Implementing BFD

This module describes the configuration of bidirectional forwarding detection (BFD) on the Cisco NCS 6000 Series Router.

Bidirectional forwarding detection (BFD) provides low-overhead, short-duration detection of failures in the path between adjacent forwarding engines. BFD allows a single mechanism to be used for failure detection over any media and at any protocol layer, with a wide range of detection times and overhead. The fast detection of failures provides immediate reaction to failure in the event of a failed link or neighbor.

Feature History for Implementing Bidirectional Forwarding Detection

Release	Modification
Release 4.3.1	Support for these features was added: • BFD over MPLS Traffic Engineering LSPs

Release	Modification
Release 5.0.0	This feature was introduced.
Release 5.2.5	Support for BFD over Logical Bundle was added.

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Prerequisites for Implementing BFD

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 following prerequisites are required to implement BFD:

- If enabling BFD on Multiprotocol Label Switching (MPLS), an installed composite PIE file including the MPLS package, or a composite-package image is required. For Border Gateway Protocol (BGP), Intermediate System-to-Intermediate System (IS-IS), Static, and Open Shortest Path First (OSPF), an installed Cisco IOS XR IP Unicast Routing Core Bundle image is required.
- Interior Gateway Protocol (IGP) is activated on the router if you are using IS-IS or OSPF.
- To enable BFD for a neighbor, the neighbor router must support BFD.
- You can use the **echo ipv4 source** command to specify the IP address that you want to use as the source address.
- To support BFD on bundle member links, be sure that the following requirements are met:
  - The routers on either end of the bundle are connected back-to-back without a Layer 2 switch in between.
  - For a BFD session to start, any one of the following configurations or states are present on the bundle member:

    Link Aggregation Control Protocol (LACP) Distributing state is reached, –Or–

    EtherChannel or POS Channel is configured, –Or–

    Hot Standby and LACP Collecting state is reached.

Restrictions for Implementing BFD

These restrictions apply to BFD:

- Demand mode is not supported in Cisco IOS XR software.
- BFD echo mode is not supported for these features:
  - BFD for IPv4 on bundled VLANs
  - BFD for IPv6 (global and link-local addressing)
  - BFD with uRPF (IPv4)
  - Rack reload and online insertion and removal (OIR) when a BFD bundle interface has member links that span multiple racks
  - BFD for Multihop Paths
  - BFD over PWHE
  - BFD over GRE
- BFD for IPv6 has these restrictions:
-
- For BFD on bundle member links, only a single BFD session for each bundle member link is created, monitored, and maintained for the IPv4 addressing type only. IPv6 and VLAN links in a bundle have the following restrictions:

- IPv6 states are not explicitly monitored on a bundle member and they inherit the state of the IPv4 BFD session for that member interface.
- VLAN subinterfaces on a bundle member also inherit the BFD state from the IPv4 BFD session for that member interface. VLAN subinterfaces are not explicitly monitored on a bundle member.

- Echo latency detection and echo validation are not supported on bundle interfaces.
- Only BGP application is supported on BFD for Multihop Paths.
- Only static and BGP applications are supported on BFD over PWHE.
- Only static, OSPF, IS-IS, and BGP applications are supported on BFD over GRE.

Information About BFD

Differences in BFD in Cisco IOS XR Software and Cisco IOS Software

If you are already familiar with BFD configuration in Cisco IOS software, be sure to consider the following differences in BFD configuration in the Cisco IOS XR software implementation:

- In Cisco IOS XR software, BFD is an application that is configured under a dynamic routing protocol, such as an OSPF or BGP instance. This is not the case for BFD in Cisco IOS software, where BFD is only configured on an interface.
- In Cisco IOS XR software, a BFD neighbor is established through routing. The Cisco IOS **bfd neighbor** interface configuration command is not supported in Cisco IOS XR software.
- Instead of using a dynamic routing protocol to establish a BFD neighbor, you can establish a specific BFD peer or neighbor for BFD responses in Cisco IOS XR software using a method of static routing to define that path. In fact, you must configure a static route for BFD if you do not configure BFD under a dynamic routing protocol in Cisco IOS XR software.
- A router running BFD in Cisco IOS software can designate a router running BFD in Cisco IOS XR software as its peer using the **bfd neighbor** command; the Cisco IOS XR router must use dynamic routing or a static route back to the Cisco IOS router to establish the peer relationship. See the BFD Peers on Routers Running Cisco IOS and Cisco IOS XR Software: Example.

BFD Modes of Operation

Cisco IOS XR software supports the asynchronous mode of operation only, with or without using echo packets. Asynchronous mode without echo will engage various pieces of packet switching paths on local and remote systems. However, asynchronous mode with echo is usually known to provide slightly wider test coverage as echo packets are self-destined packets which traverse same packet switching paths as normal traffic on the remote system.

BFD echo mode is enabled by default for the following interfaces:

- For IPv4 on member links of BFD bundle interfaces.
- For IPv4 on other physical interfaces whose minimum interval is less than two seconds.

When BFD is running asynchronously without echo packets (Figure 35), the following occurs:

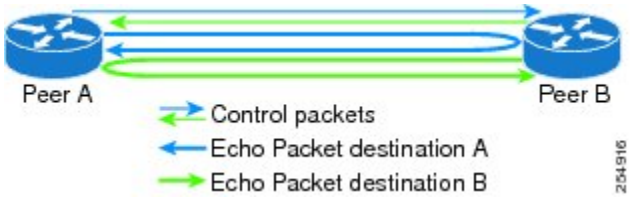
- Each system periodically sends BFD control packets to one another. Packets sent by BFD router "Peer A" to BFD router "Peer B" have a source address from Peer A and a destination address for Peer B.
- Control packet streams are independent of each other and do not work in a request/response model.
- If a number of packets in a row are not received by the other system, the session is declared down.

Figure 1: BFD Asynchronous Mode Without Echo Packets

When BFD is running asynchronously with echo packets (Figure 36), the following occurs:

- BFD echo packets are looped back through the forwarding path only of the BFD peer and are not processed by any protocol stack. So, packets sent by BFD router "Peer A" can be sent with both the source and destination address of Peer A.
- BFD echo packets are sent in addition to BFD control packets.

Figure 2: BFD Asynchronous Mode With Echo Packets



For more information about control and echo packet intervals in asynchronous mode, see the BFD Packet Intervals and Failure Detection.

BFD Packet Information

BFD Source and Destination Ports

BFD payload control packets are encapsulated in UDP packets, using destination port 3784 and source port 49152. Even on shared media, like Ethernet, BFD control packets are always sent as unicast packets to the BFD peer.

Echo packets are encapsulated in UDP packets, as well, using destination port 3785 and source port 3785.

The BFD over bundle member feature increments each byte of the UDP source port on echo packets with each transmission. UDP source port ranges from 0xC0C0 to 0xFFFF. For example:

1st echo packet: 0xC0C0

2nd echo packet: 0xC1C1

3rd echo packet: 0xC2C2

The UDP source port is incremented so that sequential echo packets are hashed to deviating bundle member.

BFD Packet Intervals and Failure Detection

BFD uses configurable intervals and multipliers to specify the periods at which control and echo packets are sent in asynchronous mode and their corresponding failure detection.

There are differences in how these intervals and failure detection times are implemented for BFD sessions running over physical interfaces, and BFD sessions on bundle member links.

BFD Packet Intervals on Physical Interfaces

When BFD is running over physical interfaces, echo mode is used only if the configured interval is less than two seconds.

BFD sessions running over physical interfaces when echo mode is enabled send BFD control packets at a slow rate of every two seconds. There is no need to duplicate control packet failure detection at a fast rate because BFD echo packets are already being sent at fast rates and link failures will be detected when echo packets are not received within the echo failure detection time.

BFD Packet Intervals on Bundle Member Links

On each bundle member interface, BFD asynchronous mode control packets run at user-configurable interval and multiplier values, even when echo mode is running.

However, on a bundle member interface when echo mode is enabled, BFD asynchronous mode must continue to run at a fast rate because one of the requirements of enabling BFD echo mode is that the bundle member interface is available in BFD asynchronous mode.

The maximum echo packet interval for BFD on bundle member links is the minimum of either 30 seconds or the asynchronous control packet failure detection time.

When echo mode is disabled, the behavior is the same as BFD over physical interfaces, where sessions exchange BFD control packets at the configured rate.

Control Packet Failure Detection In Asynchronous Mode

Control packet failure in asynchronous mode without echo is detected using the values of the minimum interval (bfd minimum-interval for non-bundle interfaces, and bfd address-family ipv4 minimum-interval for bundle interfaces) and multiplier (bfd multiplier for non-bundle interfaces, and bfd address-family ipv4 multiplier for bundle interfaces) commands.

For control packet failure detection, the local multiplier value is sent to the neighbor. A failure detection timer is started based on (*I* x *M*), where *I* is the negotiated interval, and *M* is the multiplier provided by the remote end.

Whenever a valid control packet is received from the neighbor, the failure detection timer is reset. If a valid control packet is not received from the neighbor within the time period (*I* x *M*), then the failure detection timer is triggered, and the neighbor is declared down.

Echo Packet Failure Detection In Asynchronous Mode

The standard echo failure detection scheme is done through a counter that is based on the value of the **bfd multiplier** command on non-bundle interfaces, and the value of the **bfd address-family ipv4 multiplier** command for bundle interfaces.

This counter is incremented each time the system sends an echo packet, and is reset to zero whenever *any* echo packet is received, regardless of the order that the packet was sent in the echo packet stream.

Under ideal conditions, this means that BFD generally detects echo failures that exceed the period of time (*I* x *M*) or (*I* x *M* x *M*) for bundle interfaces, where:

- *I*—Value of the minimum interval (bfd minimum-interval for non-bundle interfaces, and **bfd address-family ipv4 minimum-interval** for bundle interfaces).
- *M*—Value of the multiplier (**bfd multiplier** for non-bundle interfaces, and **bfd address-family ipv4 multiplier** for bundle interfaces) commands.

So, if the system transmits one additional echo packet beyond the multiplier count without receipt of any echo packets, echo failure is detected and the neighbor is declared down (See Example 2).

However, this standard echo failure detection does not address latency between transmission and receipt of any specific echo packet, which can build beyond (*I* x *M*) over the course of the BFD session. In this case, BFD will not declare a neighbor down as long as any echo packet continues to be received within the multiplier window and resets the counter to zero. You can configure BFD to measure this latency for non-bundle interfaces. For more information, see Example 3 and the Echo Packet Latency.

Echo Failure Detection Examples

This section provides examples of several scenarios of standard echo packet processing and failure detection without configuration of latency detection for non-bundle interfaces. In these examples, consider an interval of 50 ms and a multiplier of 3.

Note The same interval and multiplier counter scheme for echo failure detection is used for bundle interfaces, but the values are determined by the **bfd address-family ipv4 multiplier** and **bfd address-family ipv4 minimum-interval commands**, and use a window of (*I* x *M* x *M*) to detect absence of receipt of echo packets.

Example 1

The following example shows an ideal case where each echo packet is returned before the next echo is transmitted. In this case, the counter increments to 1 and is returned to 0 before the next echo is sent and no echo failure occurs. As long as the roundtip delay for echo packets in the session is less than the minimum interval, this scenario occurs:

```
Time (T): Echo#1 TX (count = 1)
T + 1 ms: Echo#1 RX (count = 0)
T + 50 ms: Echo#2 TX (count = 1)
T + 51 ms: Echo#2 RX (count = 0)
T + 100 ms: Echo#3 TX (count = 1)
T + 101 ms: Echo#3 RX (count = 0)
T + 150 ms: Echo#4 TX (count = 1)
T + 151 ms: Echo#4 RX (count = 0)
```

Example 2

The following example shows the absence in return of any echo packets. After the transmission of the fourth echo packet, the counter exceeds the multiplier value of 3 and echo failure is detected. In this case, echo failure detection occurs at the 150 ms (*I* x *M*) window:

```
Time (T): Echo#1 TX (count = 1)
T + 50 ms: Echo#2 TX (count = 2)
```

```
T + 100 ms: Echo#3 TX (count = 3)
T + 150 ms: Echo#4 TX (count = 4 -> echo failure
```

Example 3

The following example shows an example of how roundtrip latency can build beyond (*I* x *M*) for any particular echo packet over the course of a BFD session using the standard echo failure detection, but latency between return of echo packets overall in the session never exceeds the (*I* x *M*) window and the counter never exceeds the multiplier, so the neighbor is not declared down.

Note You can configure BFD to detect roundtrip latency on non-bundle interfaces using the **echo latency detect** command beginning.

```
Time (T): Echo#1 TX (count = 1)
T + 1 ms: Echo#1 RX (count = 0)
T + 50 ms: Echo#2 TX (count = 1)
T + 51 ms: Echo#2 RX (count = 0)
T + 100 ms: Echo#3 TX (count = 1)
T + 150 ms: Echo#4 TX (count = 2)
T + 151 ms: Echo#3 RX (count = 0; ~50 ms roundtrip latency)
T + 200 ms: Echo#5 TX (count = 1)
T + 250 ms: Echo#6 TX (count = 2)
T + 251 ms: Echo#4 RX (count = 0; ~100 ms roundtrip latency)
T + 300 ms: Echo#7 TX (count = 1)
T + 350 ms: Echo#8 TX (count = 2)
T + 351 ms: Echo#5 RX (count = 0; ~150 ms roundtrip latency)
T + 451 ms: Echo#6 RX (count = 0; ~200 ms roundtrip latency; no failure detection)
T + 501 ms: Echo#7 RX (count = 0; ~200 ms roundtrip latency; no failure detection)
T + 551 ms: Echo#8 RX (count = 0; ~200 ms roundtrip latency; no failure detection)
```

Looking at the delay between receipt of echo packets for the BFD session, observe that no latency is beyond the (I x M) window:

```
Echo#1 RX - Echo#2 RX: 50 ms
Echo#2 RX - Echo#3 RX: 100ms
Echo#3 RX - Echo#4 RX: 100ms
Echo#4 RX - Echo#5 RX: 100ms
Echo#5 RX - Echo#6 RX: 100ms
Echo#6 RX - Echo#7 RX: 50ms
Echo#7 RX - Echo#8 RX: 50ms
```

Summary of Packet Intervals and Failure Detection Times for BFD on Bundle Interfaces

For BFD on bundle interfaces, with a session interval *I* and a multiplier *M*, these packet intervals and failure detection times apply for BFD asynchronous mode (Table 1: BFD Packet Intervals and Failure Detection Time Examples on Bundle Interfaces):

- Value of *I*—Minimum period between sending of BFD control packets.
- Value of *I* x *M*
  - BFD control packet failure detection time.
  - Minimum period between sending of BFD echo packets.

The BFD control packet failure detection time is the maximum amount of time that can elapse without receipt of a BFD control packet before the BFD session is declared down.

- Value of (*I* x *M*) x *M*—BFD echo packet failure detection time. This is the maximum amount of time that can elapse without receipt of a BFD echo packet (using the standard multiplier counter scheme as described in Echo Packet Failure Detection In Asynchronous Mode) before the BFD session is declared down.

Table 1: BFD Packet Intervals and Failure Detection Time Examples on Bundle Interfaces

Configured Async Control Packet Interval (ms) (bfd address-family ipv4 minimum-interval)	Configured Multiplier (bfd address-family ipv4 multiplier)	Async Control Packet Failure Detection Time (ms) (Interval x Multiplier)	Echo Packet Interval (Async Control Packet Failure Detection Time)	Echo Packet Failure Detection Time (Echo Interval x Multiplier)
33	3	99	99	297
50	3	150	150	450
75	4	300	300	1200
200	2	400	400	800
2000	3	6000	6000	18000
15000	3	45000	30000[1]	90000

[1] The maximum echo packet interval for BFD on bundle member links is the minimum of either 30 seconds or the asynchronous control packet failure detection time.

Echo Packet Latency

BFD only detects an absence of receipt of echo packets, not a specific delay for TX/RX of a particular echo packet. In some cases, receipt of BFD echo packets in general can be within their overall tolerances for failure detection and packet transmission, but a longer delay might develop over a period of time for any particular roundtrip of an echo packet (See Example 3).

You can configure the router to detect the actual latency between transmitted and received echo packets on non-bundle interfaces and also take down the session when the latency exceeds configured thresholds for that roundtrip latency. For more information, see the Configuring BFD Session Teardown Based on Echo Latency Detection.

In addition, you can verify that the echo packet path is within specified latency tolerances before starting a BFD session. With echo startup validation, an echo packet is periodically transmitted on the link while it is down to verify successful transmission within the configured latency before allowing the BFD session to change state. For more information, see the Delaying BFD Session Startup Until Verification of Echo Path and Latency.

Priority Settings for BFD Packets

For all interfaces under over-subscription, the internal priority needs to be assigned to remote BFD Echo packets, so that these BFD packets are not overwhelmed by other data packets. In addition, CoS values need to be set appropriately, so that in the event of an intermediate switch, the reply back of remote BFD Echo packets are protected from all other packets in the switch.

As configured CoS values in ethernet headers may not be retained in Echo messages, CoS values must be explicitly configured in the appropriate egress QoS service policy. CoS values for BFD packets attached to a traffic class can be set using the set cos command. For more information on configuring class-based unconditional packet marking, see "Configuring Modular QoS Packet Classification" in the *Modular QoSConfiguration Guide for Cisco NCS 6000 Series Routers*.

BFD for IPv4

Cisco IOS XR software supports bidirectional forwarding detection (BFD) singlehop and multihop for both IPv4 and IPv6.

In BFD for IPv4 single-hop connectivity, Cisco IOS XR software supports both asynchronous mode and echo mode over physical numbered Packet-over-SONET/SDH (POS) and Gigabit Ethernet links, as follows:

- Echo mode is initiated only after a session is established using BFD control packets. Echo mode is always enabled for BFD bundle member interfaces. For physical interfaces, the BFD minimum interval must also be less than two seconds to support echo packets.
- BFD echo packets are transmitted over UDP/IPv4 using source and destination port 3785. The source address of the IP packet is the IP address of the output interface (default) or the address specified with the **router-id** command if set or the address specified in the **echo ipv4 source** command, and the destination address is the local interface address.
- BFD asynchronous packets are transmitted over UDP and IPv4 using source port 49152 and destination port 3784. For asynchronous mode, the source address of the IP packet is the local interface address, and the destination address is the remote interface address.

Note BFD multihop does not support echo mode.

Consider the following guidelines when configuring BFD on Cisco IOS XR software:

- BFD is a fixed-length hello protocol, in which each end of a connection transmits packets periodically over a forwarding path. Cisco IOS XR software supports BFD adaptive detection times.
- BFD can be used with the following applications:
  - BGP
  - IS-IS
  - EIGRP
  - OSPF

    and OSPFv3
  - MPLS Traffic Engineering (MPLS-TE)

- Static routes (IPv4 and IPv6)
- Hot Standby Router Protocol (HSRP)
- Virtual Router Redundancy Protocol (VRRP)

Note When multiple applications share the same BFD session, the application with the most aggressive timer wins locally. Then, the result is negotiated with the peer router.

- BFD is supported for connections over the following interface types:
  - Gigabit Ethernet (GigE)
  - Hundred Gigabit Ethernet (HundredGigE)
  - Ten Gigabit Ethernet (TenGigE)
  - Packet-over-SONET/SDH (POS)
  - Serial
  - Virtual LAN (VLAN)
  - Logical interfaces such as bundles, GRE, PWHE

Note BFD is supported on the above interface types and not on logical interfaces unless specifically stated. For example, BFD cannot be configured on BVI and interflex.

- Cisco IOS XR software supports BFD Version 0 and Version 1. BFD sessions are established using either version, depending upon the neighbor. BFD Version 1 is the default version and is tried initially for session creation.

BFD for IPv6

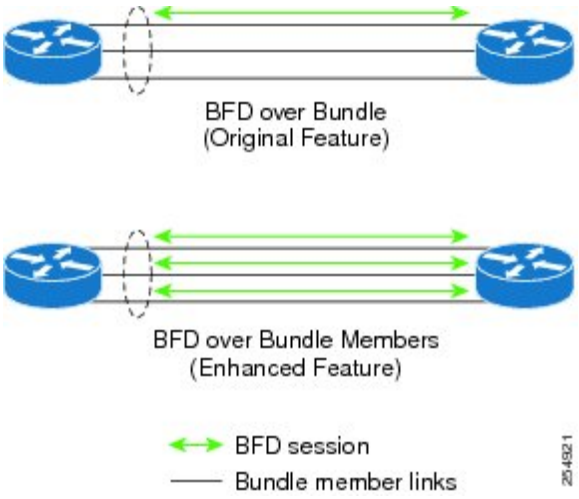
BFD on Bundled VLANs

- **Note** For more information on configuring a VLAN bundle, see the module.

BFD Over Member Links on Link Bundles

BFD supports BFD sessions on individual physical bundle member links to monitor Layer 3 connectivity on those links, rather than just at a single bundle member as in prior releases (Figure 37).

Figure 3: BFD Sessions in Original BFD Over Bundles and Enhanced BFD Over Bundle Member Links Architectures



When you run BFD on link bundles, you can run an independent BFD session on each underlying physical interface that is part of that bundle.

When BFD is running on a link bundle member, these layers of connectivity are effectively tested as part of the interface state monitoring for BFD:

- Layer 1 physical state
- Layer 2 Link Access Control Protocol (LACP) state
- Layer 3 BFD state

The BFD agent on each bundle member link monitors state changes on the link. BFD agents for sessions running on bundle member links communicate with a bundle manager. The bundle manager determines the state of member links and the overall availability of the bundle. The state of the member links contributes to the overall state of the bundle based on the threshold of minimum active links or minimum active bandwidth that is configured for that bundle.

Overview of BFD State Change Behavior on Member Links and Bundle Status

This section describes when bundle member link states are characterized as active or down, and their effect on the overall bundle status:

- You can configure BFD on a bundle member interface that is already active or one that is inactive. For the BFD session to be *up* using LACP on the interface, LACP must have reached the *distributing* state.

  A BFD member link is “IIR Active” if the link is in LACP distributing state and the BFD session is up.

- A BFD member link is “IIR Attached” when the BFD session is down, unless a LACP state transition is received.
- You can configure timers for up to 3600 seconds (1 hour) to allow for delays in receipt of BFD state change notifications (SCNs) from peers before declaring a link bundle BFD session down. The configurable timers apply to these situations:
  - BFD session startup (**bfd address-family ipv4 timers start** command)—Number of seconds to allow after startup of a BFD member link session for the expected notification from the BFD peer

to be received to declare the session up. If the SCN is not received after that period of time, the BFD session is declared down.

- Notification of removal of BFD configuration by a neighbor (**bfd address-family ipv4 timers nbr-unconfig** command)—Number of seconds to allow after receipt of notification that BFD configuration has been removed by a BFD neighbor so that any configuration inconsistency between the BFD peers can be fixed. If the BFD configuration issue is not resolved before the specified timer is reached, the BFD session is declared down.

- A BFD session sends a DOWN notification when one of these occurs:
  - The BFD configuration is removed on the local member link.

    The BFD system notifies the peer on the neighbor router that the configuration is removed. The BFD session is removed from the bundle manager without affecting other bundle member interfaces or the overall bundle state.

  - A member link is removed from the bundle.

    Removing a member link from a bundle causes the bundle member to be removed ungracefully. The BFD session is deleted and BFD on the neighboring router marks the session DOWN rather than NBR_CONFIG_DOWN.

- In these cases, a DOWN notification is not sent, but the internal infrastructure treats the event as if a DOWN has occurred:
  - The BFD configuration is removed on a neighboring router and the neighbor unconfiguration timer (if configured) expires.

    The BFD system notifies the bundle manager that the BFD configuration has been removed on the neighboring router and, if **bfd timers nbr-unconfig** is configured on the link, the timer is started. If the BFD configuration is removed on the local router before the timer expires, then the timer is stopped and the behavior is as expected for BFD configuration removal on the local router.

    If the timer expires, then the behavior is the same as for a BFD session DOWN notification.

  - The session startup timer expires before notification from the BFD peer is received.

- The BFD session on a bundle member sends BFD state change notifications to the bundle manager. Once BFD state change notifications for bundle member interfaces are received by the bundle manager, the bundle manager determines whether or not the corresponding bundle interface is usable.

- A threshold for the minimum number of active member links on a bundle is used by the bundle manager to determine whether the bundle remains active, or is down based on the state of its member links. When BFD is started on a bundle that is already active, the BFD state of the bundle is declared when the BFD state of all the existing active members is known.

  Whenever a member's state changes, the bundle manager determines if the number of active members is less than the minimum number of active links threshold. If so, then the bundle is placed, or remains, in DOWN state. Once the number of active links reaches the minimum threshold then the bundle returns to UP state.

- Another threshold is configurable on the bundle and is used by the bundle manager to determine the minimum amount of active bandwidth to be available before the bundle goes to DOWN state. This is configured using the **bundle minimum-active bandwidth** command.

- The BFD server responds to information from the bundle manager about state changes for the bundle interface and notifies applications on that interface while also sending system messages and MIB traps.

BFD for MultiHop Paths

BFD multihop (BFD-MH) is a BFD session between two addresses that are not on the same subnet. An example of BFD-MH is a BFD session between PE and CE loopback addresses or BFD sessions between routers that are several hops away. The applications that support BFD multihop are external and internal BGP. BFD multihop supports BFD on arbitrary paths, which can span multiple network hops.

The BFD Multihop feature provides sub-second forwarding failure detection for a destination more than one hop, and up to 255 hops, away. The **bfd multihop ttl-drop-threshold** command can be used to drop BFD packets coming from neighbors exceeding a certain number of hops. BFD multihop is supported on all currently supported media-type for BFD singlehop.

Setting up BFD Multihop

A BFD multihop session is set up between a unique source-destination address pair provided by the client. A session can be set up between two endpoints that have IP connectivity. For BFD Multihop, IPv4 addresses in both global routing table and in a VRF is supported.

BFD IPv6 Multihop

Bidirectional Forwarding Detection (BFD) Multihop IPv6 (MHv6) feature supports BFD sessions between interfaces that are multiple hops away. The BFD MHv6 enables a BFD session between two addresses (BFD session between provider edge (PE) and customer edge (CE) loopback addresses or BFD session between routers that are several time-to-live (TTL) hops away) that are not on the same interface. BFD MHv6 is supported in a typical CE – PE configuration over loopback as well as the physical interface addresses, with static IPv6 routes using iBGP/eBGP as the client application. BFD Multihop provides continuity check (CC) on arbitrary paths spanning multiple network hops and provides failure notifications for Multihop protocols like BGP, MPLS Traffic Engineering, and LDP. The Cisco IOS XR Software BFD MHv6 implementation is in accordance with *IETF RFC5883 for IPv6 networks*.

Note BFD over 6VPE/6PE is not supported. The BFD MHv6 does not support BFD echo mode.

BFD IPv6 Multihop removes the restriction of a single path IPv6 BFD session, where the BFD neighbor is always one hop away, and the BFD Agent in the line card always receives or transmits BFD packets over a local interface on the same line card.

The BFD switching mechanism for IPv6 Multihop link is employed when the BFD packets are transmitted from one end point node to the other. The BFD punting mechanism is employed when BFD packets are received at the remote end point node.

BFD over MPLS Traffic Engineering LSPs

Bidirectional Forwarding Detection (BFD) over MPLS Traffic Engineering Label Switched Paths (LSPs) feature in Cisco IOS XR Software detects MPLS Label Switched Path LSP data plane failures. Since the control plane processing required for BFD control packets is relatively smaller than the processing required

for LSP Ping messages, BFD can be deployed for faster detection of data plane failure for a large number of LSPs.

The BFD over MPLS TE LSPs implementation in Cisco IOS XR Software is based on *RFC 5884: Bidirectional Forwarding Detection (BFD) for MPLS Label Switched Paths (LSPs)*. LSP Ping is an existing mechanism for detecting MPLS data plane failures and for verifying the MPLS LSP data plane against the control plane. BFD can be used for for detecting MPLS data plane failures, but not for verifying the MPLS LSP data plane against the control plane. A combination of LSP Ping and BFD provides faster data plane failure detection on a large number of LSPs.

The BFD over MPLS TE LSPs is used for networks that have deployed MPLS as the multi service transport and that use BFD as fast failure detection mechanism to enhance network reliability and up time by using BFD as fast failure detection traffic black holing.

BFD over MPLS TE LSPs support:

- BFD async mode (BFD echo mode is not supported)
- IPv4 only, since MPLS core is IPv4
- BFD packets will carry IP DSCP 6 (Internet Control)
- Use of BFD for TE tunnel bring up, re-optimization, and path protection (Standby and FRR)
- Fastest detection time (100 ms x 3 = 300 ms)
- Optional Periodic LSP ping verification after BFD session is up
- Dampening to hold-down BFD failed path-option
- There are two ways in which the BFD packets from tail-end to head-end will be used:
  - BFD packets from tail-end to head-end will be IP routed (IPv4 Multihop - port# 4784)
  - BFD packets from tail-end to head-end will be Label Switched (port# 3784) if MPLS LDP is available in Core with label path from tail-end to head-end.

Bidirectional Forwarding Detection over Logical Bundle

The Bidirectional Forwarding Detection (BFD) over Logical Bundle feature implements and deploys BFD over bundle interfaces based on RFC 5880. The BFD over Logical Bundle (BLB) feature replaces the BVLAN feature and resolves certain interoperability issues with other platforms that run BFD over bundle interface in pure RFC5880 fashion. These platforms include products of other vendors, as well as other Cisco products running Cisco IOS or Cisco Nexus OS software.

BLB is a multipath (MP) single-hop session. BLB requires limited knowledge of the bundle interfaces on which the sessions run; this is because BFD treats the bundle as one big pipe. To function, BLB requires only information about IP addresses, interface types, and caps on bundle interfaces. Information such as list of bundle members, member states, and configured minimum or maximum bundle links are not required.

BLB is supported on IPv4 address, IPv6 global address, and IPv6 link-local address. The current version of the software supports a total of 200 sessions (which includes BFD Single hop for physical and logical sub-interfaces; BFD over Bundle (BoB) and BLB) per line card. The maximum processing capability of BFD control packets, per line card, has also increased to 7000 pps (packets per second).

Note ISSU is not supported for BFD over Logical Bundle feature.

BFD Object Tracking

Object Tracking is enhanced to support BFD to track the reachability of remote IP addresses.This will enable complete detection and HSRP switch over to happen within a time of less than one second as BFD can perform the detection in the order of few milliseconds

How to Configure BFD

BFD Configuration Guidelines

Before you configure BFD, consider the following guidelines:

- FRR/TE, FRR/IP, and FRR/LDP using BFD is supported on POS interfaces and Ethernet interfaces.
- To establish a BFD neighbor in Cisco IOS XR software, BFD must either be configured under a dynamic routing protocol, or using a static route.
- The maximum rate in packets-per-second (pps) for BFD sessions is linecard-dependent. If you have multiple linecards supporting BFD, then the maximum rate for BFD sessions per system is the supported linecard rate multiplied by the number of linecards.

  To know the BFD scale values, use the **show bfd summary** command.
- When using BFD with OSPF, consider the following guidelines:
  - BFD establishes sessions from a neighbor to a designated router (DR) or backup DR (BDR) only when the neighbor state is *full*.
  - BFD does not establish sessions between DR-Other neighbors (for example, when their OSPF states are both 2-way).

Caution If you are using BFD with Unicast Reverse Path Forwarding (uRPF) on a particular interface, then you need to use the **echo disable** command to disable echo mode on that interface; otherwise, echo packets will be rejected. For more information, see the Disabling Echo Mode. To enable or disable IPv4 uRPF checking on an IPv4 interface, use the **[no] ipv4 verify unicast source reachable-via** command in interface configuration mode.

Configuring BFD Under a Dynamic Routing Protocol or Using a Static Route

Enabling BFD on a BGP Neighbor

BFD can be enabled per neighbor, or per interface. This task describes how to enable BFD for BGP on a neighbor router. To enable BFD per interface, use the steps in the Enabling BFD for OSPF on an Interface.

Note BFD neighbor router configuration is supported for BGP only.

SUMMARY STEPS

1. **configure**
2. **router bgp** *autonomous-system-number*
3. **bfd minimum-interval** *milliseconds*
4. **bfd multiplier** *multiplier*
5. **neighbor** *ip-address*
6. **remote-as** *autonomous-system-number*
7. **bfd fast-detect**
8. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**router bgp** *autonomous-system-number* **Example:** `RP/0/RP0/CPU0:router(config)# router bgp 120`	Enters BGP configuration mode, allowing you to configure the BGP routing process. Use the **show bgp** command in XR EXEC mode to obtain the *autonomous-system-number* for the current router.
Step 3	**bfd minimum-interval** *milliseconds* **Example:** `RP/0/RP0/CPU0:router(config-bgp)# bfd minimum-interval 6500`	Sets the BFD minimum interval. Range is 15-30000 milliseconds.
Step 4	**bfd multiplier** *multiplier* **Example:** `RP/0/RP0/CPU0:router(config-bgp)# bfd multiplier 7`	Sets the BFD multiplier.
Step 5	**neighbor** *ip-address* **Example:** `RP/0/RP0/CPU0:router(config-bgp)# neighbor 172.168.40.24`	Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address as a BGP peer. This example configures the IP address 172.168.40.24 as a BGP peer.

	Command or Action	Purpose
Step 6	**remote-as** *autonomous-system-number* **Example:** `RP/0/RP0/CPU0:router(config-bgp-nbr)# remote-as 2002`	Creates a neighbor and assigns it a remote autonomous system. This example configures the remote autonomous system to be 2002.
Step 7	**bfd fast-detect** **Example:** `RP/0/RP0/CPU0:router(config-bgp-nbr)# bfd fast-detect`	Enables BFD between the local networking devices and the neighbor whose IP address you configured to be a BGP peer in Step 5. In the example in Step 5, the IP address 172.168.40.24 was set up as the BGP peer. In this example, BFD is enabled between the local networking devices and the neighbor 172.168.40.24.
Step 8	**commit**	

Enabling BFD for OSPF on an Interface

The following procedures describe how to configure BFD for Open Shortest Path First (OSPF) on an interface. The steps in the procedure are common to the steps for configuring BFD on IS-IS and MPLS-TE; only the command mode differs.

Note BFD per interface configuration is supported for OSPF, OSFPv3, IS-IS, and MPLS-TE only. For information about configuring BFD on an OSPFv3 interface, see Enabling BFD for OSPFv3 on an Interface.

SUMMARY STEPS

1. **configure**
2. **bfd multipath include location***node-id*
3. **router ospf** *process-name*
4. **bfd minimum-interval** *milliseconds*
5. **bfd multiplier** *multiplier*
6. **area** *area-id*
7. **interface** *type interface-path-id*
8. **bfd fast-detect**
9. **commit**
10. **show run router ospf**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**bfd multipath include location***node-id* **Example:**	(Optional) Enables BFD multipath for the specified bundle on the interface. This step is required for bundle interfaces.

	Command or Action	Purpose
	`RP/0/RP0/CPU0:router(config)# bfd multipath include location 0/0/CPU0`	**Note** • This step must be repeated for every line card that has a member link in the bundle interface.
Step 3	**router ospf** *process-name* **Example:** `RP/0/RP0/CPU0:router(config)# router ospf 0`	Enters OSPF configuration mode, allowing you to configure the OSPF routing process. Use the **show ospf** command in XR EXEC mode to obtain the process-name for the current router. **Note** • To configure BFD for IS-IS or MPLS-TE, enter the corresponding configuration mode. For example, for MPLS-TE, enter MPLS-TE configuration mode.
Step 4	**bfd minimum-interval** *milliseconds* **Example:** `RP/0/RP0/CPU0:router(config-ospf)# bfd minimum-interval 6500`	Sets the BFD minimum interval. Range is 15-30000 milliseconds. This example sets the BFD minimum interval to 6500 milliseconds.
Step 5	**bfd multiplier** *multiplier* **Example:** `RP/0/RP0/CPU0:router(config-ospf)# bfd multiplier 7`	Sets the BFD multiplier. This example sets the BFD multiplier to 7.
Step 6	**area** *area-id* **Example:** `RP/0/RP0/CPU0:router(config-ospf)# area 0`	Configures an Open Shortest Path First (OSPF) area. Replace *area-id* with the OSPF area identifier.
Step 7	**interface** *type interface-path-id* **Example:** `RP/0/RP0/CPU0:router(config-ospf-ar)# interface gigabitEthernet 0/3/0/1`	Enters interface configuration mode and specifies the interface name and notation *rack/slot/module/port*. • The example indicates a Gigabit Ethernet interface in modular services card slot 3.
Step 8	**bfd fast-detect** **Example:** `RP/0/RP0/CPU0:router(config-ospf-ar-if)# bfd fast-detect`	Enables BFD to detect failures in the path between adjacent forwarding engines.
Step 9	**commit**	
Step 10	**show run router ospf** **Example:**	Verify that BFD is enabled on the appropriate interface.

	Command or Action	Purpose
	`RP/0/RP0/CPU0:router(config-ospf-ar-if)# show run router ospf`	

Enabling BFD for OSPFv3 on an Interface

The following procedures describe how to configure BFD for OSPFv3 on an interface. The steps in the procedure are common to the steps for configuring BFD on IS-IS, and MPLS-TE; only the command mode differs.

Note BFD per-interface configuration is supported for OSPF, OSPFv3, IS-IS, and MPLS-TE only. For information about configuring BFD on an OSPF interface, see Enabling BFD for OSPF on an Interface.

SUMMARY STEPS

1. **configure**
2. **router ospfv3** *process-name*
3. **bfd minimum-interval** *milliseconds*
4. **bfd multiplier** *multiplier*
5. **area** *area-id*
6. **interface** *type interface-path-id*
7. **bfd fast-detect**
8. **commit**
9. **show run router ospfv3**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**router ospfv3** *process-name* **Example:** `RP/0/RP0/CPU0:routerconfig)# router ospfv3 0`	Enters OSPFv3 configuration mode, allowing you to configure the OSPFv3 routing process. Use the **show ospfv3** command in XR EXEC mode to obtain the process name for the current router. **Note** • To configure BFD for IS-IS or MPLS-TE, enter the corresponding configuration mode. For example, for MPLS-TE, enter MPLS-TE configuration mode.
Step 3	**bfd minimum-interval** *milliseconds* **Example:** `RP/0/RP0/CPU0:router(config-ospfv3)# bfd minimum-interval 6500`	Sets the BFD minimum interval. Range is 15-30000 milliseconds. This example sets the BFD minimum interval to 6500 milliseconds.

	Command or Action	Purpose
Step 4	**bfd multiplier** *multiplier* **Example:** `RP/0/RP0/CPU0:router(config-ospfv3)# bfd multiplier 7`	Sets the BFD multiplier. This example sets the BFD multiplier to 7.
Step 5	**area** *area-id* **Example:** `RP/0//CPU0:router(config-ospfv3)# area 0`	Configures an OSPFv3 area. Replace *area-id* with the OSPFv3 area identifier.
Step 6	**interface** *type interface-path-id* **Example:** `RP/0/RP0/CPU0:router(config-ospfv3-ar)# interface gigabitEthernet 0/1/5/0`	Enters interface configuration mode and specifies the interface name and notation *rack/slot/module/port*. • The example indicates a Gigabit Ethernet interface in modular services card slot 1.
Step 7	**bfd fast-detect** **Example:** `RP/0/RP0/CPU0:router(config-ospfv3-ar-if)# bfd fast-detect`	Enables BFD to detect failures in the path between adjacent forwarding engines.
Step 8	**commit**	
Step 9	**show run router ospfv3** **Example:** `RP/0/RP0/CPU0:router(config-ospfv3-ar-if)#show run router ospfv3`	Verifies that BFD is enabled on the appropriate interface.

Configuring BFD on Bundle Member Links

Prerequisites for Configuring BFD on Bundle Member Links

The physical interfaces that are members of a bundle must be directly connected between peer routers without any switches in between.

Specifying the BFD Destination Address on a Bundle

To specify the BFD destination address on a bundle, complete these steps:

DETAILED STEPS

SUMMARY STEPS

1. **configure**
2. **interface Bundle-Ether** | **Bundle-POS**] *bundle-id*

3. **bfd address-family ipv4 destination** *ip-address*
4. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**interface Bundle-Ether** | **Bundle-POS**] *bundle-id* **Example:** `RP/0/RP0/CPU0:router(config)# interface Bundle-Ether 1`	Enters interface configuration mode for the specified bundle ID.
Step 3	**bfd address-family ipv4 destination** *ip-address* **Example:** `RP/0/RP0/CPU0:router(config-if)# bfd address-family ipv4 destination 10.20.20.1`	Specifies the primary IPv4 address assigned to the bundle interface on a connected remote system, where *ip-address* is the 32-bit IP address in dotted-decimal format (A.B.C.D).
Step 4	**commit**	

Enabling BFD Sessions on Bundle Members

To enable BFD sessions on bundle member links, complete these steps:

SUMMARY STEPS

1. **configure**
2. **interface Bundle-Ether** \| **Bundle-POS**] *bundle-id*
3. **bfd address-family ipv4 fast-detect**
4. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**interface Bundle-Ether** | **Bundle-POS**] *bundle-id* **Example:** `RP/0/RP0/CPU0:router(config)# interface Bundle-Ether 1`	Enters interface configuration mode for the specified bundle ID.
Step 3	**bfd address-family ipv4 fast-detect** **Example:** `RP/0/RP0/CPU0:router(config-if)# bfd address-family ipv4 fast-detect`	Enables IPv4 BFD sessions on bundle member links.

	Command or Action	Purpose
Step 4	**commit**	

Configuring the Minimum Thresholds for Maintaining an Active Bundle

The bundle manager uses two configurable minimum thresholds to determine whether a bundle can be brought up or remain up, or is down, based on the state of its member links.

- Minimum active number of links
- Minimum active bandwidth available

Whenever the state of a member changes, the bundle manager determines whether the number of active members or available bandwidth is less than the minimum. If so, then the bundle is placed, or remains, in DOWN state. Once the number of active links or available bandwidth reaches one of the minimum thresholds, then the bundle returns to the UP state.

To configure minimum bundle thresholds, complete these steps:

SUMMARY STEPS

1. **configure**
2. **interface Bundle-Ether** *bundle-id*
3. **bundle minimum-active bandwidth** *kbps*
4. **bundle minimum-active links** *links*
5. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**interface Bundle-Ether** *bundle-id* **Example:** `RP/0/RP0/CPU0:router(config)# interface Bundle-Ether 1`	Enters interface configuration mode for the specified bundle ID.
Step 3	**bundle minimum-active bandwidth** *kbps* **Example:** `RP/0/RP0/CPU0:router(config-if)# bundle minimum-active bandwidth 580000`	Sets the minimum amount of bandwidth required before a bundle can be brought up or remain up. The range is from 1 through a number that varies depending on the platform and the bundle type.
Step 4	**bundle minimum-active links** *links* **Example:** `RP/0/RP0/CPU0:router(config-if)# bundle minimum-active links 2`	Sets the number of active links required before a bundle can be brought up or remain up. The range is from 1 to 32. **Note** • When BFD is started on a bundle that is already active, the BFD state of the bundle is declared when the BFD state of all the existing active members is known.

	Command or Action	Purpose
Step 5	**commit**	

Configuring BFD Packet Transmission Intervals and Failure Detection Times on a Bundle

BFD asynchronous packet intervals and failure detection times for BFD sessions on bundle member links are configured using a combination of the **bfd address-family ipv4 minimum-interval** and **bfd address-family ipv4 multiplier** interface configuration commands on a bundle.

The BFD control packet interval is configured directly using the **bfd address-family ipv4 minimum-interval** command. The BFD echo packet interval and all failure detection times are determined by a combination of the interval and multiplier values in these commands. For more information see the BFD Packet Intervals and Failure Detection.

To configure the minimum transmission interval and failure detection times for BFD asynchronous mode control and echo packets on bundle member links, complete these steps:

DETAILED STEPS

SUMMARY STEPS

1. **configure**
2. **interface Bundle-Ether** | **Bundle-POS**] *bundle-id*
3. **bfd address-family ipv4 minimum-interval** *milliseconds*
4. **bfd address-family ipv4 multiplier** *multiplier*
5. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**interface Bundle-Ether** | **Bundle-POS**] *bundle-id* **Example:** `RP/0/RP0/CPU0:router(config)# interface Bundle-Ether 1`	Enters interface configuration mode for the specified bundle ID.
Step 3	**bfd address-family ipv4 minimum-interval** *milliseconds* **Example:** `RP/0/RP0/CPU0:router(config-if)#bfd address-family ipv4 minimum-interval 2000`	

	Command or Action	Purpose
	Note • Specifies the minimum interval, in milliseconds, for asynchronous mode control packets on IPv4 BFD sessions on bundle member links. The range is from 15 to 30000.Although the command allows you to configure a minimum of 15 ms, the supported minimum on the Cisco NCS 6000 Series Router is 33 ms.	
Step 4	**bfd address-family ipv4 multiplier** *multiplier* **Example:** `RP/0/RP0/CPU0:router(config-if)#bfd address-family ipv4 multiplier 30`	Specifies a number that is used as a multiplier with the minimum interval to determine BFD control and echo packet failure detection times and echo packet transmission intervals for IPv4 BFD sessions on bundle member links. The range is from 2 to 50. The default is 3. **Note** • Although the command allows you to configure a minimum of 2, the supported minimum is 3.
Step 5	**commit**	

Configuring Allowable Delays for BFD State Change Notifications Using Timers on a Bundle

The BFD system supports two configurable timers to allow for delays in receipt of BFD SCNs from peers before declaring a BFD session on a link bundle member down:

- BFD session startup
- BFD configuration removal by a neighbor

For more information about how these timers work and other BFD state change behavior, see the Overview of BFD State Change Behavior on Member Links and Bundle Status.

To configure the timers that allow for delays in receipt of BFD SCNs from peers, complete these steps:

SUMMARY STEPS

1. **configure**
2. **interface Bundle-Ether** | **Bundle-POS**] *bundle-id*
3. **bfd address-family ipv4 timers start** *seconds*
4. **bfd address-family ipv4 timers nbr-unconfig** *seconds*
5. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	

	Command or Action	Purpose
Step 2	**interface Bundle-Ether** | **Bundle-POS**] *bundle-id* **Example:** `RP/0/RP0/CPU0:router(config)# interface Bundle-Ether 1`	Enters interface configuration mode for the specified bundle ID.
Step 3	**bfd address-family ipv4 timers start** *seconds* **Example:** `RP/0/RP0/CPU0:router(config-if)#`	Specifies the number of seconds after startup of a BFD member link session to wait for the expected notification from the BFD peer to be received, so that the session can be declared up. If the SCN is not received after that period of time, the BFD session is declared down. The range is 60 to 3600.
Step 4	**bfd address-family ipv4 timers nbr-unconfig** *seconds* **Example:** `RP/0/RP0/CPU0:router(config-if)#`	Specifies the number of seconds to wait after receipt of notification that BFD configuration has been removed by a BFD neighbor, so that any configuration inconsistency between the BFD peers can be fixed. If the BFD configuration issue is not resolved before the specified timer is reached, the BFD session is declared down. The range is 30 to 3600.
Step 5	**commit**	

Enabling Echo Mode to Test the Forwarding Path to a BFD Peer

BFD echo mode is enabled by default for the following interfaces:

- For IPv4 on member links of BFD bundle interfaces.
- For IPv4 on other physical interfaces whose minimum interval is less than two seconds.

Note If you have configured a BFD minimum interval greater than two seconds on a physical interface using the **bfd minimum-interval** command, then you will need to change the interval to be less than two seconds to support and enable echo mode. This does not apply to bundle member links, which always support echo mode.

Overriding the Default Echo Packet Source Address

If you do not specify an echo packet source address, then BFD uses the IP address of the output interface as the default source address for an echo packet.

You can use the **echo ipv4 source** command in BFD or interface BFD configuration mode to specify the IP address that you want to use as the echo packet source address.

You can override the default IP source address for echo packets for BFD on the entire router, or for a particular interface.

Specifying the Echo Packet Source Address Globally for BFD

To specify the echo packet source IP address globally for BFD on the router, complete the following steps:

SUMMARY STEPS

1. **configure**
2. **bfd**
3. **echo ipv4 source** *ip-address*
4. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**bfd** **Example:** `RP/0/RP0/CPU0:router(config)# bfd`	Enters BFD configuration mode.
Step 3	**echo ipv4 source** *ip-address* **Example:** `RP/0/RP0/CPU0:router(config-bfd)# echo ipv4 source 10.10.10.1`	Specifies an IPv4 address to be used as the source address in BFD echo packets, where *ip-address* is the 32-bit IP address in dotted-decimal format (A.B.C.D).
Step 4	**commit**	

Specifying the Echo Packet Source Address on an Individual Interface or Bundle

To specify the echo packet source IP address on an individual BFD interface or bundle, complete the following steps:

SUMMARY STEPS

1. **configure**
2. **bfd**
3. **interface** type interface-path-id
4. **echo ipv4 source** *ip-address*
5. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**bfd** **Example:**	Enters BFD configuration mode.

	Command or Action	Purpose
	`RP/0/RP0/CPU0:router(config)# bfd`	
Step 3	**interface** type interface-path-id **Example:** `RP/0/RP0/CPU0:router(config-bfd)# interface gigabitEthernet 0/1/5/0`	Enters BFD interface configuration mode for a specific interface. In BFD interface configuration mode, you can specify an IPv4 address on an individual interface.
Step 4	**echo ipv4 source** *ip-address* **Example:** `RP/0/RP0/CPU0:router(config-bfd)# echo ipv4 source 10.10.10.1`	Specifies an IPv4 address to be used as the source address in BFD echo packets, where *ip-address* is the 32-bit IP address in dotted-decimal format (A.B.C.D).
Step 5	**commit**	

Configuring BFD Session Teardown Based on Echo Latency Detection

You can configure BFD sessions on non-bundle interfaces to bring down a BFD session when it exceeds the configured echo latency tolerance.

To configure BFD session teardown using echo latency detection, complete the following steps.

Before you enable echo latency detection, be sure that your BFD configuration supports echo mode.

Echo latency detection is not supported on bundle interfaces.

DETAILED STEPS

SUMMARY STEPS

1. **configure**
2. **bfd**
3. **echo latency detect** [**percentage** *percent-value* [**count** *packet-count*]
4. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**bfd** **Example:** `RP/0/RP0/CPU0:router(config)# bfd`	Enters BFD configuration mode.
Step 3	**echo latency detect** [**percentage** *percent-value* [**count** *packet-count*] **Example:**	Enables echo packet latency detection over the course of a BFD session, where:

	Command or Action	Purpose
	`RP/0/RP0/CPU0:router(config-bfd)# echo latency detect`	• **percentage** *percent-value*—Specifies the percentage of the echo failure detection time to be detected as bad latency. The range is 100 to 250. The default is 100. • **count** *packet-count*—Specifies a number of consecutive packets received with bad latency that will take down a BFD session. The range is 1 to 10. The default is 1.
Step 4	**commit**	

Delaying BFD Session Startup Until Verification of Echo Path and Latency

You can verify that the echo packet path is working and within configured latency thresholds before starting a BFD session on non-bundle interfaces.

Note Echo startup validation is not supported on bundle interfaces.

To configure BFD echo startup validation, complete the following steps.

Before you begin

Before you enable echo startup validation, be sure that your BFD configuration supports echo mode.

SUMMARY STEPS

1. **configure**
2. **bfd**
3. **echo startup validate** [**force**]
4. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**bfd** **Example:** `RP/0/0RP0RSP0/CPU0:router(config)# bfd`	Enters BFD configuration mode.
Step 3	**echo startup validate** [**force**] **Example:** `RP/0/0RP0RSP0/CPU0:router(config-bfd)# echo startup validate`	Enables verification of the echo packet path before starting a BFD session, where an echo packet is periodically transmitted on the link to verify successful transmission within the configured latency before allowing the BFD session to change state.

	Command or Action	Purpose
		When the **force** keyword is not configured, the local system performs echo startup validation if the following conditions are true: • The local router is capable of running echo (echo is enabled for this session). • The remote router is capable of running echo (received control packet from remote system has non-zero “Required Min Echo RX Interval" value). When the force keyword is configured, the local system performs echo startup validation if following conditions are true. • The local router is capable of running echo (echo is enabled for this session). • The remote router echo capability is not considered (received control packet from remote system has zero or non-zero "Required Min Echo RX Interval" value).
Step 4	**commit**	

Disabling Echo Mode

BFD does not support asynchronous operation in echo mode in certain environments. Echo mode should be disabled when using BFD for the following applications or conditions:

- BFD with uRPF (IPv4)
- To support rack reload and online insertion and removal (OIR) when a BFD bundle interface has member links that span multiple racks.

Note BFD echo mode is automatically disabled for BFD on physical interfaces when the minimum interval is greater than two seconds. The minimum interval does not affect echo mode on BFD bundle member links. BFD echo mode is also automatically disabled for BFD on bundled VLANs and IPv6 (global and link-local addressing).

You can disable echo mode for BFD on the entire router, or for a particular interface.

Disabling Echo Mode on a Router

To disable echo mode globally on the router complete the following steps:

DETAILED STEPS

SUMMARY STEPS

1. **configure**
2. **bfd**
3. **echo disable**
4. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**bfd** **Example:** `RP/0/RP0/CPU0:router(config)# bfd`	Enters BFD configuration mode.
Step 3	**echo disable** **Example:** `RP/0/RP0/CPU0:router(config-bfd)# echo disable`	Disables echo mode on the router.
Step 4	**commit**	

Disabling Echo Mode on an Individual Interface

The following procedures describe how to disable echo mode on an interface .

SUMMARY STEPS

1. **configure**
2. **bfd**
3. **interface** *type interface-path-id*
4. **echo disable**
5. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**bfd** **Example:** `RP/0/RP0/CPU0:router(config)# bfd`	Enters BFD configuration mode.
Step 3	**interface** *type interface-path-id* **Example:**	Enters BFD interface configuration mode for a specific interface or bundle. In BFD interface configuration mode, you can disable echo mode on an individual interface or bundle.

	Command or Action	Purpose
	`RP/0/RP0/CPU0:router(config-bfd)# interface gigabitEthernet 0/1/5/0`	
Step 4	**echo disable** **Example:** `RP/0/RP0/CPU0:router(config-bfd-if)# echo disable`	Disables echo mode on the specified individual interface or bundle.
Step 5	**commit**	

Minimizing BFD Session Flapping Using BFD Dampening

To configure BFD dampening to control BFD session flapping, complete the following steps.

SUMMARY STEPS

1. **configure**
2. **bfd**
3. **dampening** [**bundle-member**] {**initial-wait** | **maximum-wait** | **secondary-wait**} *milliseconds*
4. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**bfd** **Example:** `RP/0/RP0/CPU0:router(config)# bfd`	Enters BFD configuration mode.
Step 3	**dampening** [**bundle-member**] {**initial-wait** | **maximum-wait** | **secondary-wait**} *milliseconds* **Example:** `RP/0/RP0/CPU0:router(config-bfd)# dampening initial-wait 30000`	Specifies delays in milliseconds for BFD session startup to control flapping. The value for **maximum-wait** should be greater than the value for **initial-wait**. The dampening values can be defined for bundle member interfaces and for the non-bundle interfaces.
Step 4	**commit**	

Enabling and Disabling IPv6 Checksum Support

By default, IPv6 checksum calculations on UDP packets are enabled for BFD on the router.

You can disable IPv6 checksum support for BFD either on the entire router, or for a particular interface. A misconfiguration may occur if the IPv6 checksum support is enabled at one router, but disabled at the other. Therefore, you should enable or disable IPv6 checksum support at both the routers.

These sections describe about:

Note The command-line interface (CLI) is slightly different in BFD configuration and BFD interface configuration. For BFD configuration, the **disable** keyword is not optional. Therefore, to enable BFD configuration in that mode, you need to use the **no** form of the command.

Enabling and Disabling IPv6 Checksum Calculations for BFD on a Router

To enable or disable IPv6 checksum calculations globally on the router complete the following steps:

SUMMARY STEPS

1. **configure**
2. **bfd**
3. **ipv6 checksum** [**disable**]
4. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**bfd** **Example:** `RP/0/RP0/CPU0:router(config)# bfd`	Enters BFD configuration mode.
Step 3	**ipv6 checksum** [**disable**] **Example:** `RP/0/RP0/CPU0:router(config-bfd-if)# ipv6 checksum disable`	Enables IPv6 checksum support on the interface. To disable, use the **disable** keyword.
Step 4	**commit**	

Enabling and Disabling IPv6 Checksum Calculations for BFD on an Individual Interface or Bundle

The following procedures describe how to enable or disable IPv6 checksum calculations on an interface or bundle .

DETAILED STEPS

SUMMARY STEPS

1. **configure**
2. **bfd**
3. **interface** *type interface-path-id*
4. **ipv6 checksum** [**disable**]

5. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**bfd** **Example:** `RP/0/RP0/CPU0:router(config)# bfd`	Enters BFD configuration mode.
Step 3	**interface** *type interface-path-id* **Example:** `RP/0/RP0/CPU0:router(config-bfd)# interface gigabitEthernet 0/1/5/0`	Enters BFD interface configuration mode for a specific interface.
Step 4	**ipv6 checksum** [**disable**] **Example:** `RP/0/RP0/CPU0:router(config-bfd-if)# ipv6 checksum`	Enables IPv6 checksum support on the interface. To disable, use the **disable** keyword.
Step 5	**commit**	

Clearing and Displaying BFD Counters

The following procedure describes how to display and clear BFD packet counters. You can clear packet counters for BFD sessions that are hosted on a specific node or on a specific interface.

SUMMARY STEPS

1. **show bfd counters**[**ipv4** | **ipv6** | **all**] **packet interface** *type interface-path-id*] **location** *node-id*
2. **clear bfd counters** [**ipv4** | **ipv6** |**all**] **packet** [**interface** *type interface-path-id*] **location** *node-id*
3. **show bfd counters** [**[ipv4** | **ipv6** | **all**] **packet** [**interface** *type interface-path-id*] **location** *node-id*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**show bfd counters**[**ipv4**	**ipv6**	**all**] **packet interface** *type interface-path-id*] **location** *node-id* **Example:** `RP/0/RP0/CPU0:router#show bfd counters all packet location 0/3/cpu0`	Displays the BFD counters for IPv4 packets, IPv6 packets, or all packets.

	Command or Action	Purpose
Step 2	**clear bfd counters** [**ipv4** | **ipv6** |**all**] **packet** [**interface** *type interface-path-id*] **location** *node-id* **Example:** `RP/0/RP0/CPU0:router# clear bfd counters all packet location 0/3/cpu0`	Clears the BFD counters for IPv4 packets, IPv6 packets, or all packets.
Step 3	**show bfd counters** [**[ipv4** | **ipv6** | **all**] **packet** [**interface** *type interface-path-id*] **location** *node-id* **Example:** `RP/0/RP0/CPU0:router# show bfd counters all packet location 0/3/cpu0`	Verifies that the BFD counters for IPv4 packets, IPv6 packets, or all packets have been cleared.

Configuring Coexistence Between BFD over Bundle (BoB) and BFD over Logical Bundle (BLB)

Perform this task to configure the coexistence mechanism between BoB and BLB:

Before you begin

You must configure one or more linecards to allow hosting of MP BFD sessions. If no linecards are included, linecards groups will not be formed, and consequently no BFD MP sessions are created. For default settings of group size and number, at least two lines with the **bfd multiple-paths include location** *node-id* command and valid line cards must be added to the configuration for the algorithm to start forming groups and BFD MP sessions to be established.

As sample configuration is provided:

```
(config)#bfd multipath include location 0/0/CPU0
(config)#bfd multipath include location 0/1/CPU0
```

SUMMARY STEPS

1. **configure**
2. **bfd**
3. Use one of these commands:
   - **bundle coexistence bob-blb inherit**
   - **bundle coexistence bob-blb logical**
4. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	

	Command or Action	Purpose
Step 2	**bfd** **Example:** `RP/0/RP0/CPU0:router(config)#bfd`	Configures Bi-directional Forwarding Detection (BFD) and enters global BFD configuration mode.

Step 3	Use one of these commands:
	• **bundle coexistence bob-blb inherit**
	• **bundle coexistence bob-blb logical**
	Example:
	`RP/0/RP0/CPU0:router(config-bfd)#bundle coexistence bob-blb inherit`
	Or
	`RP/0/RP0/CPU0:router(config-bfd)#bundle coexistence bob-blb logical`
		Configures the coexistence mechanism between BoB and BLB.
		• **inherit**—Use the **inherit** keyword to configure "inherited" coexistence mode.
		• **logical**—Use the **logical** keyword to configure "logical" coexistence mode.

Step 4	**commit**	

Configuring BFD over MPLS Traffic Engineering LSPs

Enabling BFD Parameters for BFD over TE Tunnels

BFD for TE tunnel is enabled at the head-end by configuring BFD parameters under the tunnel. When BFD is enabled on the already up tunnel, TE waits for the bringup timeout before bringing down the tunnel. BFD is disabled on TE tunnels by default. Perform these tasks to configure BFD parameters and enable BFD over TE Tunnels.

Note BFD paces the creation of BFD sessions by limiting LSP ping messages to be under 50 PPS to avoid variations in CPU usage.

SUMMARY STEPS

1. **configure**
2. **interface tunnel-te** *interface-number*
3. **bfd fast-detect**
4. **bfd minimum-interval***milliseconds*
5. **bfd multiplier** *number*
6. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	

	Command or Action	Purpose
Step 2	**interface tunnel-te** *interface-number* **Example:** `RP/0/RP0/CPU0:router(config)#interface tunnel-te 65535`	Configures MPLS Traffic Engineering (MPLS TE) tunnel interface and enters into MPLS TE tunnel interface configuration mode.
Step 3	**bfd fast-detect** **Example:** `RP/0/RP0/CPU0:router(config-if)#bfd fast-detect`	Enables BFD fast detection.
Step 4	**bfd minimum-interval***milliseconds* **Example:** `RP/0/RP0/CPU0:router(config-if)#bfd minimum-interval 2000`	Configures hello interval in milliseconds. Hello interval range is 100 to 30000 milliseconds. Default hello interval is 100 milliseconds
Step 5	**bfd multiplier** *number* **Example:** `RP/0/RP0/CPU0:router(config-if)#bfd multiplier 5`	Configures BFD multiplier detection. BFD multiplier range is 3 to 10. Default BFD multiplier is 3.
Step 6	**commit**	

What to do next

Configure BFD bring up timeout interval.

Once LSP is signaled and BFD session is created, TE allows given time for the BFD session to come up. If BFD session fails to come up within timeout, the LSP is torn down. Hence it is required to configure BFD bring up timeout

Configuring BFD Bring up Timeout

Perform these steps to configure BFD bring up timeout interval. The default bring up timeout interval is 60 seconds.

Before you begin

BFD must be enabled under MPLS TE tunnel interface.

SUMMARY STEPS

1. **configure**
2. **interface tunnel-te** *interface-number*
3. **bfd bringup-timeout** *seconds*
4. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	

	Command or Action	Purpose
Step 2	**interface tunnel-te** *interface-number* **Example:** `RP/0/RP0/CPU0:router(config)#interface tunnel-te 65535`	Configures MPLS Traffic Engineering (MPLS TE) tunnel interface and enters into MPLS TE tunnel interface configuration mode.
Step 3	**bfd bringup-timeout** *seconds* **Example:** `RP/0/RP0/CPU0:router(config-if)#bfd bringup-timeout 2400`	Enables the time interval (in seconds) to wait for the BFD session to come up. Bring up timeout range is 6 to 3600 seconds. Default bring up timeout interval is 60 seconds.
Step 4	**commit**	

What to do next

Configure BFD dampening parameters to bring up the TE tunnel and to avoid signaling churn in the network.

Configuring BFD Dampening for TE Tunnels

When BFD session fails to come up, TE exponentially backs off using the failed path-option to avoid signaling churn in the network.

Perform these steps to configure dampening intervals to bring the TE tunnel up.

Before you begin

- BFD must be enabled under MPLS TE tunnel interface.
- BFD bring up timeout interval must be configured using the **bfd bringup-timeout** command.

SUMMARY STEPS

1. **configure**
2. **interface tunnel-te** *interface-number*
3. **bfd dampening initial-wait** *milliseconds*
4. **bfd dampening maximum-wait** *milliseconds*
5. **bfd dampening secondary-wait** *milliseconds*
6. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**interface tunnel-te** *interface-number* **Example:** `RP/0/RP0/CPU0:router(config)#interface tunnel-te 65535`	Configures MPLS Traffic Engineering (MPLS TE) tunnel interface and enters into MPLS TE tunnel interface configuration mode.

	Command or Action	Purpose
Step 3	**bfd dampening initial-wait** *milliseconds* **Example:** `RP/0/RP0/CPU0:router(config-if)#bfd dampening initial-wait 360000`	Configures the initial delay interval before bringing up the tunnel. The initial-wait bring up delay time interval range is 1 to 518400000 milliseconds. Default initial-wait interval is 16000 milliseconds. **Note** This option brings up the TE tunnel with the previous signaled bandwidth.
Step 4	**bfd dampening maximum-wait** *milliseconds* **Example:** `RP/0/RP0/CPU0:router(config-if)#bfd dampening maximum-wait 700000`	Configures the maximum delay interval before bringing up the tunnel. The maximum-wait bring up delay time interval range is 1 to 518400000 milliseconds. Default initial-wait interval is 600000 milliseconds. **Note** This option brings up the TE tunnel with the configured bandwidth.
Step 5	**bfd dampening secondary-wait** *milliseconds* **Example:** `RP/0/RP0/CPU0:router(config-if)#bfd dampening secondary-wait 30000`	Configures the secondary delay interval before bringing up the tunnel. The secondary-wait bring up delay time interval range is 1 to 518400000 milliseconds. Default secondary-wait interval is 20000 milliseconds.
Step 6	**commit**	

What to do next

Configure periodic LSP ping option.

Configuring Periodic LSP Ping Requests

Perform this task to configure sending periodic LSP ping requests with BFD TLV, after BFD session comes up.

Before you begin

BFD must be enabled under MPLS TE tunnel interface.

SUMMARY STEPS

1. **configure**
2. **interface tunnel-te** *interface-number*
3. Use one of these commands:
   - **bfd lsp-ping interval** *300*
4. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**interface tunnel-te** *interface-number* **Example:** `RP/0/RP0/CPU0:router(config)#interface tunnel-te 65535`	Configures MPLS Traffic Engineering (MPLS TE) tunnel interface and enters into MPLS TE tunnel interface configuration mode.

Step 3	Use one of these commands:
	• **bfd lsp-ping interval** *300*
	Example:
	`RP/0/RP0/CPU0:router(config-if)#bfd lsp-ping interval 300`
	Or
	`RP/0/RP0/CPU0:router(config-if)#bfd lsp-ping disable`
		Sets periodic interval for LSP ping requests or disables LSP ping requests.
		• **interval** *seconds*—Sets periodic LSP ping request interval in seconds. The interval range is 60 to 3600 seconds. Default interval is 120 seconds.
		• **disable**—Disables periodic LSP ping requests.
		Periodic LSP ping request is enabled by default. The default interval for ping requests is 120 seconds. BFD paces LSP ping to be under 50 ping per seconds (PPS). Thus ping interval is honored; however, this is not guaranteed unless configuring an interval between 60 and 3600 seconds.

Step 4	**commit**	

What to do next

Configure BFD at the tail-end.

Configuring BFD at the Tail End

Use the tail end global configuration commands to set the BFD minimum-interval and BFD multiplier parameters for all BFD over LSP sessions. The ranges and default values are the same as the BFD head end configuration values. BFD will take the maximum value set between head end minimum interval and tail end minimum interval.

Perform these tasks to configure BFD at the tail end.

SUMMARY STEPS

1. **configure**
2. **mpls traffic-eng bfd lsp tailminimum-interval** *milliseconds*
3. **mpls traffic-eng bfd lsp tailmultiplier** *number*
4. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	

	Command or Action	Purpose
Step 2	**mpls traffic-eng bfd lsp tailminimum-interval** *milliseconds* **Example:** `RP/0/RP0/CPU0:router(config)#mpls traffic-eng bfd lsp tail minimum-interval 20000`	Configures hello interval in milliseconds. Hello interval range is 100 to 30000 milliseconds. Default hello interval is 100 milliseconds
Step 3	**mpls traffic-eng bfd lsp tailmultiplier** *number* **Example:** `RP/0/RP0/CPU0:router(config)#mpls traffic-eng bfd lsp tail multiplier 5`	Configures BFD multiplier detection. BFD multiplier detect range is 3 to 10. Default BFD multiplier is 3.
Step 4	**commit**	

What to do next

Configure **bfd multipath include location** *node-id* command to include specified line cards to host BFD multiple path sessions.

Configuring BFD over LSP Sessions on Line Cards

BFD over LSP sessions, both head-end and tail-end, will be hosted on line cards with following configuration enabled.

SUMMARY STEPS

1. **configure**
2. **bfd**
3. **multipath include location** *node-id*
4. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**bfd** **Example:** `RP/0/RP0/CPU0:router(config)# bfd`	Enters BFD configuration mode.
Step 3	**multipath include location** *node-id* **Example:** `RP/0/RP0/CPU0:router(config-bfd)# multipath include location 0/1/CPU0`	Configures BFD multiple path on specific line card. BFD over LSP sessions, both head-end and tail-end, will be hosted on line cards. BFD over LSP sessions, both head-end and tail-end, will be distributed to line cards 0/1/CPU0 and 0/2/CPU0 according to internal selection mechanism.
Step 4	**commit**	

Configuring BFD Object Tracking:

SUMMARY STEPS

1. **configure**
2. **track** *track-name*
3. **type bfdrtr rate** *tx-rate*
4. **debounce***debounce*
5. **interface** *if-name*
6. **destaddress** *dest_addr*
7. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure**	
Step 2	**track** *track-name* **Example:** `RP/0/RP0/CPU0:router(config)# track track1`	Enters track configuration mode. • *track-name*—Specifies a name for the object to be tracked.
Step 3	**type bfdrtr rate** *tx-rate* **Example:** `RP/0/RP0/CPU0:router(config-track)# type bfdrtr rate 4`	tx_rate - time in msec at which the BFD should probe the remote entity
Step 4	**debounce***debounce* **Example:** `RP/0/RP0/CPU0:router(config-if)# debounce 10`	debounce - count of consecutive BFD probes whose status should match before BFD notifies OT
Step 5	**interface** *if-name* **Example:** `RP/0/RP0/CPU0:router(config-track-line-prot)# interface atm 0/2/0/0.1`	if_name - interface name on the source to be used by BFD to check the remote BFD status.
Step 6	**destaddress** *dest_addr* **Example:** `RP/0/RP0/CPU0:router(config-if)#destaddress 1.2.3.4`	dest_addr - IPV4 address of the remote BFD entity being tracked.
Step 7	**commit**	

Configuration Examples for Configuring BFD

BFD Over BGP: Example

The following example shows how to configure BFD between autonomous system 65000 and neighbor 192.168.70.24:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#router bgp 65000
RP/0/RP0/CPU0:router(config-bgp)#bfd multiplier 2
RP/0/RP0/CPU0:router(config-bgp)#bfd minimum-interval 20
RP/0/RP0/CPU0:router(config-bgp)#neighbor 192.168.70.24
RP/0/RP0/CPU0:router(config-bgp-nbr)#remote-as 2
RP/0/RP0/CPU0:router(config-bgp-nbr)#bfd fast-detect
RP/0/RP0/CPU0:router(config-bgp-nbr)#commit
RP/0/RP0/CPU0:router(config-bgp-nbr)#end
RP/0/RP0/CPU0:router#show run router bgp
```

BFD Over OSPF: Examples

The following example shows how to enable BFD for OSPF on a Gigabit Ethernet interface:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#router ospf 0
RP/0/RP0/CPU0:router(config-ospf)#area 0
RP/0/RP0/CPU0:router(config-ospf-ar)#interface gigabitEthernet 0/3/0/1
RP/0/RP0/CPU0:router(config-ospf-ar-if)#bfd fast-detect
RP/0/RP0/CPU0:router(config-ospf-ar-if)#commit
RP/0/RP0/CPU0:router(config-ospf-ar-if)#end

RP/0/RP0/CPU0:router#show run router ospf

router ospf 0
area 0
interface GigabitEthernet0/3/0/1
bfd fast-detect
```

The following example shows how to enable BFD for OSPFv3 on a Gigabit Ethernet interface:

BFD Over Static Routes: Examples

The following example shows how to enable BFD on an IPv4 static route. In this example, BFD sessions are established with the next-hop 10.3.3.3 when it becomes reachable.

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#router static
RP/0/RP0/CPU0:router(config-static)#address-family ipv4 unicast
RP/0/RP0/CPU0:router(config-static)#10.2.2.0/24 10.3.3.3 bfd fast-detect
RP/0/RP0/CPU0:router(config-static)#end
```

The following example shows how to enable BFD on an IPv6 static route. In this example, BFD sessions are established with the next hop 2001:0DB8:D987:398:AE3:B39:333:783 when it becomes reachable.

BFD on Bundled VLANs: Example

The following example shows how to configure BFD on bundled VLANs:

BFD Over Bridge Group Virtual Interface: Example

The following examples show the configurations of the peer and uut nodes. You can see the BVI interface is under a VRF instead of default table:

```
interface BVI100
vrf cctv1 <<<<<<<<<
```

Below is the peer nodes example:

```
l2vpn
 bridge group bg
  bridge-domain bd
   interface Bundle-Ether1.100
   !
   routed interface BVI100
  !
 !
!
router vrrp
 interface BVI100
  bfd minimum-interval 15
  address-family ipv4
   vrrp 100
    address 192.168.1.254
    bfd fast-detect peer ipv4 192.168.1.2
   !
  !
 !
!
router ospf 100
vrf cctv1
  router-id 192.168.1.1
  area 0
   interface BVI100
   !
  !
 !
!
interface BVI100
 vrf cctv1
 ipv4 address 192.168.1.1 255.255.255.0
!
interface GigE0/1/0/10
 bundle id 1 mode active
 no shut
!
interface Bundle-Ether1
no shut
!
interface Bundle-Ether1.100 l2transport
 encapsulation dot1q 100
```

```
 rewrite ingress tag pop 1 symmetric

!
bfd multipath include loc 0/1/cpu0

interface MgmtEth0/RSP1/CPU0/0
 ipv4 address 7.37.19.20 255.255.0.0
 no shutdown
!
router static
 address-family ipv4 unicast
  0.0.0.0/0 7.37.0.1
```

Below is the uut node example:

```
l2vpn
 bridge group bg
  bridge-domain bd
   interface Bundle-Ether1.100
   !
   routed interface BVI100
  !
 !
!
router vrrp
 interface BVI100
  bfd minimum-interval 15
  address-family ipv4
   vrrp 100
    address 192.168.1.254
    bfd fast-detect peer ipv4 192.168.1.1
   !
  !
 !
!
router ospf 100
 vrf cctv1
  router-id 192.168.1.2
  area 0
   interface BVI100
   !
  !
 !
!
interface BVI100
 vrf cctv1
 ipv4 address 192.168.1.2 255.255.255.0
!


interface GigE0/1/0/0
 bundle id 1 mode active
 no shut
 !
 interface Bundle-Ether1
 no shut
!
interface Bundle-Ether1.100 l2transport
 encapsulation dot1q 100
 rewrite ingress tag pop 1 symmetric
```

```
!
bfd multipath include location 0/1/CPU0
```

BFD on Bundle Member Links: Examples

The following example shows how to configure BFD on member links of a POS bundle interface:

```
interface Bundle-POS 1
 bfd address-family ipv4 timers start 60
 bfd address-family ipv4 timers nbr-unconfig 60
 bfd address-family ipv4 multiplier 4
 bfd address-family ipv4 destination 192.168.77.2
 bfd address-family ipv4 fast-detect
 bfd address-family ipv4 minimum-interval 120
 ipv4 address 192.168.77.1 255.255.255.252

bundle minimum-active links 2
 bundle minimum-active bandwidth 150000
!
interface Loopback1
 ipv4 address 10.1.1.2 255.255.255.255
!
!
interface Pos0/2/0/0
 bundle id 1 mode active
!
interface Pos0/1/0/0
 bundle id 1 mode active
!
interface Pos0/1/0/1
 bundle id 1 mode active

interface Pos0/1/0/2
 bundle id 1 mode active

interface Pos0/1/0/3
 bundle id 1 mode active
router static
 address-family ipv4 unicast
  ! IPv4 Bundle-Pos1 session, shares ownership with bundle manager
  192.168.177.1/32 192.168.77.2 bfd fast-detect



router ospf foo
 bfd fast-detect
 redistribute connected
 area 0
  interface Bundle-Pos1
   ! IPv4 Bundle-Pos1 session, shares ownership with bundle manager
  !
router ospfv3 bar
 router-id 10.1.1.2
 bfd fast-detect
 redistribute connected
 area 0
  interface Bundle-Pos1
```

The following example shows how to configure BFD on member links of Ethernet bundle interfaces:

```
bfd
 interface Bundle-Ether4
  echo disable
 !
 interface GigabitEthernet0/0/0/2.3
  echo disable
 !
!
interface GigabitEthernet0/0/0/3 bundle id 1 mode active
interface GigabitEthernet0/0/0/4 bundle id 2 mode active
interface GigabitEthernet0/1/0/2 bundle id 3 mode active
interface GigabitEthernet0/1/0/3 bundle id 4 mode active
interface Bundle-Ether1
 ipv4 address 192.168.1.1/30
 bundle minimum-active links 1
!
interface Bundle-Ether1.1
 ipv4 address 192.168.100.1/30
 encapsulation dot1q 1001
!
interface Bundle-Ether2
 bfd address-family ipv4 destination 192.168.2.2
 bfd address-family ipv4 fast-detect
 bfd address-family ipv4 min 83
 bfd address-family ipv4 mul 3
 ipv4 address 192.168.2.1/30
 bundle minimum-active links 1
!
interface Bundle-Ether3
 bfd address-family ipv4 destination 192.168.3.2
 bfd address-family ipv4 fast-detect
 bfd address-family ipv4 min 83
 bfd address-family ipv4 mul 3
 ipv4 address 192.168.3.1/30
 bundle minimum-active links 1
!
interface Bundle-Ether4
 bfd address-family ipv4 destination 192.168.4.2
 bfd address-family ipv4 fast-detect
 bfd address-family ipv4 min 83
 bfd address-family ipv4 mul 3
 ipv4 address 192.168.4.1/30
 bundle minimum-active links 1
!
interface GigabitEthernet 0/0/0/2
 ipv4 address 192.168.10.1/30
!
interface GigabitEthernet 0/0/0/2.1
 ipv4 address 192.168.11.1/30

 encapsulation dot1q 2001
!
interface GigabitEthernet 0/0/0/2.2
 ipv4 address 192.168.12.1/30
 encapsulation dot1q 2002
!
interface GigabitEthernet 0/0/0/2.3
 ipv4 address 192.168.13.1/30
 encapsulation dot1q 2003
!
router static
 address-family ipv4 unicast
  10.10.11.2/32 192.168.11.2 bfd fast-detect minimum-interval 250 multiplier 3
```

```
  10.10.12.2/32 192.168.12.2 bfd fast-detect minimum-interval 250 multiplier 3
  10.10.13.2/32 192.168.13.2 bfd fast-detect minimum-interval 250 multiplier 3
  10.10.100.2/32 192.168.100.2 bfd fast-detect minimum-interval 250 multiplier 3
!
```

Echo Packet Source Address: Examples

The following example shows how to specify the IP address 10.10.10.1 as the source address for BFD echo packets for all BFD sessions on the router:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#echo ipv4 source 10.10.10.1
```

The following example shows how to specify the IP address 10.10.10.1 as the source address for BFD echo packets on an individual Gigabit Ethernet interface:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#interface gigabitethernet 0/1/0/0
RP/0/RP0/CPU0:router(config-bfd-if)#echo ipv4 source 10.10.10.1
```

The following example shows how to specify the IP address 10.10.10.1 as the source address for BFD echo packets on an individual Packet-over-SONET (POS) interface:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#interface pos 0/1/0/0
RP/0/RP0/CPU0:router(config-bfd-if)#echo ipv4 source 10.10.10.1
```

Echo Latency Detection: Examples

In the following examples, consider that the BFD minimum interval is 50 ms, and the multiplier is 3 for the BFD session.

The following example shows how to enable echo latency detection using the default values of 100% of the echo failure period (I x M) for a packet count of 1. In this example, when one echo packet is detected with a roundtrip delay greater than 150 ms, the session is taken down:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#echo latency detect
```

The following example shows how to enable echo latency detection based on 200% (two times) of the echo failure period for a packet count of 1. In this example, when one packet is detected with a roundtrip delay greater than 300 ms, the session is taken down:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#echo latency detect percentage 200
```

The following example shows how to enable echo latency detection based on 100% of the echo failure period for a packet count of 3. In this example, when three consecutive echo packets are detected with a roundtrip delay greater than 150 ms, the session is taken down:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#echo latency detect percentage 100 count 3
```

Echo Startup Validation: Examples

The following example shows how to enable echo startup validation for BFD sessions on non-bundle interfaces if the last received control packet contains a non-zero “Required Min Echo RX Interval” value:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#echo startup validate
```

The following example shows how to enable echo startup validation for BFD sessions on non-bundle interfaces regardless of the “Required Min Echo RX Interval” value in the last control packet:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#echo startup validate force
```

BFD Echo Mode Disable: Examples

The following example shows how to disable echo mode on a router:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:routerr(config-bfd)#echo disable
```

The following example shows how to disable echo mode on an interface:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#interface gigabitethernet 0/1/0/0
RP/0/RP0/CPU0:router(config-bfd-if)#echo disable
```

BFD Dampening: Examples

The following example shows how to configure an initial and maximum delay for BFD session startup on BFD bundle members:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#dampening bundle-member initial-wait 8000
```

```
RP/0/RP0/CPU0:router(config-bfd)#dampening bundle-member maximum-wait 15000
```

The following example shows how to change the default initial-wait for BFD on a non-bundle interface:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#dampening initial-wait 30000
RP/0/RP0/CPU0:router(config-bfd)#dampening maximum-wait 35000
```

BFD IPv6 Checksum: Examples

The following example shows how to disable IPv6 checksum calculations for UDP packets for all BFD sessions on the router:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#ipv6 checksum disable
```

The following example shows how to reenable IPv6 checksum calculations for UDP packets for all BFD sessions on the router:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#no ipv6 checksum disable
```

The following example shows how to enable echo mode for BFD sessions on an individual interface:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#interface gigabitethernet 0/1/0/0
RP/0/RP0/CPU0:router(config-bfd-if)#ipv6 checksum
```

The following example shows how to disable echo mode for BFD sessions on an individual interface:

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#bfd
RP/0/RP0/CPU0:router(config-bfd)#interface gigabitethernet 0/1/0/0
RP/0/RP0/CPU0:router(config-bfd-if)#ipv6 checksum disable
```

BFD Peers on Routers Running Cisco IOS and Cisco IOS XR Software: Example

The following example shows how to configure BFD on a router interface on Router 1 that is running Cisco IOS software, and use the **bfd neighbor** command to designate the IP address 192.0.2.1 of an interface as its BFD peer on Router 2. Router 2 is running Cisco IOS XR software and uses the **router static** command and **address-family ipv4 unicast** command to designate the path back to Router 1's interface with IP address 192.0.2.2.

Router 1 (Cisco IOS software)

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#interface GigabitEthernet8/1/0
RP/0/RP0/CPU0:router(config-if)#description to-TestBed1 G0/0/0/0
RP/0/RP0/CPU0:router(config-if)#ip address 192.0.2.2 255.255.255.0
```

```
RP/0/RP0/CPU0:router(config-if)#bfd interval 100 min_rx 100 multiplier 3
RP/0/RP0/CPU0:router(config-if)#bfd neighbor 192.0.2.1
```

Router 2 (Cisco IOS XR Software)

```
RP/0/RP0/CPU0:router#configure
RP/0/RP0/CPU0:router(config)#router static
RP/0/RP0/CPU0:router(config-static)#address-family ipv4 unicast
RP/0/RP0/CPU0:router(config-static-afi)#10.10.10.10/32 192.0.2.2 bfd fast-detect
RP/0/RP0/CPU0:router(config-static-afi)#exit
RP/0/RP0/CPU0:router(config-static)#exit
RP/0/RP0/CPU0:router(config)#interface GigabitEthernet0/0/0/0
RP/0/RP0/CPU0:router(config-if)#ipv4 address 192.0.2.1 255.255.255.0
```

BFD over MPLS TE LSPs: Examples

These examples explain how to configure BFD over MPLS TE LSPs.

BFD over MPLS TE Tunnel Head-end Configuration: Example

This example shows how to configure BFD over MPLS TE Tunnel at head-end.

```
bfd multipath include loc 0/1/CPU0
mpls oam
interface tunnel-te 1 bfd fast-detect
interface tunnel-te 1
 bfd minimum-interval
 bfd multiplier
 bfd bringup-timeout
 bfd lsp-ping interval 60
 bfd lsp-ping disable
 bfd dampening initial-wait    (default 16000 ms)
 bfd dampening maximum-wait    (default 600000 ms)
 bfd dampening secondary-wait  (default 20000 ms)
 logging events bfd-status
```

BFD over MPLS TE Tunnel Tail-end Configuration: Example

This example shows how to configure BFD over MPLS TE Tunnels at tail-end.

```
bfd multipath include loc 0/1/CPU0
mpls oam
mpls traffic-eng bfd lsp tail multiplier 3
mpls traffic-eng bfd lsp tail minimum-interval 100
```

Where to Go Next

BFD is supported over multiple platforms. For more detailed information about these commands, see the related chapters in the corresponding *Cisco IOS XR Routing Command Reference* and *Cisco IOS XR MPLS Command Reference* for your platform at:

http://www.cisco.com/en/US/products/ps5845/prod_command_reference_list.html

- *BGP Commands on Cisco IOS XR Software*
- *IS-IS Commands on Cisco IOS XR Software*
- *OSPF Commands on Cisco IOS XR Software*
- *Static Routing Commands on Cisco IOS XR Software*
- *MPLS Traffic Engineering Commands on Cisco IOS XR Software*

Additional References

The following sections provide references related to implementing BFD for Cisco IOS XR software.

Related Documents

Related Topic	Document Title
BFD commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Routing Command Reference for Cisco NCS 6000 Series Routers*
Configuring QoS packet classification	

Standards

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

RFCs

RFCs	Title
rfc5880_bfd_base	*Bidirectional Forwarding Detection*, June 2010
rfc5881_bfd_ipv4_ipv6	*BFD for IPv4 and IPv6 (Single Hop)*, June 2010
rfc5883_bfd_multihop	*BFD for Multihop Paths*, June 2010

MIBs

MIBs	MIBs Link
—	To locate and download MIBs using Cisco IOS XR software, use the Cisco MIB Locator found at the following URL and choose a platform under the Cisco Access Products menu: https://mibs.cloudapps.cisco.com/ITDIT/MIBS/servlet/index

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.	http://www.cisco.com/techsupport