



Configuring Link Bundling

This module describes the configuration of link bundle interfaces on the Cisco CRS-1 Router.

A link bundle is a group of one or more ports that are aggregated together and treated as a single link.

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 3.2	This feature was introduced on the Cisco CRS-1 Router.

Release 3.3.0	<p>This feature was updated as follows:</p> <ul style="list-style-type: none"> • To support the 1:N redundancy feature, users can configure the minimum number of active links using the bundle minimum-active links command. • To support the 1:N redundancy feature, users can configure the minimum bandwidth in kbps using the bundle minimum-active links command. • Support was added for VLAN subinterfaces on Ethernet link bundles. • Output for show bundle bundle-Ether command and show bundle bundle-POS command was modified. • The reasons keyword was added to the show bundle bundle-Ether command and the show bundle bundle-POS command. • The bundle id command was changed from bundle-id. • BFD over bundled VLANs using static routes.
Release 3.4.0	<p>The configuration procedures in this module were modified with enhancements.</p>
Release 3.7.0	<p>Note was added, specifying that link bundling is supported on the multishelf Cisco CRS-1 Router.</p>
Release 3.8.0	<p>This feature was updated as follows:</p> <ul style="list-style-type: none"> • The reasons keyword was removed from the show bundle bundle-Ether command and the show bundle bundle-POS command. Now, if a port is in a state other than the distributing state, the output of both commands displays the reason. • The hot-standby keyword was added to the bundle maximum-active links command. • The lacp fast-switchover command was added.
Release 3.8.4	<p>Bundle member links are put into new err-disable link interface status and admin-down protocol state when a bundle interface is shut down.</p>
Release 3.9.0	<p>Support for super short LACP was added.</p> <p>Support for load balancing was added.</p> <p>Support for a maximum of 64 member links per bundle was added.</p>

Release 4.0.0	Support for the following physical layer interface modules (PLIMs) was added: <ul style="list-style-type: none"> • 14-Port 10-Gigabit Ethernet LAN/WAN-PHY PLIM (14X10GBE-WL-XFP) (with the Cisco CRS-3 Modular Services Card or Cisco CRS-3 Forwarding Processor Card) • 20-Port 10-Gigabit Ethernet LAN/WAN-PHY PLIM (20X10GBE-WL-XFP) (with the Cisco CRS-3 Modular Services Card or Cisco CRS-3 Forwarding Processor Card)
Release 4.0.1	Support for the following PLIMs was added: <ul style="list-style-type: none"> • 1-Port 100-Gigabit Ethernet PLIM (1X100GBE) (with the Cisco CRS-3 Modular Services Card or Cisco CRS-3 Forwarding Processor Card) • 4-Port 10-Gigabit Ethernet LAN/WAN-PHY PLIM (4-10GBE-WL-XFP) • 8-Port 10-Gigabit Ethernet LAN/WAN-PHY PLIM (8-10GBE-WL-XFP)
Release 5.1.1	Support for Multichassis Link Aggregation on IPv6 traffic was included.
Release 5.1.2	Support for mixed speed member links in a bundle interface was included.
Release 6.0.0	Bundle scale support increases to 1600 bundles on A9K-RSP880-SE, A99-RP2-SE and the third generation of ASR 9000 Ethernet line card.
Release 6.2.2	Support for Layer 3 Multicast traffic over mixed speed bundles was added.

- [Prerequisites for Configuring Link Bundling, on page 3](#)
- [Information About Configuring Link Bundling, on page 4](#)
- [How to Configure Link Bundling, on page 12](#)
- [Configuration Examples for Link Bundling, on page 34](#)

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 on a Cisco CRS-1 Router

Before configuring link bundling on a Cisco IOS XR Router, be sure that the following 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:
 - 1-port 10-Gigabit Ethernet SPA (LAN and WAN-PHY)
 - 4-Port 10-Gigabit Ethernet Tunable WDMPHY Physical Layer Interface Module (PLIM)
 - 4-Port 10-Gigabit Ethernet PLIM
 - 5-Port Gigabit Ethernet SPA
 - 8-Port Gigabit Ethernet SPA (versions 1 and 2)
 - 8-Port 10-Gigabit Ethernet PLIM
 - 10-Port Gigabit Ethernet SPA
 - 42-Port Gigabit Ethernet PLIM
 - 4-Port 10-Gigabit Ethernet LAN/WAN-PHY PLIM
 - 8-Port 10-Gigabit Ethernet LAN/WAN-PHY PLIM
 - 14-Port 10-Gigabit Ethernet LAN/WAN-PHY PLIM
 - 20-Port 10-Gigabit Ethernet LAN/WAN-PHY PLIM
 - 1-Port 100-Gigabit Ethernet PLIM
- If you are configuring a POS link bundle, you have a POS line card or SPA installed in a router that is running Cisco IOS XR software.

**Note**

For more information about physical interfaces, PLIMs, and modular services cards, refer to the *Cisco CRS-1 Carrier Routing System 8-Slot Line Card Chassis System Description*.

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 and SPAs 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 move onto another link if one of the links within a bundle fails. You can add or remove bandwidth without interrupting packet flow. For example, you can upgrade from an OC-48c PLIM modular services card to an OC-192 PLIM modular services card without interrupting traffic.

All links within a bundle must be of the same type. 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 and POS 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.
- Ether Channel 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 Ethernet Link Bundles

This list describes the properties and limitations of ethernet link bundles:

- Any type of Ethernet interfaces can be bundled, with or without the use of LACP (Link Aggregation Control Protocol).
- Bundle membership can span across several line cards that are installed in a single router or multiple routers in the case of MC-LAG.
- With mixed speed bundles, the total weight of a bundle is greater than the number of members in the bundle, as the weight represents the smallest active number bandwidth.
- The weight of each bundle member is the ratio of its bandwidth to the lowest bandwidth member. Total weight of the bundle is the sum of weights or relative bandwidth of each bundle member. Since the weight for a bundle member is greater than or equal to 1 and less than or equal to 10, the total member of links in a bundle is less than 64 in mixed bundle case.
- Mixed speed bundles are supported in MC-LAG.
- 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.
- A bundle can be administratively enabled or disabled. Beginning in Cisco IOS XR Release 3.8.4, when you shut down a bundle interface, the member links are put into err-disable link interface status and

admin-down line protocol state. You can show the status of a bundle interface and its members using the **show interfaces** command.

- Each individual link within a bundle can be administratively enabled or disabled.
- The MAC address that is set on the bundle becomes the MAC address of the links within that bundle.
- MAC address is set on the bundle the address of the
- 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 except in the case of MC-LAG.
- Bundled interfaces are point-to-point.
- A bundle can contain physical links only. Tunnels and VLAN subinterfaces cannot be bundle members. However, you can create VLANs as subinterfaces 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, the control plane selects the member, and all traffic for that flow is sent over that member. The system supports Layer 3 Multicast traffic over mixed speed bundles.

Characteristics of CRS-1 Series Router Link Bundles

The following list describes additional properties and limitations of link bundles that are specific to CRS-1 Series:

- Link bundling is supported on all multishelf Cisco CRS-1 Routers.
- A bundle can contain all Ethernet interfaces or all POS interfaces, but not a mix of Ethernet and POS interfaces.
- A single bundle supports a maximum of 64 physical links. If you add more than 64 links to a bundle, only 64 of the links function, and the remaining links are automatically disabled.
- A Cisco CRS Router supports a maximum of 64 bundles.
- Ethernet and POS link bundles are created in the same way as Ethernet channels and POS channels, where the user enters the same configuration on both end systems.
- For Ethernet link bundles, links within a single bundle should have the same speed.
- For POS link bundles, 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.

- HDLC is the only supported encapsulation type for POS link bundles in Cisco IOS XR software. POS links that are configured with any other encapsulation type cannot join a bundle. Keep in mind that all POS link bundle members must be running HDLC for HDLC to work on a bundle.
- QoS is supported and is applied proportionally on each bundle member.
- Link layer protocols, such as CDP and HDLC keepalives, work independently on each link within a bundle.
- All links within a single bundle must be configured to run either POS Channel or 802.3ad. Mixed bundles are not supported.

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. In Cisco IOS XR software, the IEEE 802.3ad standard is used on both Ethernet and POS 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.



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

ICCP Based Service Multihoming

In the case of ICCP based Service Multihoming (ICCP-SM), the CE device uses two independent bundle interfaces to connect to the PoAs. Although bundle interfaces are used, they are not aggregated across the two chassis, and mLACP is not involved in the communication. The CE device configures the bundle interfaces in such a manner that all VLANs are allowed on both bundles. You can manually configure the PoAs to distribute the VLANs across the two bundles in order that individual VLANs are active (forwarding) on one bundle or PoA, and standby (blocked) on the other. The CE device initially floods a traffic flow on both bundles and learns the MAC address on the interface where it receives the response.

With ICCP-SM, you are not limited to a dual homed device. The access links can connect to a dual homed network (DHN) that are separate devices in the access network. The two bundles on the DHD or the DHN must be in a bridge domain so that L2 learning selects the link with the active set of VLANs.

Figure 1: ICCP Based Service Multihoming

If a bundle interface between the CE and the PoA fails, ICCP-SM on the PoA with the failed bundle communicates through ICCP to the other PoA's ICCP-SM. This activates the standby VLANs on the remaining bundle. A MAC flush is sent to the CE so that packets destined to hosts on the failed bundle are again flooded, in order to be learned on the newly activated bundle. The MAC flush is required because it is possible that the bundle interface failure is not detected by the CE.

In ICCP Based Service Multihoming, the total set of VLANs are split into a primary set and a secondary set and are configured on each PoA such that the primary set on one PoA is configured as secondary on the other. On each PoA, the VLANs are associated with ACs. If the VLANs are primary on a PoA and there are no faults, the associated ACs are set to forwarding. If the VLANs are secondary on a PoA, the associated ACs are blocked. ICCP-SM is only supported in VPLS cores.

Advantages of Pseudo mLACP:

Pseudo mLACP has these three major advantages over mLACP:

- Pseudo mLACP can support a Dual Homed Network (DHN), while mLACP can only support a Dual Homed Device (DHD).
- Pseudo mLACP supports per-VLAN active/active redundancy without any load-balancing requirements on the CE.

- Pseudo mLACP does not require LACP support from the DHD, or DHN. It is independent of the access redundancy mechanism; therefore, it provides a network based redundancy solution. It allows maximum flexibility for the PE-CE interoperability in terms of dual-homing redundancy and recovery.

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.



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.

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.



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.

QoS and Link Bundling

On the Cisco CRS-1 Router, QoS is applied to the local instance of a bundle in the ingress direction. Each bundle is associated with a set of queues. QoS is applied to the various network layer protocols that are configured on the bundle. In the egress direction, QoS is applied on the bundle with a reference to the member links. QoS is applied based on the sum of the member bandwidths.

For complete information on configuring QoS on link bundles on the Cisco CRS-1 Router, refer to the *Cisco IOS XR Modular Quality of Service Configuration Guide for the Cisco CRS Router* and the *Cisco IOS XR Modular Quality of Service Command Reference for the Cisco CRS Router*.

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.



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

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 subinterfaces 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 global 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. On a CRS-1 Series router, 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.



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

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.



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

Link Switchover

By default, a maximum of 64 links in a bundle can actively carry traffic on a Cisco CRS-1 Router. If one member link in a bundle fails, traffic is redirected to the remaining operational member links.

On a Cisco CRS-1 Router, you can optionally implement 1:1 link protection for a bundle by setting the **bundle maximum-active links** command to 1. By doing so, you designate one active link and one or more dedicated standby links. If the active link fails, a switchover occurs and a standby link immediately becomes active, thereby ensuring uninterrupted traffic.

If the active and standby links are running LACP, you can choose between an IEEE standard-based switchover (the default) or a faster proprietary optimized switchover. If the active and standby links are not running LACP, the proprietary optimized switchover option is used.

Regardless of the type of switchover you are using, you can disable the wait-while timer, which expedites the state negotiations of the standby link and causes a faster switchover from a failed active link to the standby link.

To do so, you can use the **lACP fast-switchover** command.

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.



Note

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

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** {GigabitEthernet | TenGigE} *interface-path-id*
10. **bundle id** *bundle-id* [**mode** {**active** | **on** | **passive**}]
11. **bundle port-priority** *priority*
12. **no shutdown**
13. **exit**
14. **bundle id** *bundle-id* [**mode** {**active** | **passive** | **on**}] **no shutdown exit**

15. **end** or **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
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	interface Bundle-Ether <i>bundle-id</i> Example: 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. This interface Bundle-Ether command enters you into the interface configuration submode, where you can enter interface specific configuration commands are entered. Use the exit command to exit from the interface configuration submode back to the normal global configuration mode.
Step 3	ipv4 address <i>ipv4-address mask</i> Example: 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 ipv4 address configuration subcommand.
Step 4	bundle minimum-active bandwidth <i>kbps</i> Example: 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.
Step 5	bundle minimum-active links <i>links</i> Example: 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.
Step 6	bundle maximum-active links <i>links</i> [hot-standby] Example: 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.

	Command or Action	Purpose
		<p>Note</p> <ul style="list-style-type: none"> The priority of the active and standby links is based on the value of the bundle port-priority command.
Step 7	<p>lACP fast-switchover</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# lACP fast-switchover</pre>	<p>(Optional) If you enabled 1:1 link protection (you set the value of the bundle maximum-active links 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.</p>
Step 8	<p>exit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# exit</pre>	<p>Exits interface configuration submode for the Ethernet link bundle.</p>
Step 9	<p>interface {GigabitEthernet TenGigE} interface-path-id</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config)# interface GigabitEthernet 1/0/0/0</pre>	<p>Enters interface configuration mode for the specified interface.</p> <p>Enter the GigabitEthernet or TenGigE 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>
Step 10	<p>bundle id bundle-id [mode {active on passive}]</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# bundle-id 3</pre>	<p>Adds the link to the specified bundle.</p> <p>To enable active or passive LACP on the bundle, include the optional mode active or mode passive keywords in the command string.</p> <p>To add the link to the bundle without LACP support, include the optional mode on keywords with the command string.</p> <p>Note</p> <ul style="list-style-type: none"> If you do not specify the mode keyword, the default mode is on (LACP is not run over the port).
Step 11	<p>bundle port-priority priority</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# bundle port-priority 1</pre>	<p>(Optional) If you set the bundle maximum-active links 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.</p>
Step 12	<p>no shutdown</p> <p>Example:</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>

	Command or Action	Purpose
Step 13	<p>exit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# exit</pre>	Exits interface configuration submode for the Ethernet interface.
Step 14	<p>bundle id <i>bundle-id</i> [mode {active passive on}] no shutdown exit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config)# interface GigabitEthernet 1/0/2/1 RP/0/RP0/CPU0:router(config-if)# bundle id 3 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 RP/0/RP0/CPU0:router(config)# interface GigabitEthernet 1/0/2/3 RP/0/RP0/CPU0:router(config-if)# bundle id 3 RP/0/RP0/CPU0:router(config-if)# no shutdown RP/0/RP0/CPU0:router(config-if)# exit</pre>	(Optional) Repeat Step 8 through Step 11 to add more links to the bundle.
Step 15	<p>end or commit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# end</pre> <p>or</p> <pre>RP/0/RP0/CPU0:router(config-if)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> • Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. • Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. • Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. • Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

	Command or Action	Purpose
Step 16	exit Example: RP/0/RP0/CPU0:router(config-if)# exit	Exits interface configuration mode.
Step 17	exit Example: RP/0/RP0/CPU0:router(config)# exit	Exits global configuration mode.
Step 18	Perform Step 1 through Step 15 on the remote end of the connection.	Brings up the other end of the link bundle.
Step 19	show bundle Bundle-Ether <i>bundle-id</i> Example: RP/0/RP0/CPU0:router# show bundle Bundle-Ether 3	(Optional) Shows information about the specified Ethernet link bundle.
Step 20	show lacp bundle Bundle-Ether <i>bundle-id</i> Example: RP/0/RP0/CPU0:router# show lacp bundle Bundle-Ether 3	(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. **bundle load-balance hash *hash-value* [auto]**
4. **end** or **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	interface Bundle-Ether <i>bundle-id</i> l2transport Example: 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. The range is 1 to 65535.
Step 3	bundle load-balance hash <i>hash-value</i> [auto] Example: RP/0/RP0/CPU0:router(config-subif)# bundle load-balancing hash 1 OR 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"> • <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. • auto—The physical member link through which all egressing traffic on this bundle will flow is automatically chosen.
Step 4	end or commit Example: RP/0/RP0/CPU0:router(config-if)# end OR RP/0/RP0/CPU0:router(config-if)# commit	Saves configuration changes. <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting (yes/no/cancel)? • Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. • Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. • Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. • Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring VLAN Bundles

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

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose
Step 1	Create an Ethernet bundle	
Step 2	Create VLAN subinterfaces and assign them to the Ethernet bundle.	
Step 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. **dot1q vlan**
11. **ipv4 address** *ipv4-address mask*
12. **no shutdown**
13. **exit**
14. Repeat Step 9 through Step 12 to add more VLANs to the bundle you created in Step 2.
15. **end** or **commit**
16. **exit**
17. **exit**
18. **configure**
19. **interface** {**GigabitEthernet** | **TenGigE**} *interface-path-id*
20. **bundle id** *bundle-id* [**mode** {**active** | **on** | **passive**}]
21. **bundle port-priority** *priority*
22. **no shutdown**
23. Repeat Step 19 through Step 21 to add more Ethernet interfaces to the VLAN bundle.

24. **end** or **commit**
25. Perform Step 1 through Step 23 on the remote end of the VLAN bundle connection.
26. **show bundle Bundle-Ether** *bundle-id*
27. **show vlan interface**
28. **show vlan trunks** [{GigabitEthernet | TenGigE | Bundle-Ether} *interface-path-id*] [brief | summary] [location *node-id*]
29. **lACP fast-switchover**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	interface Bundle-Ether <i>bundle-id</i> Example: RP/0/RP0/CPU0:router#(config)# interface Bundle-Ether 3	Creates and names a new Ethernet link bundle. This interface Bundle-Ether command enters you into the interface configuration submode, where you can enter interface-specific configuration commands. Use the exit command to exit from the interface configuration submode back to the normal global configuration mode.
Step 3	ipv4 address <i>ipv4-address mask</i> Example: 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 ipv4 address configuration subcommand.
Step 4	bundle minimum-active bandwidth <i>kbps</i> Example: 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.
Step 5	bundle minimum-active links <i>links</i> Example: 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.
Step 6	bundle maximum-active links <i>links</i> [hot-standby] Example: 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.

	Command or Action	Purpose
		Note The priority of the active and standby links is based on the value of the bundle port-priority command.
Step 7	lacp fast-switchover Example: <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 bundle maximum-active links 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.
Step 8	exit Example: <pre>RP/0/RP0/CPU0:router(config-if)# exit</pre>	Exits the interface configuration submode.
Step 9	interface Bundle-Ether <i>bundle-id.vlan-id</i> Example: <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>Note When you include the <i>.vlan-id</i> argument with the interface Bundle-Ether <i>bundle-id</i> command, you enter subinterface configuration mode.</p>
Step 10	dot1q vlan Example: <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>
Step 11	ipv4 address <i>ipv4-address mask</i> Example: <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.
Step 12	no shutdown Example: <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.

	Command or Action	Purpose
Step 13	<p>exit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-subif)# exit</pre>	Exits subinterface configuration mode for the VLAN subinterface.
Step 14	Repeat Step 9 through Step 12 to add more VLANs to the bundle you created in Step 2.	(Optional) Adds more subinterfaces to the bundle.
Step 15	<p>end or commit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-subif)# end</pre> <p>or</p> <pre>RP/0/RP0/CPU0:router(config-subif)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end 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"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
Step 16	<p>exit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-subif)# end</pre>	Exits interface configuration mode.
Step 17	<p>exit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config)# exit</pre>	Exits global configuration mode.
Step 18	<p>configure</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router # configure</pre>	Enters global configuration mode.
Step 19	<p>interface {GigabitEthernet TenGigE} <i>interface-path-id</i></p> <p>Example:</p>	Enters 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 GigabitEthernet 1/0/0/0</pre>	<p>Enter the GigabitEthernet or TenGigE 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>Note A VLAN bundle is not active until you add an Ethernet interface on both ends of the link bundle.</p>
Step 20	<p>bundle id <i>bundle-id</i> [mode {active on passive}]</p> <p>Example:</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 mode active or mode passive keywords in the command string.</p> <p>To add the interface to the bundle without LACP support, include the optional mode on keywords with the command string.</p> <p>Note If you do not specify the mode keyword, the default mode is on (LACP is not run over the port).</p>
Step 21	<p>bundle port-priority <i>priority</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# bundle port-priority 1</pre>	<p>(Optional) If you set the bundle maximum-active links 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.</p>
Step 22	<p>no shutdown</p> <p>Example:</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>
Step 23	Repeat Step 19 through Step 21 to add more Ethernet interfaces to the VLAN bundle.	—
Step 24	<p>end or commit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-subif)# end or RP/0/RP0/CPU0:router(config-subif)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> - Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.

	Command or Action	Purpose
		<ul style="list-style-type: none"> - Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. - Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. • Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
Step 25	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 26	<p>show bundle Bundle-Ether <i>bundle-id</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router# show bundle Bundle-Ether 3</pre>	<p>(Optional) Shows information about the specified Ethernet link bundle.</p> <p>The show bundle Bundle-Ether command displays information about the specified bundle. If your bundle has been configured properly and is carrying traffic, the State field in the show bundle Bundle-Ether command output shows the number “4,” which means the specified VLAN bundle port is “distributing.”</p>
Step 27	<p>show vlan interface</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router # show vlan interface</pre>	Displays the current VLAN interface and status configuration.
Step 28	<p>show vlan trunks [{GigabitEthernet TenGigE Bundle-Ether} <i>interface-path-id</i>] [brief summary] [<i>location node-id</i>]</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router# show vlan trunk summary</pre>	<p>(Optional) Displays summary information about each of the VLAN trunk interfaces.</p> <ul style="list-style-type: none"> • The keywords have the following meanings: <ul style="list-style-type: none"> brief—Displays a brief summary. summary—Displays a full summary. location—Displays information about the VLAN trunk interface on the given slot. interface—Displays information about the specified interface or subinterface. <p>Use the show vlan trunks command to verify that all configured VLAN subinterfaces on an Ethernet bundle are “up.”</p>
Step 29	<p>lACP fast-switchover</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router (config-if) # lACP fast-switchover</pre>	<p>(Optional) If you enabled 1:1 link protection (you set the value of the bundle maximum-active links 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</p>

	Command or Action	Purpose
		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 POS Link Bundles

This section describes how to configure a POS link bundle.



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

SUMMARY STEPS

1. **configure**
2. **interface Bundle-POS** *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 POS** *interface-path-id*
10. **bundle id** *bundle-id* [*mode {active | on | passive}*]
11. **bundle port-priority** *priority*
12. **no shutdown**
13. **exit**
14. Repeat Step 8 through Step 11 to add more links to a bundle
15. **end** or **commit**
16. **exit**
17. **exit**
18. Perform Step 1 through Step 15 on the remote end of the connection.
19. **show bundle Bundle-POS** *number*
20. **show lACP bundle Bundle-POS** *bundle-id*

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	interface Bundle-POS <i>bundle-id</i>	Configures and names the new bundled POS interface.

	Command or Action	Purpose
	<p>Example:</p> <pre>RP/0/RP0/CPU0:router#(config)#interface Bundle-POS 2</pre>	<p>Enters the interface configuration submode, from where interface specific configuration commands are executed. Use the exit command to exit from the interface configuration submode, and get back to the normal global configuration mode.</p>
Step 3	<p>ipv4 address <i>ipv4-address mask</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# ipv4 address 10.1.2.3 255.0.0.0</pre>	<p>Assigns an IP address and subnet mask to the virtual interface using the ip address configuration subcommand.</p>
Step 4	<p>bundle minimum-active bandwidth <i>kbps</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# bundle minimum-active bandwidth 620000</pre>	<p>(Optional) Sets the minimum amount of bandwidth required before a user can bring up a bundle.</p>
Step 5	<p>bundle minimum-active links <i>links</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# bundle minimum-active links 2</pre>	<p>(Optional) Sets the number of active links required before you can bring up a specific bundle.</p>
Step 6	<p>bundle maximum-active links <i>links [hot-standby]</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# bundle maximum-active links 1 hot-standby</pre>	<p>(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 according to a proprietary optimization.</p> <p>Note</p> <ul style="list-style-type: none"> The priority of the active and standby links is based on the value of the bundle port-priority command.
Step 7	<p>lacp fast-switchover</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# lacp fast-switchover</pre>	<p>(Optional) If you enabled 1:1 link protection (you set the value of the bundle maximum-active links 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.</p>
Step 8	<p>exit</p>	<p>Exits the interface configuration submode.</p>

	Command or Action	Purpose
Step 9	interface POS <i>interface-path-id</i> Example: <pre>RP/0/RP0/CPU0:router(config)# interface POS 0/1/0/0</pre>	Enters POS interface configuration mode and specifies the POS interface name and interface-path-id notation <i>rack/slot/module/port</i> .
Step 10	bundle id <i>bundle-id [mode {active on passive}]</i> Example: <pre>RP/0/RP0/CPU0:router(config-if)# bundle-id 3</pre>	Adds the link to the specified bundle. To enable active or passive LACP on the bundle, include the optional mode active or mode passive keywords in the command string. To add the link to the bundle without LACP support, include the optional mode on keywords with the command string. Note <ul style="list-style-type: none"> If you do not specify the mode keyword, the default mode is on (LACP is not run over the port).
Step 11	bundle port-priority <i>priority</i> Example: <pre>RP/0/RP0/CPU0:router(config-if)# bundle port-priority 1</pre>	(Optional) If you set the bundle maximum-active links 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.
Step 12	no shutdown Example: <pre>RP/0/RP0/CPU0:router(config-if)# no shutdown</pre>	Removes the shutdown configuration which forces the interface administratively down. The no shutdown command then returns the link to an up or down state, depending on the configuration and state of the link.
Step 13	exit Example: <pre>RP/0/RP0/CPU0:router# exit</pre>	Exits the interface configuration submode for the POS interface.
Step 14	Repeat Step 8 through Step 11 to add more links to a bundle	(Optional) Adds more links to the bundle you created in Step 2.
Step 15	end or commit Example: <pre>RP/0/RP0/CPU0:router(config-if)# end or RP/0/RP0/CPU0:router(config-if)# commit</pre>	Saves configuration changes. <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre>

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

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. **end** or **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	interface GigabitEthernet <i>interface-path</i> Example: RP/0/RP0/CPU0:router(config)# interface GigabitEthernet 0/0/0/1	Creates a Gigabit Ethernet interface and enters interface configuration mode.
Step 3	bundle id <i>number</i> mode active Example: RP/0/RP0/CPU0:router(config-if)# bundle id 1 mode active	Specifies the bundle interface and puts the member interface in active mode.
Step 4	lACP period short Example: RP/0/RP0/CPU0:router(config-if)# lACP period short	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	end or commit Example: RP/0/RP0/CPU0:router(config-if)# end or RP/0/RP0/CPU0:router(config-if)# commit	Saves configuration changes. <ul style="list-style-type: none"> • When you issue the end command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]: - Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. - Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. - Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes.

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

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. **end** or **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. **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
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	interface Bundle-Ether <i>bundle-id</i> Example: RP/0/RP0/CPU0:router#(config)# interface Bundle-Ether 3	Creates and names a new Ethernet link bundle. This interface Bundle-Ether command enters you into the interface configuration submode, where you can enter interface-specific configuration commands. Use the exit command to exit from the interface configuration submode back to the normal global configuration mode.
Step 3	ipv4 address <i>ipv4-address mask</i> Example: 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 ipv4 address configuration subcommand.
Step 4	bundle minimum-active bandwidth <i>kbps</i> Example: 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.
Step 5	bundle minimum-active links <i>links</i> Example: 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.
Step 6	bundle maximum-active links <i>links</i> Example: 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). Note <ul style="list-style-type: none"> • The default number of active links allowed in a single bundle is 8. • If the bundle maximum-active command is issued, then only the highest-priority link within the bundle is active. The priority is based on the value from the bundle port-priority 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.

	Command or Action	Purpose
Step 7	<p>exit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# exit</pre>	Exits the interface configuration submode.
Step 8	<p>interface Bundle-Ether <i>bundle-id.vlan-id</i></p> <p>Example:</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>Note</p> <ul style="list-style-type: none"> When you include the <i>.vlan-id</i> argument with the interface Bundle-Ether <i>bundle-id</i> command, you enter subinterface configuration mode.
Step 9	<p>dot1q vlan <i>vlan-id</i></p> <p>Example:</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>
Step 10	<p>ipv4 address <i>ipv4-address mask</i></p> <p>Example:</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.
Step 11	<p>no shutdown</p> <p>Example:</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.
Step 12	<p>exit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-subif)# exit</pre>	Exits subinterface configuration mode for the VLAN subinterface.
Step 13	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.
Step 14	<p>end or commit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-subif)# end or</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting (yes/no/cancel)?

	Command or Action	Purpose
	<pre>RP/0/RP0/CPU0:router(config-subif)# commit</pre>	<ul style="list-style-type: none"> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
Step 15	<p>exit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-subif)# exit</pre>	Exits interface configuration mode.
Step 16	<p>exit</p> <p>Example:</p> <pre>RP/0/RSP0/CPU0:router(config)# exit</pre>	Exits global configuration mode.
Step 17	<p>show ethernet trunk bundle-ether <i>instance</i></p> <p>Example:</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>
Step 18	<p>configure</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router # configure</pre>	Enters global configuration mode.
Step 19	<p>interface {GigabitEthernet TenGigE} <i>interface-path-id</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config)# interface GigabitEthernet 1/0/0/0</pre>	<p>Enters the interface configuration mode for the Ethernet interface you want to add to the Bundle.</p> <p>Enter the GigabitEthernet or TenGigE 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>Note</p> <ul style="list-style-type: none"> A VLAN bundle is not active until you add an Ethernet interface on both ends of the link bundle.
Step 20	<p>bundle id <i>bundle-id</i> [mode {active on passive}]</p> <p>Example:</p>	Adds an Ethernet interface to the bundle you configured in Step 2 through Step 13.

	Command or Action	Purpose
	RP/0/RP0/CPU0:router (config-if) # bundle-id 3	<p>To enable active or passive LACP on the bundle, include the optional mode active or mode passive keywords in the command string.</p> <p>To add the interface to the bundle without LACP support, include the optional mode on keywords with the command string.</p> <p>Note</p> <ul style="list-style-type: none"> If you do not specify the mode keyword, the default mode is on (LACP is not run over the port).
Step 21	<p>no shutdown</p> <p>Example:</p> <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.
Step 22	Repeat Step 19 through Step 21 to add more Ethernet interfaces to the VLAN bundle.	—
Step 23	<p>end or commit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router (config-subif) # end</pre> <p>or</p> <pre>RP/0/RP0/CPU0:router (config-subif) # commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <code>Uncommitted changes found, commit them before exiting (yes/no/cancel)?</code> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.
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>show bundle Bundle-Ether <i>bundle-id</i> [reasons]</p> <p>Example:</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 show bundle Bundle-Ether command displays information about the specified bundle. If your bundle has been configured properly and is carrying traffic, the State field in the show bundle Bundle-Ether command output</p>

	Command or Action	Purpose
		will show the number “4,” which means the specified VLAN bundle port is “distributing.”
Step 26	show ethernet trunk bundle-ether <i>instance</i> Example: RP/0/RP0/CPU0:router# show ethernet trunk bundle-ether 5	(Optional) Displays the interface configuration. The Ethernet bundle instance range is from 1 through 65535.

Configuration Examples for Link Bundling

This section contains the following examples:

Example: Configuring an Ethernet Link Bundle

The following 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
```

This example shows the configuration in the case of a mixed speed bundle:

```
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)# interface bundle-ether 50
RP/0/RP0/CPU0:Router(config-if)# rootlacp 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)#
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-if)# bundle id 3 mode active
```

```
RP/0/RP0/CPU0:Router(config-if)# bundleport-priority 2
RP/0/RP0/CPU0:Router(config-if)# no shutdown
RP/0/RP0/CPU0:Router(config-if)#
RP/0/RP0/CPU0:Router(config-if)# bundleport-priority 2
RP/0/RP0/CPU0:Router(config-if)# no shutdown
RP/0/RP0/CPU0:Router(config-if)# root
RP/0/RP0/CPU0:Router(config)# commit
RP/0/RP0/CPU0:Router(config)# end
```

The following output is shown for the **show bundle bundle-ether** command:

show bundle bundle-ether50

```
Bundle-Ether50
Status: Up
Local links <active/standby/configured>: 4 / 0 / 4
Local bandwidth <effective/available>: 130000000 (130000000) kbps
MAC address (source): 0011.2233.4458 (Chassis pool)
Inter-chassis link: No
Minimum active links / bandwidth: 1 / 1 kbps
Maximum active links: 64
Wait while timer: 2000 ms
Load balancing: Default
LACP: Operational
Flap suppression timer: Off
Cisco extensions: Disabled
mLACP: Not configured
IPv4 BFD: Not configured
```

Port	Device	State	Port ID	B/W, kbps
Te0/0/0/11	Local	Active	0x8000, 0x0002	10000000
Link is Active				
Te0/0/0/16	Local	Active	0x8000, 0x0003	10000000
Link is Active				
Te0/0/0/27	Local	Active	0x8000, 0x0004	10000000
Link is Active				
Hu0/6/0/1	Local	Active	0x8000, 0x0001	100000000
Link is Active				

In order to view the weight of a mixed speed bundle, run the **show bundle load-balancing** command. The following is the truncated output of this command.

```
show bundle load-balancing bundle-ether50 location 0/0/cpu0
```

```
<snip>
```

```
Bundle-Ether50
Type: Ether (L3)
Members <current/max>: 4/64
Total Weighting: 13
Load balance: Default
Locality threshold: 65
Avoid rebalancing? False
Sub-interfaces: 1
```

```
Member Information:
Port: LON ULID BW
-----
Hu0/6/0/1 0 0 10
Te0/0/0/11 1 1 1
Te0/0/0/16 2 2 1
```

Example: Configuring a VLAN Link Bundle

```

Te0/0/0/27      3  3  1

Platform Information:
=====

      * Bundle Summary Information *
      -----

Interface       : Bundle-Ether50   Ifhandle       : 0x00000ce0
Lag ID          : 1                 Virtual Port    : 255
Number of Members : 4                 Local to LC     : Yes
Hash Modulo Index : 13
MGSCP Operational Mode : No

Member Information:
LON   Interface   ifhandle      SFP  port  slot  remote/rack_id
-----
0     Hu0/6/0/1    0x100001c0    648  116  8     0/0
1     Te0/0/0/11   0x04000380    65   9    2     0/0
2     Te0/0/0/16   0x040004c0    67   8    2     0/0
3     Te0/0/0/27   0x04000780    72   4    2     0/0

</snip>

```

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)# 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 active
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 a POS Link Bundle

The following example shows how to join two ports to form a Packet-over-SONET (POS) link bundle:

```

RP/0/RP0/CPU0:Router# config
RP/0/RP0/CPU0:Router(config)# interface Bundle-POS 5
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 bandwidth 620000
RP/0/RP0/CPU0:Router(config-if)# exit
RP/0/RP0/CPU0:Router(config)# interface POS 0/0/1/1
RP/0/RP0/CPU0:Router(config-if)# bundle id 5
RP/0/RP0/CPU0:Router(config-if)# no shutdown
RP/0/RP0/CPU0:Router(config-if)# exit

```

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 gigabitethernet 0/0/0/1
  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 gigabitethernet 0/0/0/1
  bundle id 1 mode active
  lacp period short
  commit

```

Router B

```

config
interface gigabitethernet 0/0/0/1
  bundle id 1 mode active

```

```
lacp period short
commit
```

Router A

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

Router B

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

Router A

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

Router B

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