than 1000 milliseconds) for sending and receiving LACP packets on a Gigabit Ethernet interface.



### Note

You must always configure the *transmit* interval at both ends of the connection before you configure the *receive* interval at either end of the connection. Failure to configure the *>transmit* interval at both ends first results in route flapping (a route going up and down continuously). When you remove a custom LACP short period, you must do it in reverse order. You must remove the *receive* intervals first and then the *transmit* intervals.

### SUMMARY STEPS

1. **configure**
2. **interface Bundle-Ether** *bundle-id*
3. **ipv4 address** *ipv4-address mask*
4. **bundle minimum-active bandwidth** *kbps*
5. **bundle minimum-active links** *links*
6. **bundle maximum-active links** *links*
7. **exit**
8. **interface Bundle-Ether** *bundle-id.vlan-id*
9. **dot1q vlan** *vlan-id*
10. **ipv4 address** *ipv4-address mask*
11. **no shutdown**
12. **exit**
13. Repeat Step 7 through Step 12 to add more VLANs to the bundle you created in Step 2.
14. Do one of the following:
  - **end**
  - 
  - **commit**
15. **exit**
16. **exit**
17. **show ethernet trunk bundle-ether** *instance*
18. **configure**
19. **interface** {GigabitEthernet | TenGigE} *interface-path-id*
20. **bundle id** *bundle-id* [**mode** {**active** | **on** | **passive**}]
21. **no shutdown**
22. Repeat Step 19 through Step 21 to add more Ethernet interfaces to the VLAN bundle.



23. Do one of the following:
  - end
  - or
  - commit
24. Perform Step 1 through Step 23 on the remote end of the VLAN bundle connection.
25. **show bundle Bundle-Ether** bundle-id [reasons]
26. **show ethernet trunk bundle-ether** instance

## DETAILED STEPS

|               | Command or Action   | Purpose  |
|---------------|---|--|
| <b>Step 1</b> | <b>configure</b><br><b>Example:</b><br>RP/0/RP0/CPU0:router# configure  | Enters XR configuration mode.  |
| <b>Step 2</b> | <b>interface Bundle-Ether</b> bundle-id<br><b>Example:</b><br>RP/0/RP0/CPU0:router#(config)# interface Bundle-Ether 3                     | Creates and names a new Ethernet link bundle.<br><br>This <b>interface Bundle-Ether</b> command enters you into the interface configuration submode, where you can enter interface-specific configuration commands. Use the <b>exit</b> command to exit from the interface configuration submode back to the normal XR configuration mode. |
| <b>Step 3</b> | <b>ipv4 address</b> ipv4-address mask<br><b>Example:</b><br>RP/0/RP0/CPU0:router(config-if)# ipv4 address 10.1.2.3 255.0.0.0              | Assigns an IP address and subnet mask to the virtual interface using the <b>ipv4 address</b> configuration subcommand.   |
| <b>Step 4</b> | <b>bundle minimum-active bandwidth</b> kbps<br><b>Example:</b><br>RP/0/RP0/CPU0:router(config-if)# bundle minimum-active bandwidth 580000 | (Optional) Sets the minimum amount of bandwidth required before a user can bring up a bundle.  |
| <b>Step 5</b> | <b>bundle minimum-active links</b> links<br><b>Example:</b><br>RP/0/RP0/CPU0:router(config-if)# bundle minimum-active links 2             | (Optional) Sets the number of active links required before you can bring up a specific bundle.   |
| <b>Step 6</b> | <b>bundle maximum-active links</b> links<br><b>Example:</b><br>RP/0/RP0/CPU0:router(config-if)# bundle maximum-active links 1             | (Optional) Designates one active link and one link in standby mode that can take over immediately for a bundle if the active link fails (1:1 protection).<br><br><b>Note</b> The default number of active links allowed in a single bundle is 8.   |

|                | Command or Action   | Purpose   |
|----------------|---|---|
|                |   | <p><b>Note</b> If the <b>bundle maximum-active</b> command is issued, then only the highest-priority link within the bundle is active. The priority is based on the value from the <b>bundle port-priority</b> command, where a lower value is a higher priority. Therefore, we recommend that you configure a higher priority on the link that you want to be the active link.</p>   |
| <b>Step 7</b>  | <p><b>exit</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-if)# exit</pre>  | Exits the interface configuration submode.  |
| <b>Step 8</b>  | <p><b>interface Bundle-Ether <i>bundle-id.vlan-id</i></b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router#(config)# interface Bundle-Ether 3.1</pre> | <p>Creates a new VLAN, and assigns the VLAN to the Ethernet bundle you created in Step 2.</p> <p>Replace the <i>bundle-id</i> argument with the <i>bundle-id</i> you created in Step 2.</p> <p>Replace the <i>vlan-id</i> with a subinterface identifier. Range is from 1 to 4094 inclusive (0 and 4095 are reserved).</p> <p><b>Note</b> When you include the <i>.vlan-id</i> argument with the <b>interface Bundle-Ether <i>bundle-id</i></b> command, you enter subinterface configuration mode.</p> |
| <b>Step 9</b>  | <p><b>dot1q vlan <i>vlan-id</i></b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router#(config-subif)# dot1q vlan 10</pre>                              | <p>Assigns a VLAN to the subinterface.</p> <p>Replace the <i>vlan-id</i> argument with a subinterface identifier. Range is from 1 to 4094 inclusive (0 and 4095 are reserved).</p>  |
| <b>Step 10</b> | <p><b>ipv4 address <i>ipv4-address mask</i></b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router#(config-subif)# ipv4 address 10.1.2.3/24</pre>       | Assigns an IP address and subnet mask to the subinterface.  |
| <b>Step 11</b> | <p><b>no shutdown</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router#(config-subif)# no shutdown</pre>  | (Optional) If a link is in the down state, bring it up. The no shutdown command returns the link to an up or down state depending on the configuration and state of the link.   |
| <b>Step 12</b> | <p><b>exit</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-subif)# exit</pre>   | Exits subinterface configuration mode for the VLAN subinterface.  |

|                | Command or Action  | Purpose  |
|----------------|--|--|
| <b>Step 13</b> | Repeat Step 7 through Step 12 to add more VLANs to the bundle you created in Step 2.   | (Optional) Adds more subinterfaces to the bundle.  |
| <b>Step 14</b> | <p>Do one of the following:</p> <ul style="list-style-type: none"> <li>• <b>end</b></li> <li>•</li> <li>• <b>commit</b></li> </ul> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-subif)# end</pre> <p><b>Example:</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-subif)# commit</pre> | <p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>• When you issue the <b>end</b> command, the system prompts you to commit changes:</li> </ul> <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>• Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.</li> <li>• Entering <b>no</b> exits the configuration session and returns the router to EXEC mode without committing the configuration changes.</li> <li>• Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> <li>• Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |
| <b>Step 15</b> | <p><b>exit</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-subif)# exit</pre>  | Exits interface configuration mode.  |
| <b>Step 16</b> | <p><b>exit</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config)# exit</pre>  | Exits XR configuration mode.   |
| <b>Step 17</b> | <p><b>show ethernet trunk bundle-ether <i>instance</i></b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router# show ethernet trunk bundle-ether 5</pre>  | <p>(Optional) Displays the interface configuration.</p> <p>The Ethernet bundle instance range is from 1 through 65535.</p>   |
| <b>Step 18</b> | <p><b>configure</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router # configure</pre>   | Enters XR configuration mode.  |
| <b>Step 19</b> | <p><b>interface {GigabitEthernet   TenGigE} interface-path-id</b></p> <p><b>Example:</b></p>   | Enters the interface configuration mode for the Ethernet interface you want to add to the Bundle.  |

|                | Command or Action   | Purpose  |
|----------------|---|--|
|                | <pre>RP/0/RP0/CPU0:router(config)# interface TenGigE 1/0/0/0</pre>  | <p>Enter the <b>TenGigE</b> keyword to specify the interface type. Replace the <i>interface-path-id</i> argument with the node-id in the <i>rack/slot/module</i> format.</p> <p><b>Note</b> A VLAN bundle is not active until you add an Ethernet interface on both ends of the link bundle.</p>   |
| <b>Step 20</b> | <p><b>bundle id</b> <i>bundle-id</i> [<b>mode</b> {<b>active</b>   <b>on</b>   <b>passive</b>}]</p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-if)# bundle-id 3</pre>  | <p>Adds an Ethernet interface to the bundle you configured in Step 2 through Step 13.</p> <p>To enable active or passive LACP on the bundle, include the optional <b>mode active</b> or <b>mode passive</b> keywords in the command string.</p> <p>To add the interface to the bundle without LACP support, include the optional <b>mode on</b> keywords with the command string.</p> <p><b>Note</b> If you do not specify the <b>mode</b> keyword, the default mode is <b>on</b> (LACP is not run over the port).</p>   |
| <b>Step 21</b> | <p><b>no shutdown</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-if)# no shutdown</pre>  | <p>(Optional) If a link is in the down state, bring it up. The no shutdown command returns the link to an up or down state depending on the configuration and state of the link.</p>   |
| <b>Step 22</b> | <p>Repeat Step 19 through Step 21 to add more Ethernet interfaces to the VLAN bundle.</p>   | —  |
| <b>Step 23</b> | <p>Do one of the following:</p> <ul style="list-style-type: none"> <li>• <b>end</b></li> <li>• <b>or</b></li> <li>• <b>commit</b></li> </ul> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-subif)# end</pre> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router(config-subif)# commit</pre> | <p>Saves configuration changes.</p> <ul style="list-style-type: none"> <li>• When you issue the <b>end</b> command, the system prompts you to commit changes:</li> </ul> <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> <ul style="list-style-type: none"> <li>• Entering <b>yes</b> saves configuration changes to the running configuration file, exits the configuration session, and returns the router to XR EXEC mode.</li> <li>• Entering <b>no</b> exits the configuration session and returns the router to XR EXEC mode without committing the configuration changes.</li> <li>• Entering <b>cancel</b> leaves the router in the current configuration session without exiting or committing the configuration changes.</li> <li>• Use the <b>commit</b> command to save the configuration changes to the running configuration file and remain within the configuration session.</li> </ul> |

|         | Command or Action   | Purpose  |
|---------|---|--|
| Step 24 | Perform Step 1 through Step 23 on the remote end of the VLAN bundle connection.   | Brings up the other end of the link bundle.  |
| Step 25 | <p><b>show bundle Bundle-Ether bundle-id [reasons]</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router# show bundle Bundle-Ether 3 reasons</pre> | <p>(Optional) Shows information about the specified Ethernet link bundle.</p> <p>The <b>show bundle Bundle-Ether</b> command displays information about the specified bundle. If your bundle has been configured properly and is carrying traffic, the State field in the <b>show bundle Bundle-Ether</b> command output will show the number “4,” which means the specified VLAN bundle port is “distributing.”</p> |
| Step 26 | <p><b>show ethernet trunk bundle-ether instance</b></p> <p><b>Example:</b></p> <pre>RP/0/RP0/CPU0:router# show ethernet trunk bundle-ether 5</pre>    | <p>(Optional) Displays the interface configuration.</p> <p>The Ethernet bundle instance range is from 1 through 65535.</p>   |

## Configuration Examples for Link Bundling

This section contains the following examples:

### Example: Configuring an Ethernet Link Bundle

This example shows how to join two ports to form an EtherChannel bundle running LACP:

```
RP/0/RP0/CPU0:router# config
RP/0/RP0/CPU0:router(config) #interface Bundle-Ether 3
RP/0/RP0/CPU0:router(config-if) #ipv4 address 1.2.3.4/24
RP/0/RP0/CPU0:router(config-if) # bundle minimum-active bandwidth 620000
RP/0/RP0/CPU0:router(config-if) # bundle minimum-active links 1

RP/0/RP0/CPU0:router(config -if) # bundle maximum-active links 1 hot -standby
RP/0/RP0/CPU0:router(config-if) # lacp fast-switchover
RP/0/RP0/CPU0:router(config-if) # exit
RP/0/RP0/CPU0:router(config) #interface TenGigE 0/3/0/0
RP/0/RP0/CPU0:router(config-if) #bundle id 3 mode active
RP/0/RP0/CPU0:router(config -if) # bundle port-priority 1
RP/0/RP0/CPU0:router(config-if) # no shutdown
RP/0/RP0/CPU0:router(config) # exit
RP/0/RP0/CPU0:router(config) #interface TenGigE 0/3/0/1
RP/0/RP0/CPU0:router(config -if) #bundle id 3 mode active
RP/0/RP0/CPU0:router(config-if) # bundle port-priority 2
RP/0/RP0/CPU0:router(config-if) # no shutdown
RP/0/RP0/CPU0:router(config-if) # exit
```

## Example: Configuring a VLAN Link Bundle

The following example shows how to create and bring up two VLANs on an Ethernet bundle:

```
RP/0/RP0/CPU0:Router# config
RP/0/RP0/CPU0:Router(config)# interface Bundle-Ether 1
RP/0/RP0/CPU0:Router(config-if)# ipv4 address 1.2.3.4/24
RP/0/RP0/CPU0:Router(config-if)# bundle minimum-active bandwidth 620000
RP/0/RP0/CPU0:Router(config-if)# bundle minimum-active links 1
RP/0/RP0/CPU0:Router(config-if)# exit
RP/0/RP0/CPU0:Router(config)# interface Bundle-Ether 1.1
RP/0/RP0/CPU0:Router(config-subif)# dot1q vlan 10
RP/0/RP0/CPU0:Router(config-subif)# ip addr 10.2.3.4/24
RP/0/RP0/CPU0:Router(config-subif)# no shutdown
RP/0/RP0/CPU0:Router(config-subif)# exit
RP/0/RP0/CPU0:Router(config)# interface Bundle-Ether 1.2
RP/0/RP0/CPU0:Router(config-subif)# dot1q vlan 20
RP/0/RP0/CPU0:Router(config-subif)# ip addr 20.2.3.4/24
RP/0/RP0/CPU0:Router(config-subif)# no shutdown
RP/0/RP0/CPU0:Router(config-subif)# exit
RP/0/RP0/CPU0:Router(config)# interface gig 0/1/5/7
RP/0/RP0/CPU0:Router(config-if)# bundle-id 1 mode act
RP/0/RP0/CPU0:Router(config-if)# commit
RP/0/RP0/CPU0:Router(config-if)# exit
RP/0/RP0/CPU0:Router(config)# exit
RP/0/RP0/CPU0:Router # show vlan trunks
```

## Example: Configuring EFP Load Balancing on an Ethernet Link Bundle

The following example shows how to configure all egressing traffic on the fixed members of a bundle to flow through the same physical member link automatically.

```
RP/0/RP0/CPU0:router# configuration terminal
RP/0/RP0/CPU0:router(config)# interface bundle-ether 1.1 l2transport
RP/0/RP0/CPU0:router(config-subif)# bundle load-balancing hash auto
RP/0/RP0/CPU0:router(config-subif)#
```

The following example shows how to configure all egressing traffic on the fixed members of a bundle to flow through a specified physical member link.

```
RP/0/RP0/CPU0:router# configuration terminal
RP/0/RP0/CPU0:router(config)# interface bundle-ether 1.1 l2transport
RP/0/RP0/CPU0:router(config-subif)# bundle load-balancing hash 1
RP/0/RP0/CPU0:router(config-subif)#
```

## Examples: Configuring LACP Short Periods

The following example shows how to configure the LACP short period time interval to the default time of 1000 milliseconds (1 second):

```
config
interface TenGigE 0/1/0/1
bundle id 1 mode active
lACP period short
commit
```

The following example shows how to configure custom LACP short period transmit and receive intervals to *less than* the default of 1000 milliseconds (1 second):

**Router A**

```
config
interface TenGigE 0/1/0/1
bundle id 1 mode active
lacp period short
commit
```

**Router B**

```
config
interface TenGigE 0/1/0/1
bundle id 1 mode active
lacp period short
commit
```

**Router A**

```
config
interface TenGigE 0/1/0/1
lacp period short transmit 100
commit
```

**Router B**

```
config
interface TenGigE 0/1/0/1
lacp period short transmit 100
commit
```

**Router A**

```
config
interface TenGigE 0/1/0/1
lacp period short receive 100
commit
```

**Router B**

```
config
interface TenGigE 0/1/0/1
lacp period short receive 100
commit
```

## Additional References

These sections provide references related to link bundle configuration.

## Related Documents

### Standards

| Standards   | Title |
|---|-------|
| IEEE 802.3ad (incorporated as Annex 43 into 802.3-2002) | —     |

### MIBs

| MIBs   | MIBs Link   |
|--|---|
| The IEEE-defined MIB for Link Aggregation (defined in 802.3 Annex 30C) | To locate and download MIBs for selected platforms using Cisco IOS XR Software, use the Cisco MIB Locator found at the following URL: <a href="http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml">http://cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml</a> |

### RFCs

| RFCs  | Title |
|---|-------|
| No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature. | —     |

### Technical Assistance

| Description   | Link  |
|---|---|
| The Cisco Technical Support website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content. | <a href="http://www.cisco.com/techsupport">http://www.cisco.com/techsupport</a> |