IP Routing BFD Configuration Guide, Cisco IOS Release 15SY

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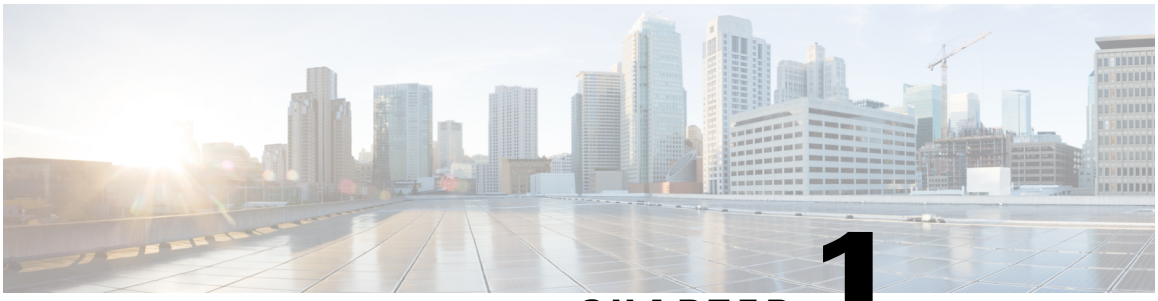


CHAPTER 1

Bidirectional Forwarding Detection

This document describes how to enable the Bidirectional Forwarding Detection (BFD) protocol. BFD is a detection protocol that is designed to provide fast forwarding path failure detection times for all media types, encapsulations, topologies, and routing protocols. It includes a description of how to configure multihop BFD sessions.

BFD provides a consistent failure detection method for network administrators, in addition to fast forwarding path failure detection. Because the network administrator can use BFD to detect forwarding path failures at a uniform rate, rather than the variable rates for different routing protocol hello mechanisms, network profiling and planning will be easier, and reconvergence time will be consistent and predictable.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for Bidirectional Forwarding Detection

- Cisco Express Forwarding and IP routing must be enabled on all participating routers.
- You must enable Cisco Parallel eXpress Forwarding (PXF) on the Cisco 10720 Internet router in order for BFD to operate properly. PXF is enabled by default and is generally not turned off.
- One of the IP routing protocols supported by BFD must be configured on the routers before BFD is deployed. You should implement fast convergence for the routing protocol that you are using. See the IP routing documentation for your version of Cisco IOS software for information on configuring fast convergence. See the Restrictions for Bidirectional Forwarding Detection section for more information on BFD routing protocol support in Cisco IOS software.
- Before Virtual Circuit Connection Verification (VCCV) BFD on pseudowires can be run, pseudowires must be configured on the network.
- In Cisco IOS Release 15.1(2)S and later releases, support for offloading BFD sessions to ES+ line cards on Cisco 7600 series routers has the following prerequisites:
    - The router must be running BFD Version 1.
    - The BFD session type must be IPv4 single hop.
    - BFD echo mode must be disabled for the session.

  See the "Configuring Synchronous Ethernet on the Cisco 7600 Router with ES+ Line Card" section of the *Cisco 7600 Series Ethernet Services Plus (ES+) and Ethernet Services Plus T (ES+T) Line Card Configuration Guide* for more information about prerequisites for hardware offload.
- In Cisco IOS Release 15.1(3)S and later releases, support for multihop BFD sessions on Cisco 7600 series routers has the following prerequisites:
    - The client must support multihop.
    - A valid multihop template and map must be configured..
    - Each BFD multihop session must have a unique source-destination address pair.

Restrictions for Bidirectional Forwarding Detection

- With CSCts32440, the maximum number of supported VRF-aware IS-IS BFD sessions is 28.
- For the Cisco implementation of BFD for Cisco IOS Releases 12.2(18)SXE, 12.0(31)S, 12.4(4)T, 12.0(32)S, 12.2(33)SRA, and 12.2(33)SRB, only asynchronous mode is supported. In asynchronous mode, either BFD peer can initiate a BFD session.
- For Cisco IOS Releases 12.2(33)SRC, 12.2(33)SXH, and 12.2(33)SXI, echo mode is the default.
- The Cisco IOS software incorrectly allows configuration of BFD on virtual-template and dialer interfaces; however, BFD functionality on virtual-template and dialer interfaces is not supported. Avoid configuring BFD on virtual-template and dialer interfaces.

- For Cisco IOS Releases 12.2(18)SXE (and later SX releases), 12.0(31)S, 12.4(4)T, 12.0(32)S, 12.2(33)SRA, 12.2(33)SRB, 12.2(33)SRC, and 12.2(33)SB, the Cisco implementation of BFD is supported only for IPv4 networks.
- For Cisco IOS Release 12.2(33)SRB, the Cisco implementation of BFD supports only the following routing protocols: Border Gateway Protocol (BGP), Enhanced Interior Gateway Routing Protocol (EIGRP), Intermediate System-to-Intermediate System (IS-IS), and Open Shortest Path First (OSPF). In Cisco IOS Release 12.2(33)SRC, BFD supports static routing.
- For Cisco IOS Release 12.2(33)SRA, the Cisco implementation of BFD supports only the following routing protocols: BGP, IS-IS, and OSPF.
- For Cisco IOS Release 12.4(4)T, the Cisco implementation of BFD supports only the following routing protocols: BGP, EIGRP, IS-IS, and OSPF.
- For Cisco IOS Release 12.4(11)T, the Cisco implementation of BFD introduced support for the Hot Standby Router Protocol (HSRP). BFD support is not available for all platforms and interfaces.
- For Cisco IOS Releases 12.0(31)S and 12.0(32)S, the Cisco implementation of BFD supports only the following routing protocols: BGP, IS-IS, and OSPF.
- For Cisco IOS Release 12.2(18)SXE, the Cisco implementation of BFD supports only the following routing protocols: EIGRP, IS-IS, and OSPF.
- For Cisco IOS Release 12.2(18)SXH and 12.2(33)SB, the Cisco implementation of BFD supports the following routing protocols: BGP, EIGRP, IS-IS, and OSPF.
- BFD works only for directly connected neighbors. BFD neighbors must be no more than one IP hop away. Multihop configurations are not supported.
- BFD support is not available for all platforms and interfaces. To confirm BFD support for a specific platform or interface and obtain the most accurate platform and hardware restrictions, see the Cisco IOS software release notes for your software version.
- For the following Cisco IOS Releases, BFD on PortChannel is not a supported configuration: 12.2SXF, 12.2SRC, and 12.2SRB.
- On the Cisco 10720 Internet router, BFD is supported only on Fast Ethernet, Gigabit Ethernet, and RPR-IEEE interfaces. BFD is not supported on Spatial Reuse Protocol (SRP) and Packet-over-SONET (POS) interfaces.
- When you configure the BFD session parameters on a Cisco 10720 interface using the **bfd** command (in interface configuration mode), the minimum configurable time period supported for the *milliseconds* argument in both the **interval** *milliseconds* and **min_rx** *milliseconds* parameters is 50 milliseconds (ms).
- A maximum of 100 BFD sessions is supported on the Cisco 10720 Internet router. When BFD tries to set up a connection between routing protocols and establish a 101th session between a Cisco 10720 Internet router and adjacent routers, the following error message is displayed:

```
00:01:24: %OSPF-5-ADJCHG: Process 100, Nbr 10.0.0.0 on RPR-IEEE1/1 from LOADING to
FULL, Loading Done
00:01:24: %BFD-5-SESSIONLIMIT: Attempt to exceed session limit of 100 neighbors.
```

- BFD packets are not matched in the QoS policy for self-generated packets.
- BFD packets are matched in the **class class-default** command. So, the user must make sure of the availability of appropriate bandwidth to prevent dropping of BFD packets due to oversubscription.
- The Cisco 10720 Internet router does not support the following BFD features:

    - Demand mode
    - Echo packets
    - BFD over IP Version 6

- On the Cisco 12000 series router, asymmetrical routing between peer devices may cause a BFD control packet to be received on a line card other than the line card that initiated the session. In this special case, the BFD session between the routing peers will not be established.
- A maximum 100 sessions per line card are supported for the distributed Cisco 12000 series Internet router. The minimum hello interval is 50 ms with up to three Max retries for a BFD control packet to be received from a remote system before a session with a neighbor is declared down.
- In Cisco IOS Release 12.2(33)SB, BFD is not stateful switchover (SSO) aware, and it is not supported with NSF/SSO and these features should not be used together. Enabling BFD along with NSF/SSO causes the nonstop forwarding capability to break during failover since BFD adjacencies are not maintained and the routing clients are forced to mark down adjacencies and reconverge.

BFD Control Channel over VCCV--Support for ATM Pseudowire

- The BFD Control Channel over VCCV--Support for Asynchronous Transfer Mode Pseudowire feature supports VCCV type 1 only, without IP/User Datagram Protocol (UDP) encapsulation.
- Any Transport over Multiprotocol Label Switching (AToM) is the only transport protocol supported by the BFD Control Channel over VCCV--Support for ATM Pseudowire feature.
- Layer 2 Transport Protocol version 3 (L2TPv3) is not supported.
- Pseudowire redundancy is not supported.
- Only ATM attachment circuits (AC) are supported.

Cisco IOS Release 12.2(33)SXI2 and Cisco Catalyst 6500 Series Switches

- Cisco Catalyst 6500 series switches support up to 100 BFD sessions with a minimum hello interval of 50 ms and a multiplier of 3. The multiplier specifies the minimum number of consecutive packets that can be missed before a session is declared down.
- If SSO is enabled on a dual RP system, the following limitations apply:
    - The maximum number of BFD sessions supported is 50.
    - The minimum hello interval is 500 ms with a multiplier of 3 or higher.
    - If EIGRP is enabled, the maximum number of BFD sessions supported is reduced to 30.
    - Echo mode is supported on Distributed Forwarding Cards (DFCs) only.
- BFD SSO is supported on Cisco Catalyst 6500 series switches using the E-chassis and 67xx line cards only. Centralized Forwarding Cards (CFCs) are not supported.
- BFD is not supported on Switch Virtual Interfaces (SVIs) in Cisco Catalyst 6500 series switches.
- To enable echo mode the system must be configured with the **no ip redirects** command.
- During the In Service Software Upgrade (ISSU) cycle the line cards are reset, causing a routing flap in the BFD session.

Cisco Catalyst 6000 Series Switches

- In the Cisco Catalyst 6000 series switches, the supervisor uplink ports have to be associated with the BFD timer value of 750*750*5 milliseconds because during the stateful switchover (SSO) or peer reload, the redundancy facility (RF) progression and EtherChannel (port-channel) load calculation takes 1.5 to 2.5 seconds. This is applicable even if the BFD echo packets are exchanged over the supervisor uplinks.

Cisco IOS Release 15.0S and Cisco Catalyst 7600 SeriesRouters

BFD support on SVI interfaces is only available on Cisco 7600 series routers beginning with Cisco IOS release 15.0.

Cisco IOS Release 15.1(2)S and ES+ Line Cards for Cisco 7600 Series Routers

Cisco IOS Release 15.1(2)S, supports offloading BFD sessions to ES+ line cards on Cisco 7600 series routers. See the "Configuring Synchronous Ethernet on the Cisco 7600 Router with ES+ Line Card" section of the *Cisco 7600 Series Ethernet Services Plus (ES+) and Ethernet Services Plus T (ES+T) Line Card Configuration Guide* for more information about restrictions for hardware offload.

Cisco IOS Release 15.1(3)S-Support for BFD Multihop

- Only IPv4 and IPv6 BFD multihop sessions are supported.
- Multihop sessions will not be offloaded to hardware.
- IPv6 link local addresses are not supported for BFD multihop sessions.
- Echo mode is not supported in multihop.

Note For the most accurate platform and hardware restrictions, see the Cisco IOS software release notes for your software version.

Support for Point-to-Point IPv4, IPv6, and GRE Tunnels

Depending on your release, Cisco software supports BFD forwarding on point-to-point IPv4, IPv6, and generic routing encapsulation (GRE) tunnels.

Only numbered interfaces are allowed. When the tunnel type is changed from a supported tunnel type to an unsupported one, BFD sessions are brought down for that tunnel and the BFD configuration is removed from the interface.

BFD detection time depends on the topology and infrastructure. For a single-hop IP tunnel that is deployed across physically adjacent devices, the 150 ms (that is, a hello interval of 50 ms with up to three retries) detection rate applies. However, when the source and destination endpoints of the tunnel are not connected back-to-back, the 150 ms detection rate is not guaranteed.

BFD uses the IP address configured on the tunnel interface. It does not use the tunnel source and destination addresses.

Information About Bidirectional Forwarding Detection

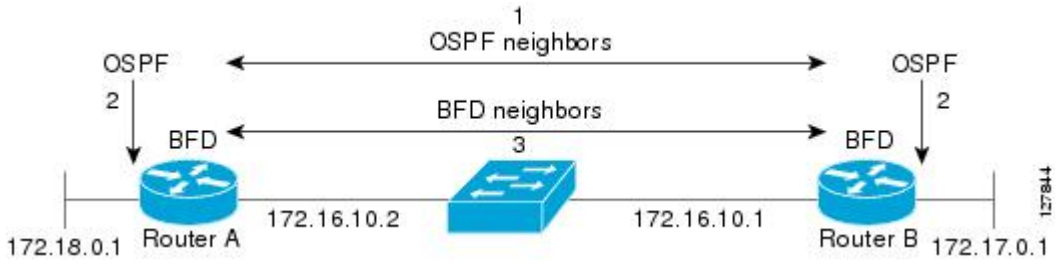
BFD Operation

BFD provides a low-overhead, short-duration method of detecting failures in the forwarding path between two adjacent routers, including the interfaces, data links, and forwarding planes.

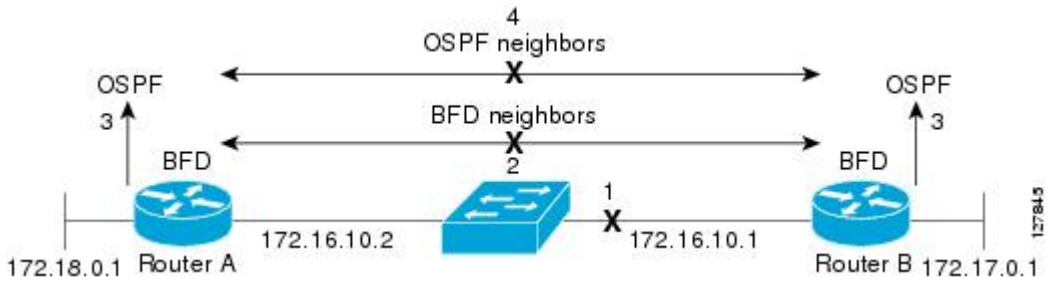
BFD is a detection protocol that you enable at the interface and routing protocol levels. Cisco supports BFD asynchronous mode, which depends on the sending of BFD control packets between two systems to activate and maintain BFD neighbor sessions between routers. Therefore, in order for a BFD session to be created, you must configure BFD on both systems (or BFD peers). Once BFD has been enabled on the interfaces and at the router level for the appropriate routing protocols, a BFD session is created, BFD timers are negotiated, and the BFD peers will begin to send BFD control packets to each other at the negotiated interval.

Neighbor Relationships

BFD provides fast BFD peer failure detection times independently of all media types, encapsulations, topologies, and routing protocols BGP, EIGRP, IS-IS, and OSPF. By sending rapid failure detection notices to the routing protocols in the local router to initiate the routing table recalculation process, BFD contributes to greatly reduced overall network convergence time. The figure below shows a simple network with two routers running OSPF and BFD. When OSPF discovers a neighbor (1) it sends a request to the local BFD process to initiate a BFD neighbor session with the OSPF neighbor router (2). The BFD neighbor session with the OSPF neighbor router is established (3).



The figure below shows what happens when a failure occurs in the network (1). The BFD neighbor session with the OSPF neighbor router is torn down (2). BFD notifies the local OSPF process that the BFD neighbor is no longer reachable (3). The local OSPF process tears down the OSPF neighbor relationship (4). If an alternative path is available, the routers will immediately start converging on it.



A routing protocol needs to register with BFD for every neighbor it acquires. Once a neighbor is registered, BFD initiates a session with the neighbor if a session does not already exist.

OSPF registers with BFD when:

- A neighbor finite state machine (FSM) transitions to full state.
- Both OSPF BFD and BFD are enabled.

On broadcast interfaces, OSPF establishes a BFD session only with the designated router (DR) and backup designated router (BDR), but not between any two routers in DROTHER state.

BFD Detection of Failures

Once a BFD session has been established and timer negations are complete, BFD peers send BFD control packets that act in the same manner as an IGP hello protocol to detect liveliness, except at a more accelerated rate. The following information should be noted:

- BFD is a forwarding path failure detection protocol. BFD detects a failure, but the routing protocol must take action to bypass a failed peer.
- Cisco devices will use one BFD session for multiple client protocols in the Cisco implementation of BFD for Cisco IOS Releases 12.2(18)SXE, 12.0(31)S, and 12.4(4)T. For example, if a network is running OSPF and EIGRP across the same link to the same peer, only one BFD session will be established, and BFD will share session information with both routing protocols.

BFD Version Interoperability

All BFD sessions come up as Version 1 by default and will be interoperable with Version 0. The system automatically performs BFD version detection, and BFD sessions between neighbors will run in the highest common BFD version between neighbors. For example, if one BFD neighbor is running BFD Version 0 and the other BFD neighbor is running Version 1, the session will run BFD Version 0. The output from the **show bfd neighbors** [**details**] command will verify which BFD version a BFD neighbor is running.

See the Example Configuring BFD in an EIGRP Network with Echo Mode Enabled by Default for an example of BFD version detection.

BFD Support on Cisco 12000 Routers

The Cisco 12000 series routers support distributed BFD to take advantage of its distributed Route Processor (RP) and line card (LC) architecture. The BFD tasks will be divided and assigned to the BFD process on the RP and LC, as described in the following sections:

BFD Process on the RP

Client Interaction

The BFD process on the RP will handle the interaction with clients, which create and delete BFD sessions.

Session Management for the BFD Process on the RP

The BFD RP process will primarily own all BFD sessions on the router. It will pass the session creation and deletion requests to the BFD processes on all LCs. BFD LC sessions will have no knowledge of sessions being added or deleted by the clients. Only the BFD RP process will send session addition and deletion commands to the BFD LC process.

Session Database Management

The BFD RP process will maintain a database of all the BFD sessions on the router. This database will contain only the minimum required information.

Process EXEC Commands

The BFD RP process services the BFD **show** commands.

BFD Process on the LC

Session Management for the BFD Process on the LC

The BFD LC process manages sessions, adds and deletes commands from the BFD RP process, and creates and deletes new sessions based on the commands. In the event of transmit failure, receive failure, or session-down detection, the LC BFD instance will immediately notify the BFD RP process. It will also update transmit and receive counters. The BFD session is maintained completely on the LC. BFD control packets are received and processed, as well as sent, from the LC itself.

Session Database Management

The BFD LC process maintains a database of all the BFD sessions hosted on the LC.

Receive and Transmit

The BFD LC process is responsible for transmitting and receiving BFD packets for the sessions on the LC.

BFD Session Limits

In Cisco IOS Release 12.2(33)SRC, the number of BFD sessions that can be created has been increased to 128.

BFD Support for Nonbroadcast Media Interfaces

In Cisco IOS Release 12.2(33)SRC, the BFD feature is supported on nonbroadcast media interfaces including ATM, POS, serial, and VLAN interfaces. BFD support also extends to ATM, Frame Relay (FR), POS, and serial subinterfaces.

The **bfd interval** command must be configured on the interface to initiate BFD monitoring.

BFD Support for VPN Routing and Forwarding Interfaces

The BFD feature is extended in Cisco IOS Release 12.2(33)SRC to be VPN Routing and Forwarding (VRF) aware to provide fast detection of routing protocol failures between provider edge (PE) and customer edge (CE) routers.

BFD Support for Nonstop Forwarding with Stateful Switchover

Typically, when a networking device restarts, all routing peers of that device detect that the device went down and then came back up. This transition results in a routing flap, which could spread across multiple routing domains. Routing flaps caused by routing restarts create routing instabilities, which are detrimental to the overall network performance. Nonstop forwarding (NSF) helps to suppress routing flaps in devices that are enabled with stateful switchover (SSO), thereby reducing network instability.

NSF allows for the forwarding of data packets to continue along known routes while the routing protocol information is being restored after a switchover. With NSF, peer networking devices do not experience routing flaps. Data traffic is forwarded through intelligent line cards or dual forwarding processors while the standby RP assumes control from the failed active RP during a switchover. The ability of line cards and forwarding processors to remain up through a switchover and to be kept current with the Forwarding Information Base (FIB) on the active RP is key to NSF operation.

In devices that support dual RPs, SSO establishes one of the RPs as the active processor; the other RP is designated as the standby processor, and then synchronizes information between them. A switchover from the active to the standby processor occurs when the active RP fails, when it is removed from the networking device, or when it is manually taken down for maintenance.

BFD Support for Stateful Switchover

The BFD protocol provides short-duration detection of failures in the path between adjacent forwarding engines. In network deployments that use dual RP routers or switches (to provide redundancy), the routers have a graceful restart mechanism that protects the forwarding state during a switchover between the active RP and the standby RP.

The dual RPs have variable switchover times that depend on the ability of the hardware to detect a communication failure. When BFD is running on the RP, some platforms are not able to detect a switchover before the BFD protocol times out; these platforms are referred to as slow switchover platforms.

Stateful BFD on the Standby RP

To ensure a successful switchover to the standby RP, the BFD protocol uses checkpoint messages to send session information from the active RP Cisco IOS instance to the standby RP Cisco IOS instance. The session information includes local and remote discriminators, adjacent router timer information, BFD setup information, and session-specific information such as the type of session and the session version. In addition, the BFD protocol sends session creation and deletion checkpoint messages to create or delete a session on the standby RP.

The BFD sessions on the standby RP do not receive or send packets and do not process expired timers. These sessions wait for a switchover to occur and then send packets for any active sessions so that sessions do not time out on adjacent routers.

When the BFD protocol on the standby RP is notified of a switchover it changes its state to active, registers itself with Cisco Express Forwarding so that it can receive packets, and then sends packets for any elements that have expired.

BFD also uses checkpoint messages to ensure that sessions created by clients on the active RP are maintained during a switchover. When a switchover occurs, BFD starts an SSO reclaim timer. Clients must reclaim their sessions within the duration specified by the reclaim timer or else the session is deleted.

BFD Support for Static Routing

Unlike dynamic routing protocols, such as OSPF and BGP, static routing has no method of peer discovery. Therefore, when BFD is configured, the reachability of the gateway is completely dependent on the state of the BFD session to the specified neighbor. Unless the BFD session is up, the gateway for the static route is considered unreachable, and therefore the affected routes will not be installed in the appropriate Routing Information Base (RIB).

For a BFD session to be successfully established, BFD must be configured on the interface on the peer and there must be a BFD client registered on the peer for the address of the BFD neighbor. When an interface is used by dynamic routing protocols, the latter requirement is usually met by configuring the routing protocol instances on each neighbor for BFD. When an interface is used exclusively for static routing, this requirement must be met by configuring static routes on the peers.

If a BFD configuration is removed from the remote peer while the BFD session is in the up state, the updated state of the BFD session is not signaled to IPv4 static. This will cause the static route to remain in the RIB. The only workaround is to remove the IPv4 static BFD neighbor configuration so that the static route no longer tracks BFD session state. Also, if you change the encapsulation type on a serial interface to one that is unsupported by BFD, BFD will be in a down state on that interface. The workaround is to shut down the interface, change to a supported encapsulation type, and then reconfigure BFD.

A single BFD session can be used by an IPv4 static client to track the reachability of next hops through a specific interface. You can assign a BFD group for a set of BFD-tracked static routes. Each group must have one active static BFD configuration, one or more passive BFD configurations, and the corresponding static routes to be BFD-tracked. Nongroup entries are BFD-tracked static routes for which a BFD group is not assigned. A BFD group must accommodate static BFD configurations that can be part of different VRFs. Effectively, the passive static BFD configurations need not be in the same VRF as that of the active configuration.

For each BFD group, there can be only one active static BFD session. You can configure the active BFD session by adding a static BFD configuration and a corresponding static route that uses the BFD configuration. The BFD session in a group is created only when there is an active static BFD configuration and the static route that uses the static BFD configuration. When the active static BFD configuration or the active static route is removed from a BFD group, all the passive static routes are withdrawn from the RIB. Effectively, all the passive static routes are inactive until an active static BFD configuration and a static route to be tracked by the active BFD session are configured in the group.

Similarly, for each BFD group, there can be one or more passive static BFD configurations and their corresponding static routes to be BFD-tracked. Passive static session routes take effect only when the active BFD session state is reachable. Though the active BFD session state of the group is reachable, the passive static route is added to the RIB only if the corresponding interface state is up. When a passive BFD session is removed from a group, it will not affect the active BFD session if one existed, or the BFD group reachability status.

BFD Control Channel over VCCV Support for ATM Pseudowire

Multiprotocol Label Switching (MPLS) pseudowires enable L2 traffic to be carried over an IP/MPLS core network. The BFD control channel over VCCV--Support for ATM Pseudowires feature provides operations and management (OAM) functions for MPLS pseudowires.

Note This feature provides support for VCCV type 1 only. VCCV Type 1 is in-band VCCV and can be used only for MPLS pseudowires that use a control word.

The BFD detection protocol can be used to provide OAM functionality to the MPLS protocol. VCCV provides a control channel associated with the pseudowire to provide OAM functions over that pseudowire. BFD can use the VCCV control channel as a pseudowire fault mechanism to detect dataplane failures. BFD can also use the VCCV control channel to carry the fault status of an attachment circuit (AC).

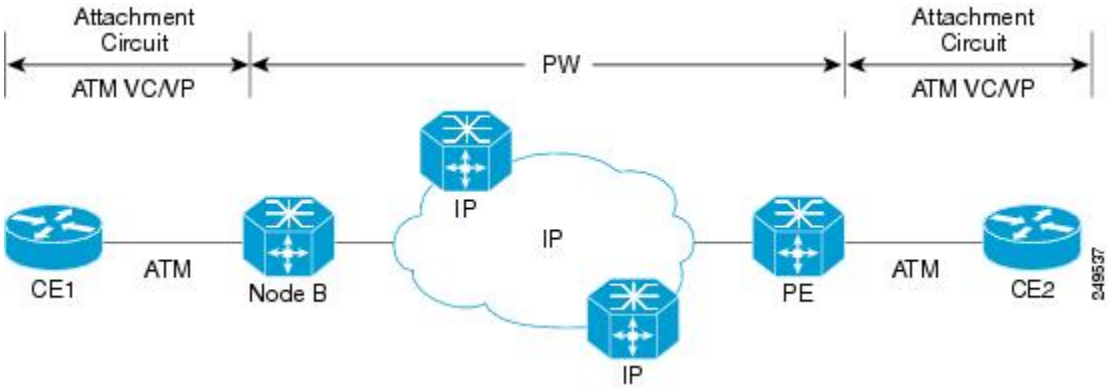
MPLS pseudowires can dynamically signal or statically configure virtual circuit (VC) labels. In dynamically signaled pseudowires, the control channel (CC) types and connection verification (CV) types are also signaled. In statically configured pseudowires, the CC and CV types must be configured on both ends of the pseudowire.

The CC types define whether VCCV packets are in-band or out-of-band for the pseudowire. The CV types define whether BFD monitoring is required for the pseudowire. If BFD monitoring is required for the pseudowire, the CV types also define how the BFD packets are encapsulated and whether BFD provides status signaling functionality.

Any protocol that requires BFD monitoring must register with BFD as a client. For example, the Xconnect protocol registers as a BFD client, and BFD assigns a client ID to Xconnect. Xconnect uses this client ID to create the BFD sessions that monitor the pseudowire.

BFD can detect forwarding failures (end-to-end) in the pseudowire path. When BFD detects a failure in the pseudowire forwarding path it notifies the Xconnect client that created the session. In addition, BFD can signal the status in any concatenated path, or AC, to the remote device where the BFD session is terminated.

The figure below shows a dynamically signaled MPLS pseudowire carrying an ATM payload. In this example, BFD monitoring of the pseudowire occurs from the Node B device to the PE device. BFD also monitors the signal status of the ACs between the PE and CE2 device, and between the Node B and CE1 device.



BFD on Multiple Hops

Cisco IOS Release 15.1(3)S and later releases support BFD on arbitrary paths, which might span multiple network hops. The BFD Multihop feature provides subsecond forwarding failure detection for a destination more than one hop, and up to 255 hops, away.

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.

You must configure the **bfd-template** and **bfd map** commands to create a multihop template and associate it with one or more maps of destinations and associated BFD timers. You can enable authentication and configure a key chain for BFD multihop sessions.

Benefits of Using BFD for Failure Detection

When you deploy any feature, it is important to consider all the alternatives and be aware of any trade-offs being made.

The closest alternative to BFD in conventional EIGRP, IS-IS, and OSPF deployments is the use of modified failure detection mechanisms for EIGRP, IS-IS, and OSPF routing protocols.

If you set EIGRP hello and hold timers to their absolute minimums, the failure detection rate for EIGRP falls to within a one- to two-second range.

If you use fast hellos for either IS-IS or OSPF, these Interior Gateway Protocol (IGP) protocols reduce their failure detection mechanisms to a minimum of one second.

There are several advantages to implementing BFD over reduced timer mechanisms for routing protocols:

- Although reducing the EIGRP, IS-IS, and OSPF timers can result in minimum detection timer of one to two seconds, BFD can provide failure detection in less than one second.
- Because BFD is not tied to any particular routing protocol, it can be used as a generic and consistent failure detection mechanism for EIGRP, IS-IS, and OSPF.
- Because some parts of BFD can be distributed to the data plane, it can be less CPU-intensive than the reduced EIGRP, IS-IS, and OSPF timers, which exist wholly at the control plane.

How to Configure Bidirectional Forwarding Detection

Configuring BFD Session Parameters on the Interface

The steps in this procedure show how to configure BFD on the interface by setting the baseline BFD session parameters on an interface. Repeat the steps in this procedure for each interface over which you want to run BFD sessions to BFD neighbors.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Perform one of the following steps:
   - **ip address** *ipv4-address mask*
   - **ipv6 address** *ipv6-address*/*mask*
4. **bfd interval** *milliseconds* **min_rx** *milliseconds* **multiplier** *interval-multiplier*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

Step 3	Perform one of the following steps:
	• **ip address** *ipv4-address mask*
	• **ipv6 address** *ipv6-address*/*mask*
	
	Example:
	Configuring an IPv4 address for the interface:
	`Device(config-if)# ip address 10.201.201.1 255.255.255.0`
	Configuring an IPv6 address for the interface:
	`Device(config-if)# ipv6 address 2001:db8:1:1::1/32`
		Configures an IP address for the interface.

Step 4	**bfd interval** *milliseconds* **min_rx** *milliseconds* **multiplier** *interval-multiplier* **Example:** `Device(config-if)# bfd interval 50 min_rx 50 multiplier 5`	Enables BFD on the interface. The bfd interval configuration is removed when the subinterface on which it is configured is removed. The bfd interval configuration is not removed when: • an IPv4 address is removed from an interface

	Command or Action	Purpose
		• an IPv6 address is removed from an interface • IPv6 is disabled from an interface • an interface is shutdown • IPv4 CEF is disabled globally or locally on an interface • IPv6 CEF is disabled globally or locally on an interface
Step 5	**end** **Example:** `Device(config-if)# end`	Exits interface configuration mode and returns to privileged EXEC mode.

Configuring BFD Support for Dynamic Routing Protocols

You can enable BFD support for dynamic routing protocols at the router level to enable BFD support globally for all interfaces or you can configure BFD on a per-interface basis at the interface level.

For Cisco IOS Release 12.2(18)SXE, you may configure BFD support for one or more of the following routing protocols: EIGRP, IS-IS, and OSPF.

For Cisco IOS Releases 12.2(33)SRA, you may configure BFD support for one or more of the following routing protocols: EIGRP, IS-IS, and OSPF.

For Cisco IOS Releases 12.2(33)SRB, you may configure BFD support for one or more of the following routing protocols: BGP, EIGRP, IS-IS, and OSPF.

For Cisco IOS Release 12.2(33)SRC, you may configure BFD support for static routing.

For Cisco IOS Releases 12.0(31)S and 12.4(4)T, you may configure BFD support for one or more of the following routing protocols: BGP, IS-IS, and OSPF.

For Cisco IOS Release 12.0(32)S, for the Cisco 10720 platform, you may configure BFD for one or more of the following routing protocols: BGP, IS-IS, and OSPF.

For Cisco IOS Release 12.4(11)T, BFD support for HSRP was introduced.

This section describes the following procedures:

Configuring BFD Support for BGP

This section describes the procedure for configuring BFD support for BGP so that BGP is a registered protocol with BFD and will receive forwarding path detection failure messages from BFD.

Before You Begin

BGP must be running on all participating routers.

The baseline parameters for BFD sessions on the interfaces over which you want to run BFD sessions to BFD neighbors must be configured. See the Configuring BFD Session Parameters on the Interface section for more information.

Note Output from the **show bfd neighbors details** command shows the configured intervals. The output does not show intervals that were changed because hardware-offloaded BFD sessions were configured with Tx and Rx intervals that are not multiples of 50 ms.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *as-tag*
4. **neighbor** *ip-address* **fall-over bfd**
5. **end**
6. **show bfd neighbors** [**details**]
7. **show ip bgp neighbor**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router bgp** *as-tag* **Example:** `Router(config)# router bgp tag1`	Specifies a BGP process and enters router configuration mode.
Step 4	**neighbor** *ip-address* **fall-over bfd** **Example:** `Router(config-router)# neighbor 172.16.10.2 fall-over bfd`	Enables BFD support for fallover.

	Command or Action	Purpose
Step 5	**end** **Example:** `Router(config-router)# end`	Exits router configuration mode and returns the router to privileged EXEC mode.
Step 6	**show bfd neighbors** [**details**] **Example:** `Router# show bfd neighbors detail`	(Optional) Verifies that the BFD neighbor is active and displays the routing protocols that BFD has registered. **Note** In order to display the full output of the **show bfd neighbors details** command on a Cisco 12000 series router, you must enter the command on the line card. Enter the **attach** *slot-number* command to establish a CLI session with a line card. The registered protocols are not shown in the output of the **show bfd neighbors details** command when it is entered on a line card. **Note** If hardware-offloaded BFD sessions are configured with Tx and Rx intervals that are not multiples of 50 ms, the hardware intervals are changed. However, output from the **show bfd neighbors details** command will show the configured intervals, not the changed ones.
Step 7	**show ip bgp neighbor** **Example:** `Router# show ip bgp neighbor`	(Optional) Displays information about BGP and TCP connections to neighbors.

What to Do Next

See the Monitoring and Troubleshooting BFD section for more information on monitoring and troubleshooting BFD. If you want to configure BFD support for another routing protocol, see the following sections.

Configuring BFD Support for EIGRP

This section describes the procedure for configuring BFD support for EIGRP so that EIGRP is a registered protocol with BFD and will receive forwarding path detection failure messages from BFD. There are two methods for enabling BFD support for EIGRP:

- You can enable BFD for all of the interfaces for which EIGRP is routing by using the **bfd all-interfaces** command in router configuration mode.
- You can enable BFD for a subset of the interfaces for which EIGRP is routing by using the **bfd interface** *type number* command in router configuration mode.

Before You Begin

EIGRP must be running on all participating routers.

The baseline parameters for BFD sessions on the interfaces over which you want to run BFD sessions to BFD neighbors must be configured. See the Configuring BFD Session Parameters on the Interface section for more information.

Note Output from the **show bfd neighbors details** command shows the configured intervals. The output does not show intervals that were changed because hardware-offloaded BFD sessions were configured with Tx and Rx intervals that are not multiples of 50 ms.

Note BFD for EIGRP is not supported on the Cisco 12000 series routers for Cisco IOS Releases 12.0(31)S, 12.0(32)S, 12.4(4)T, and 12.2(33)SRA.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router eigrp** *as-number*
4. Do one of the following:
   - **bfd all-interfaces**
   - **bfd interface** *type number*
5. **end**
6. **show bfd neighbors** [**details**]
7. **show ip eigrp interfaces** [*type number*] [*as-number*] [**detail**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router eigrp** *as-number* **Example:** `Router(config)# router eigrp 123`	Configures the EIGRP routing process and enters router configuration mode.

	Command or Action	Purpose

Step 4	Do one of the following:
	• **bfd all-interfaces**
	• **bfd interface** *type number*
	Example:
	`Router(config-router)# bfd all-interfaces`
	Example:
	`Router(config-router)# bfd interface FastEthernet 6/0`
		Enables BFD globally on all interfaces associated with the EIGRP routing process.
		or
		Enables BFD on a per-interface basis for one or more interfaces associated with the EIGRP routing process.

Step 5	**end** **Example:** `Router(config-router) end`	Exits router configuration mode and returns the router to privileged EXEC mode.
Step 6	**show bfd neighbors** [**details**] **Example:** `Router# show bfd neighbors details`	(Optional) Verifies that the BFD neighbor is active and displays the routing protocols that BFD has registered. **Note** In order to see the full output of the **show bfd neighbors details** command on a Cisco 12000 series router, you must enter the command on the line card. Enter the **attach** *slot-number* command to establish a CLI session with a line card. The registered protocols are not shown in the output of the **show bfd neighbors details** command when it is entered on a line card. **Note** If hardware-offloaded BFD sessions are configured with Tx and Rx intervals that are not multiples of 50 ms, the hardware intervals are changed. However, output from the **show bfd neighbors details** command will show the configured intervals, not the changed ones.
Step 7	**show ip eigrp interfaces** [*type number*] [*as-number*] [**detail**] **Example:** `Router# show ip eigrp interfaces detail`	(Optional) Displays the interfaces for which BFD support for EIGRP has been enabled.

What to Do Next

See the Monitoring andTroubleshooting BFD section for more information on monitoring and troubleshooting BFD. If you want to configure BFD support for another routing protocol, see the following sections.

Configuring BFD Support for IS-IS

This section describes the procedures for configuring BFD support for IS-IS so that IS-IS is a registered protocol with BFD and will receive forwarding path detection failure messages from BFD. There are two methods for enabling BFD support for IS-IS:

- You can enable BFD for all of the interfaces on which IS-IS is supporting IPv4 routing by using the **bfd all-interfaces** command in router configuration mode. You can then disable BFD for one or more of those interfaces using the **isis bfd disable** command in interface configuration mode.
- You can enable BFD for a subset of the interfaces for which IS-IS is routing by using the **isis bfd** command in interface configuration mode.

To configure BFD support for IS-IS, perform the steps in one of the following sections:

Prerequisites

IS-IS must be running on all participating routers.

The baseline parameters for BFD sessions on the interfaces that you want to run BFD sessions to BFD neighbors over must be configured. See the Configuring BFD Session Parameters on the Interface section for more information.

Note Output from the **show bfd neighbors details** command shows the configured intervals. The output does not show intervals that were changed because hardware-offloaded BFD sessions were configured with Tx and Rx intervals that are not multiples of 50 ms.

Configuring BFD Support for IS-IS for All Interfaces

To configure BFD on all IS-IS interfaces that support IPv4 routing, perform the steps in this section.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router isis** *area-tag*
4. **bfd all-interfaces**
5. **exit**
6. **interface** *type number*
7. **ip router isis** [*tag*]
8. **isis bfd** [**disable**]
9. **end**
10. **show bfd neighbors** [**details**]
11. **show clns interface**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router isis** *area-tag* **Example:** `Router(config)# router isis tag1`	Specifies an IS-IS process and enters router configuration mode.
Step 4	**bfd all-interfaces** **Example:** `Router(config-router)# bfd all-interfaces`	Enables BFD globally on all interfaces associated with the IS-IS routing process.
Step 5	**exit** **Example:** `Router(config-router)# exit`	(Optional) Returns the router to global configuration mode.

	Command or Action	Purpose
Step 6	**interface** *type number* **Example:** `Router(config)# interface fastethernet 6/0`	(Optional) Enters interface configuration mode.
Step 7	**ip router isis** [*tag*] **Example:** `Router(config-if)# ip router isis tag1`	(Optional) Enables support for IPv4 routing on the interface.
Step 8	**isis bfd** [**disable**] **Example:** `Router(config-if)# isis bfd`	(Optional) Enables or disables BFD on a per-interface basis for one or more interfaces associated with the IS-IS routing process. **Note** You should use the **disable** keyword only if you enabled BFD on all of the interfaces that IS-IS is associated with using the **bfd all-interfaces** command in router configuration mode.
Step 9	**end** **Example:** `Router(config-if)# end`	Exits interface configuration mode and returns the router to privileged EXEC mode.
Step 10	**show bfd neighbors** [**details**] **Example:** `Router# show bfd neighbors details`	(Optional) Displays information that can be used to verify if the BFD neighbor is active and displays the routing protocols that BFD has registered. **Note** In order to display the full output of the **show bfd neighbors details** command on a Cisco 12000 series router, you must enter the command on the line card. Enter the **attach** *slot-number* command to establish a CLI session with a line card. The registered protocols are not shown in the output of the **show bfd neighbors details** command when it is entered on a line card. **Note** If hardware-offloaded BFD sessions are configured with Tx and Rx intervals that are not multiples of 50 ms, the hardware intervals are changed. However, output from the **show bfd neighbors details** command will show the configured intervals, not the changed ones.
Step 11	**show clns interface** **Example:** `Router# show clns interface`	(Optional) Displays information that can be used to verify if BFD for IS-IS has been enabled for a specific IS-IS interface that is associated.

What to Do Next

See the Monitoring and Troubleshooting BFD section for more information on monitoring and troubleshooting BFD. If you want to configure only for a specific subset of interfaces, perform the tasks in the Configuring BFD Support for IS-IS for One or More Interfaces section.

Configuring BFD Support for IS-IS for One or More Interfaces

To configure BFD for only one or more IS-IS interfaces, perform the steps in this section.

Note Output from the **show bfd neighbors details** command shows the configured intervals. The output does not show intervals that were changed because hardware-offloaded BFD sessions were configured with Tx and Rx intervals that are not multiples of 50 ms.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip router isis** [*tag*]
5. **isis bfd [disable]**
6. **end**
7. **show bfd neighbors** [**details**]
8. **show clns interface**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface fastethernet 6/0`	Enters interface configuration mode.

	Command or Action	Purpose
Step 4	**ip router isis** [*tag*] **Example:** `Router(config-if)# ip router isis tag1`	Enables support for IPv4 routing on the interface.
Step 5	**isis bfd [disable]** **Example:** `Router(config-if)# isis bfd`	Enables or disables BFD on a per-interface basis for one or more interfaces associated with the IS-IS routing process. **Note** You should use the **disable** keyword only if you enabled BFD on all of the interfaces that IS-IS is associated with using the **bfd all-interfaces** command in router configuration mode.
Step 6	**end** **Example:** `Router(config-if)# end`	Exits interface configuration mode and returns the router to privileged EXEC mode.
Step 7	**show bfd neighbors** [**details**] **Example:** `Router# show bfd neighbors details`	(Optional) Displays information that can help verify if the BFD neighbor is active and displays the routing protocols that BFD has registered. **Note** In order to display the full output of the **show bfd neighbors details** command on a Cisco 12000 series router, you must enter the command on the line card. Enter the **attach** *slot-number* command to establish a CLI session with a line card. The registered protocols are not shown in the output of the **show bfd neighbors details** command when it is entered on a line card. **Note** If hardware-offloaded BFD sessions are configured with Tx and Rx intervals that are not multiples of 50 ms, the hardware intervals are changed. However, output from the **show bfd neighbors details** command will show the configured intervals, not the changed ones.
Step 8	**show clns interface** **Example:** `Router# show clns interface`	(Optional) Displays information that can help verify if BFD for IS-IS has been enabled for a specific IS-IS interface that is associated.

What to Do Next

See the Monitoring and Troubleshooting BFD section for more information on monitoring and maintaining BFD. If you want to configure BFD support for another routing protocol, see one of the following sections.

Configuring BFD Support for OSPF

This section describes the procedures for configuring BFD support for OSPF so that OSPF is a registered protocol with BFD and will receive forwarding path detection failure messages from BFD. You can either configure BFD support for OSPF globally on all interfaces or configure it selectively on one or more interfaces.

There are two methods for enabling BFD support for OSPF:

- You can enable BFD for all of the interfaces for which OSPF is routing by using the **bfd all-interfaces** command in router configuration mode. You can disable BFD support on individual interfaces using the **ip ospf bfd** [**disable**] command in interface configuration mode.
- You can enable BFD for a subset of the interfaces for which OSPF is routing by using the **ip ospf bfd** command in interface configuration mode.

See the following sections for tasks for configuring BFD support for OSPF:

Configuring BFD Support for OSPF for All Interfaces

To configure BFD for all OSPF interfaces, perform the steps in this section.

If you do not want to configure BFD on all OSPF interfaces and would rather configure BFD support specifically for one or more interfaces, see the Configuring BFD Support for OSPF for One or More Interfaces section.

Before You Begin

OSPF must be running on all participating routers.

The baseline parameters for BFD sessions on the interfaces over which you want to run BFD sessions to BFD neighbors must be configured. See the Configuring BFD Session Parameters on the Interface section for more information.

Note Output from the **show bfd neighbors details** command shows the configured intervals. The output does not show intervals that were changed because hardware-offloaded BFD sessions were configured with Tx and Rx intervals that are not multiples of 50 ms.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router ospf** *process-id*
4. **bfd all-interfaces**
5. **exit**
6. **interface** *type number*
7. **ip ospf bfd** [**disable**]
8. **end**
9. **show bfd neighbors** [**details**]
10. **show ip ospf**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**router ospf** *process-id* **Example:** `Router(config)# router ospf 4`	Specifies an OSPF process and enters router configuration mode.
Step 4	**bfd all-interfaces** **Example:** `Router(config-router)# bfd all-interfaces`	Enables BFD globally on all interfaces associated with the OSPF routing process.
Step 5	**exit** **Example:** `Router(config-router)# exit`	(Optional) Returns the router to global configuration mode. Enter this command only if you want to perform Step 7 to disable BFD for one or more interfaces.
Step 6	**interface** *type number* **Example:** `Router(config)# interface fastethernet 6/0`	(Optional) Enters interface configuration mode. Enter this command only if you want to perform Step 7 to disable BFD for one or more interfaces.
Step 7	**ip ospf bfd** [**disable**] **Example:** `Router(config-if)# ip ospf bfd disable`	(Optional) Disables BFD on a per-interface basis for one or more interfaces associated with the OSPF routing process. **Note** You should use the **disable** keyword only if you enabled BFD on all of the interfaces that OSPF is associated with using the **bfd all-interfaces** command in router configuration mode.
Step 8	**end** **Example:** `Router(config-if)# end`	Exits interface configuration mode and returns the router to privileged EXEC mode.

	Command or Action	Purpose
Step 9	**show bfd neighbors** [**details**] **Example:** `Router# show bfd neighbors detail`	(Optional) Displays information that can help verify if the BFD neighbor is active and displays the routing protocols that BFD has registered. **Note** In order to display the full output of the **show bfd neighbors details** command on a Cisco 12000 series router, you must enter the command on the line card. Enter the **attach** *slot-number* command to establish a CLI session with a line card. The registered protocols are not shown in the output of the **show bfd neighbors details**commandwhen it is entered on a line card. **Note** If hardware-offloaded BFD sessions are configured with Tx and Rx intervals that are not multiples of 50 ms, the hardware intervals are changed. However, output from the **show bfd neighbors details** command will show the configured intervals, not the changed ones.
Step 10	**show ip ospf** **Example:** `Router# show ip ospf`	(Optional) Displays information that can help verify if BFD for OSPF has been enabled.

What to Do Next

See the Monitoring and Troubleshooting BFD section for more information on monitoring and troubleshooting BFD. If you want to configure BFD support for another routing protocol, see the following sections.

Configuring BFD Support for OSPF for One or More Interfaces

To configure BFD on one or more OSPF interfaces, perform the steps in this section.

Before You Begin

OSPF must be running on all participating routers.

The baseline parameters for BFD sessions on the interfaces over which you want to run BFD sessions to BFD neighbors must be configured. See the Configuring BFD Session Parameters on the Interface section for more information.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip ospf bfd** [**disable**]
5. **end**
6. **show bfd neighbors** [**details**]
7. **show ip ospf**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Router(config)# interface fastethernet 6/0`	Enters interface configuration mode.
Step 4	**ip ospf bfd** [**disable**] **Example:** `Router(config-if)# ip ospf bfd`	Enables or disables BFD on a per-interface basis for one or more interfaces associated with the OSPF routing process. **Note** You should use the **disable** keyword only if you enabled BFD on all of the interfaces that OSPF is associated with using the **bfd all-interfaces** command in router configuration mode.
Step 5	**end** **Example:** `Router(config-if)# end`	Exits interface configuration mode and returns the router to privileged EXEC mode.
Step 6	**show bfd neighbors** [**details**] **Example:** `Router# show bfd neighbors details`	(Optional) Displays information that can help verify if the BFD neighbor is active and displays the routing protocols that BFD has registered. **Note** In order to display the full output of the **show bfd neighbors details** command on a Cisco 12000 series router, you must enter the command on the line card. Enter the **attach** *slot-number* command to establish a CLI session with a line card. The registered protocols are not shown in the output of the **show bfd neighbors details** command when it is entered on a line card. **Note** If hardware-offloaded BFD sessions are configured with Tx and Rx intervals that are not multiples of 50 ms, the hardware intervals are changed. However, output from the **show bfd neighbors details** command will show the configured intervals, not the changed ones.
Step 7	**show ip ospf** **Example:** `Router# show ip ospf`	(Optional) Displays information that can help verify if BFD support for OSPF has been enabled.

What to Do Next

See the Monitoring and Troubleshooting BFD section for more information on monitoring and troubleshooting BFD. If you want to configure BFD support for another routing protocol, see the following sections.

Configuring BFD Support for HSRP

Perform this task to enable BFD support for Hot Standby Router Protocol (HSRP.) Repeat the steps in this procedure for each interface over which you want to run BFD sessions to HSRP peers.

HSRP supports BFD by default. If HSRP support for BFD has been manually disabled, you can reenable it at the router level to enable BFD support globally for all interfaces or on a per-interface basis at the interface level.

Before You Begin

- HSRP must be running on all participating routers.
- Cisco Express Forwarding must be enabled.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip cef** [**distributed**]
4. **interface** *type number*
5. **ip address** *ip-address mask*
6. **standby** [*group-number*] **ip** [*ip-address* [**secondary**]]
7. **standby bfd**
8. **exit**
9. **standby bfd all-interfaces**
10. **exit**
11. **show standby neighbors**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**ip cef** [**distributed**] **Example:** `Router(config)# ip cef`	Enables Cisco Express Forwarding or distributed Cisco Express Forwarding.
Step 4	**interface** *type number* **Example:** `Router(config)# interface FastEthernet 6/0`	Enters interface configuration mode.
Step 5	**ip address** *ip-address mask* **Example:** `Router(config-if)# ip address 10.0.0.11 255.255.255.0`	Configures an IP address for the interface.
Step 6	**standby** [*group-number*] **ip** [*ip-address* [**secondary**]] **Example:** `Router(config-if)# standby 1 ip 10.0.0.11`	Activates HSRP.
Step 7	**standby bfd** **Example:** `Router(config-if)# standby bfd`	(Optional) Enables HSRP support for BFD on the interface.
Step 8	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode.
Step 9	**standby bfd all-interfaces** **Example:** `Router(config)# standby bfd all-interfaces`	(Optional) Enables HSRP support for BFD on all interfaces.

	Command or Action	Purpose
Step 10	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode.
Step 11	**show standby neighbors** **Example:** `Router# show standby neighbors`	(Optional) Displays information about HSRP support for BFD.

What to Do Next

See the Monitoring and Troubleshooting BFD section for more information on monitoring and troubleshooting BFD. If you want to configure BFD support for another routing protocol, see the following sections.

Configuring BFD Support for Static Routing

Perform this task to configure BFD support for static routing. Repeat the steps in this procedure on each BFD neighbor. For more information, see the "Example: Configuring BFD Support for Static Routing" section.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. Perform one of the following steps:
   - **ip address** *ipv4-address mask*
   - **ipv6 address** *ipv6-address*/*mask*
5. **bfd interval** *milliseconds* **mix_rx** *milliseconds* **multiplier** *interval-multiplier*
6. **exit**
7. **ip route static bfd** *interface-type interface-number ip-address* [**group** *group-name* [**passive**]]
8. **ip route** [**vrf** *vrf-name*] *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]} [**dhcp**] [*distance*] [**name** *next-hop-name*] [**permanent** | **track** *number*] [**tag** *tag*]
9. **exit**
10. **show ip static route**
11. **show ip static route bfd**
12. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface serial 2/0`	Configures an interface and enters interface configuration mode.

Step 4	Perform one of the following steps:
	• **ip address** *ipv4-address mask*
	• **ipv6 address** *ipv6-address*/*mask*
	
	Example:
	Configuring an IPv4 address for the interface:
	`Device(config-if)# ip address 10.201.201.1 255.255.255.0`
	Configuring an IPv6 address for the interface:
	`Device(config-if)# ipv6 address 2001:db8:1:1::1/32`
		Configures an IP address for the interface.

Step 5	**bfd interval** *milliseconds* **mix_rx** *milliseconds* **multiplier** *interval-multiplier* **Example:** `Device(config-if)# bfd interval 500 min_rx 500 multiplier 5`	Enables BFD on the interface. The bfd interval configuration is removed when the subinterface on which it is configured is removed. The bfd interval configuration is not removed when: • an IPv4 address is removed from an interface • an IPv6 address is removed from an interface • IPv6 is disabled from an interface • an interface is shutdown • IPv4 CEF is disabled globally or locally on an interface

	Command or Action	Purpose
		• IPv6 CEF is disabled globally or locally on an interface
Step 6	**exit** **Example:** `Device(config-if)# exit`	Exits interface configuration mode and returns to global configuration mode.
Step 7	**ip route static bfd** *interface-type interface-number ip-address* [**group** *group-name* [**passive**]] **Example:** `Device(config)# ip route static bfd serial 2/0 10.1.1.1 group group1 passive`	Specifies a static route BFD neighbor. • The *interface-type*, *interface-number*, and *ip-address* arguments are required because BFD support exists only for directly connected neighbors.
Step 8	**ip route** [**vrf** *vrf-name*] *prefix mask* {*ip-address* | *interface-type interface-number* [*ip-address*]} [**dhcp**] [*distance*] [**name** *next-hop-name*] [**permanent** | **track** *number*] [**tag** *tag*] **Example:** `Device(config)# ip route 10.0.0.0 255.0.0.0`	Specifies a static route BFD neighbor.
Step 9	**exit** **Example:** `Device(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode.
Step 10	**show ip static route** **Example:** `Device# show ip static route`	(Optional) Displays static route database information.
Step 11	**show ip static route bfd** **Example:** `Device# show ip static route bfd`	(Optional) Displays information about the static BFD configuration from the configured BFD groups and nongroup entries.
Step 12	**exit** **Example:** `Device# exit`	Exits privileged EXEC mode and returns to user EXEC mode.

Configuring BFD Echo Mode

BFD echo mode is enabled by default, but you can disable it such that it can run independently in each direction.

BFD echo mode works with asynchronous BFD. Echo packets are sent by the forwarding engine and forwarded back along the same path in order to perform detection--the BFD session at the other end does not participate in the actual forwarding of the echo packets. The echo function and the forwarding engine are responsible for the detection process; therefore, the number of BFD control packets that are sent out between two BFD neighbors is reduced. In addition, because the forwarding engine is testing the forwarding path on the remote (neighbor) system without involving the remote system, there is an opportunity to improve the interpacket delay variance, thereby achieving quicker failure detection times than when using BFD Version 0 with BFD control packets for the BFD session.

Echo mode is described as without asymmetry when it is running on both sides (both BFD neighbors are running echo mode).

Prerequisites

BFD must be running on all participating routers.

Before using BFD echo mode, you must disable the sending of Internet Control Message Protocol (ICMP) redirect messages by entering the **no ip redirects** command, in order to avoid high CPU utilization.

The baseline parameters for BFD sessions on the interfaces over which you want to run BFD sessions to BFD neighbors must be configured. See the Configuring BFD Session Parameters on the Interface section for more information.

Restrictions

BFD echo mode, which is supported in BFD Version 1, is available only in Cisco IOS Releases 12.4(9), and 12.2(33)SRA.

Note BFD echo mode does not work in conjunction with Unicast Reverse Path Forwarding (uRPF) configuration. If BFD echo mode and uRPF configurations are enabled, then the sessions will flap.

Configuring the BFD Slow Timer

The steps in this procedure show how to change the value of the BFD slow timer. Repeat the steps in this procedure for each BFD router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **bfd slow-timer** *milliseconds*
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Switch> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Switch# configure terminal`	Enters global configuration mode.
Step 3	**bfd slow-timer** *milliseconds* **Example:** `Switch(config)# bfd slow-timer 12000`	Configures the BFD slow timer.
Step 4	**end** **Example:** `Switch(config)# end`	Exits global configuration mode and returns the router to privileged EXEC mode.

Disabling BFD Echo Mode Without Asymmetry

The steps in this procedure show how to disable BFD echo mode without asymmetry—no echo packets will be sent by the router, and the router will not forward BFD echo packets that are received from any neighbor routers.

Repeat the steps in this procedure for each BFD router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **no bfd echo**
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**no bfd echo** **Example:** `Router(config)# no bfd echo`	Disables BFD echo mode. • Use the **no** form to disable BFD echo mode.
Step 4	**end** **Example:** `Router(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.

Creating and Configuring BFD Templates

You can configure a single-hop template to specify a set of BFD interval values. BFD interval values specified as part of the BFD template are not specific to a single interface. You can configure a multihop template to associate these values with one or more maps of destinations and associated BFD timers. You can enable authentication and configure a key chain for BFD multihop sessions.

Configuring a Single-Hop Template

Perform this task to create a BFD single-hop template and configure BFD interval timers.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **bfd-template single-hop** *template-name*
4. **interval min-tx** *milliseconds* **min-rx** *milliseconds* **multiplier** *multiplier-value*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**bfd-template single-hop** *template-name* **Example:** `Router(config)# bfd-template single-hop bfdtemplate1`	Creates a single-hop BFD template and enters BFD configuration mode.
Step 4	**interval min-tx** *milliseconds* **min-rx** *milliseconds* **multiplier** *multiplier-value* **Example:** `Router(bfd-config)# interval min-tx 120 min-rx 100 multiplier 3`	Configures the transmit and receive intervals between BFD packets, and specifies the number of consecutive BFD control packets that must be missed before BFD declares that a peer is unavailable.
Step 5	**end** **Example:** `Router(bfd-config)# end`	Exits BFD configuration mode and returns the router to privileged EXEC mode.

Configuring a Multihop Template

Perform this task to create a BFD multihop template and configure BFD interval timers, authentication, and key chain.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **bfd-template multi-hop** *template-name*
4. **interval min-tx** *milliseconds* **min-rx** *milliseconds* **multiplier** *multiplier-value*
5. **authentication** *authentication-type* **keychain** *keychain-name*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**bfd-template multi-hop** *template-name* **Example:** `Router(config)# bfd-template multi-hop mh-template1`	Creates a BFD multihop BFD template and enters BFD configuration mode.
Step 4	**interval min-tx** *milliseconds* **min-rx** *milliseconds* **multiplier** *multiplier-value* **Example:** `Router(bfd-config)# interval min-tx 120 min-rx 100 multiplier 3`	Configures the transmit and receive intervals between BFD packets, and specifies the number of consecutive BFD control packets that must be missed before BFD declares that a peer is unavailable.
Step 5	**authentication** *authentication-type* **keychain** *keychain-name* **Example:** `Router(bfd-config)# authentication keyed-sha-1 keychain bfd-multihop`	Configures authentication for the multihop template and specifies the authentication type.

	Command or Action	Purpose
Step 6	**end** **Example:** `Router(bfd-config)# end`	Exits BFD configuration mode and returns the router to privileged EXEC mode.

What to Do Next

The BFD templates that you create can be applied to pseudowire classes to enable BFD control channel over VCCV on ATM pseudowire networks. For more information, see the Configuring BFD Control Channel over VCCV Support for ATM Pseudowire section.

Configuring a BFD Map

Perform this task to configure a BFD map that associates the interval timers and authentication configured in a template with unique source-destination address pairs for multihop BFD sessions.

Before You Begin

You must configure a BFD multihop template before you associate it with a map.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **bfd mapipv4 vrf** *vrf-name destination length source-address length template-name*
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**bfd mapipv4 vrf** *vrf-name destination length source-address length template-name* **Example:** `Router(config)# bfd map ipv4 vrf vpn1 192.168.0.0/24 192.168.42.5/32 mh-template1`	Configures a BFD map and associates it with the template.
Step 4	**end** **Example:** `Router(config)# end`	Exits BFD configuration mode and returns the router to privileged EXEC mode.

Configuring BFD Control Channel over VCCV Support for ATM Pseudowire

Perform this task to configure BFD over VCCV Support for ATM Pseudowire networks.

Before You Begin

You must create and configure the BFD template before you assign it to the pseudowire class. For more information, see the Creating and Configuring BFD Templates section.

Before VCCV BFD can be run on pseudowires, pseudowires must be configured on the network.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **pseudowire-class** *name*
4. **encapsulation** *type*
5. **protoco** l {**ldp** | **none**}
6. **vccv** {**control-word** | **router-alert** | **ttl**}
7. **vccv bfd template** *name* {**udp** | **raw-bfd**}
8. **vccv bfd status signaling**
9. **exit**
10. **interface atm** *interface-number*
11. **atm asynchronous**
12. **pvc vpi/** *vci* **l2transport**
13. **xconnect** *peer-ip-address vc-id* {**encapsulation mpls** [**manual**] | **pw-class** *pw-class-name*} [**pw-class** *pw-class-name*] [**sequencing** {**transmit** | **receive** | **both**}]
14. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**pseudowire-class** *name* **Example:** `Router(config)# pseudowire-class vccv-bfd1`	Specifies the name of the pseudowire class and enters pseudowire class configuration mode.
Step 4	**encapsulation** *type* **Example:** `Router(config-pw-class)# encapsulation mpls`	Specifies that MPLS is used as the data encapsulation method for tunneling Layer 2 traffic over the pseudowire. • You must specify mpls encapsulation as part of the **xconnect** command or as part of a pseudowire class for the AToM Virtual Circuits to work properly.
Step 5	**protoco** l {**ldp** | **none**} **Example:** `Router(config-pw-class)# protocol none`	Specifies that no signaling is configured and that manually configured sessions are used. • To configure static pseudowires, you must specify the **none** keyword.
Step 6	**vccv** {**control-word** | **router-alert** | **ttl**} **Example:** `Router(config-pw-class)# vccv control-word`	Sets the MPLS pseudowire CC type. • For MPLS pseudowires that use a CV type that does not include IP/UDP headers, you must set the CC type to CC type 1: pseudowire control word.
Step 7	**vccv bfd template** *name* {**udp** | **raw-bfd**} **Example:** `Router(config-pw-class)# vccv bfd template bfdtemplate1 raw-bfd`	Enables VCCV BFD for the pseudowire class.
Step 8	**vccv bfd status signaling** **Example:** `Router(config-pw-class)# vccv bfd status signaling`	Enables status signaling for BFD VCCV.

	Command or Action	Purpose
Step 9	**exit** **Example:** `Router(config-pw-class)# exit`	Exits pseudowire class configuration mode and returns to global configuration mode.
Step 10	**interface atm** *interface-number* **Example:** `Router(config)# interface atm 9/0/0`	Configures an ATM interface and enters interface configuration mode
Step 11	**atm asynchronous** **Example:** `Router(config-if)# atm asynchronous`	Enables asynchronous mode on the ATM interface.
Step 12	**pvc vpi/** *vci* **l2transport** **Example:** `Router(config-if)# pvc 0/100 l2transport`	Creates the ATM permanent virtual circuit (PVC), specifies the encapsulation type on an ATM PVC, and enters ATM virtual circuit configuration mode.
Step 13	**xconnect** *peer-ip-address vc-id* {**encapsulation mpls** [**manual**] | **pw-class** *pw-class-name*} [**pw-class** *pw-class-name*] [**sequencing** {**transmit** | **receive** | **both**}] **Example:** `Router(cfg-if-atm-l2trans-pvc)# xconnect 10.0.0.7 100 pw-class vccv-bfd1`	Binds an attachment circuit to a pseudowire, configures an AToM static pseudowire, and specifies the pseudowire class.
Step 14	**end** **Example:** `Router(cfg-if-atm-l2trans-pvc)# end`	Exits ATM virtual circuit configuration mode and returns to global configuration mode.

Monitoring and Troubleshooting BFD

This section describes how to retrieve BFD information for maintenance and troubleshooting. The commands in these tasks can be entered as needed, in any order desired.

For more information about BFD session initiation and failure, refer to the BFD Operation, on page 6.

This section contains information for monitoring and troubleshooting BFD for the following Cisco platforms:

Monitoring and Troubleshooting BFD for Cisco 7600 Series Routers

To monitor or troubleshoot BFD on Cisco 7600 series routers, perform one or more of the steps in this section.

Note See the "Configuring Synchronous Ethernet on the Cisco 7600 Router with ES+ Line Card" section of the *Cisco 7600 Series Ethernet Services Plus (ES+) and Ethernet Services Plus T (ES+T) Line Card Configuration Guide* for more information about troubleshooting BFD on Cisco 7600 series routers.

SUMMARY STEPS

1. **enable**
2. **show bfd neighbors** [**details**]
3. **debug bfd** [**packet** | **event**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show bfd neighbors** [**details**] **Example:** `Router# show bfd neighbors details`	(Optional) Displays the BFD adjacency database. • The **details** keyword shows all BFD protocol parameters and timers per neighbor. **Note** In order to see the full output of the **show bfd neighbors details** command on a Cisco 12000 series router, you must enter the command on the line card. Enter the **attach** *slot-number* command to establish a CLI session with a line card. The registered protocols are not shown in the output of the **show bfd neighbors details** command when it is entered on a line card. **Note** If hardware-offloaded BFD sessions are configured with Tx and Rx intervals that are not multiples of 50 ms, the hardware intervals are changed. However, output from the **show bfd neighbors details** command will show the configured intervals, not the changed ones.
Step 3	**debug bfd** [**packet**	**event**] **Example:** `Router# debug bfd packet`	(Optional) Displays debugging information about BFD packets.

Monitoring and Troubleshooting BFD for Cisco 10720 Internet Routers

To monitor or troubleshoot BFD on Cisco 10720 Internet routers, perform one or more of the steps in this section.

SUMMARY STEPS

1. **enable**
2. **show bfd neighbors** [**details**]
3. **debug bfd event**
4. **debug bfd packet**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show bfd neighbors** [**details**] **Example:** `Router# show bfd neighbors details`	(Optional) Displays the BFD adjacency database. • The **details** keyword will show all BFD protocol parameters and timers per neighbor. **Note** The registered protocols are not shown in the output of the **show bfd neighbors details** when it is entered on a line card.
Step 3	**debug bfd event** **Example:** `Router# debug bfd event`	(Optional) Displays debugging information about BFD state transitions.
Step 4	**debug bfd packet** **Example:** `Router# debug bfd packet`	(Optional) Displays debugging information about BFD control packets.

Monitoring and Troubleshooting BFD for Cisco 12000 Series Routers

To monitor or troubleshoot BFD on Cisco 12000 series routers, perform one or more of the steps in this section.

SUMMARY STEPS

1. **enable**
2. **attach** *slot-number*
3. **show bfd neighbors** [**details**]
4. **show monitor event-trace bfd** [**all**]
5. **debug bfd event**
6. **debug bfd packet**
7. **debug bfd ipc-error**
8. **debug bfd ipc-event**
9. **debug bfd oir-error**
10. **debug bfd oir-event**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**attach** *slot-number* **Example:** `Router# attach 6`	Connects you to a specific line card for the purpose of executing monitoring and maintenance commands on the specified line card. Slot numbers range from 0 to 11 for the Cisco 12012 and from 0 to 7 for the Cisco 12008. • If the slot number is omitted, you are prompted for the slot number. **Note** In order to display the full output of the **show bfd neighbors details** command on a Cisco 12000 series router, you must enter the command on the line card. Enter the **attach** *slot-number* command to establish a CLI session with a line card.
Step 3	**show bfd neighbors** [**details**] **Example:** `Router# show bfd neighbors details`	Displays the BFD adjacency database. • The **details** keyword shows all BFD protocol parameters and timers per neighbor. **Note** The registered protocols are not shown in the output of the **show bfd neighbors details** when it is entered on a line card. **Note** If hardware-offloaded BFD sessions are configured with Tx and Rx intervals that are not multiples of 50 ms, the hardware intervals are changed. However, output from the **show bfd neighbors details** command will show the configured intervals, not the changed ones.

	Command or Action	Purpose
Step 4	**show monitor event-trace bfd** [**all**] **Example:** `Router# show monitor event-trace bfd all`	Displays logged messages for important events in "recent past" on BFD activities that occur on the line cards. This is a rolling buffer based log, so "distant past" events would be lost. Depending on traffic and frequency of events, these events could be seen over a variable time window.
Step 5	**debug bfd event** **Example:** `Router# debug bfd event`	Displays debugging information about BFD state transitions.
Step 6	**debug bfd packet** **Example:** `Router# debug bfd packet`	Displays debugging information about BFD control packets.
Step 7	**debug bfd ipc-error** **Example:** `Router# debug bfd ipc-error`	Displays debugging information with IPC errors on the RP and LC.
Step 8	**debug bfd ipc-event** **Example:** `Router# debug bfd ipc-event`	Displays debugging information with IPC events on the RP and LC.
Step 9	**debug bfd oir-error** **Example:** `Router# debug bfd oir-error`	Displays debugging information with OIR errors on the RP and LC.
Step 10	**debug bfd oir-event** **Example:** `Router# debug bfd oir-event`	Displays debugging information with OIR events on the RP and LC.

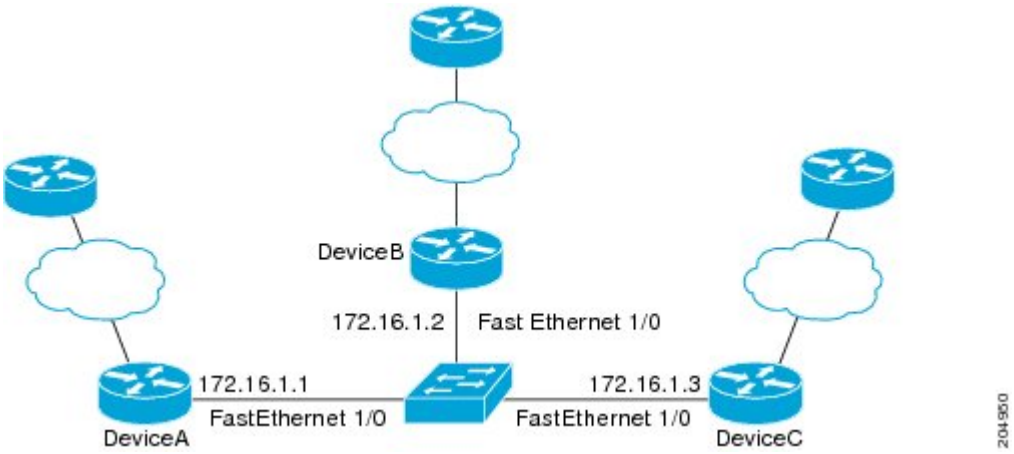
Configuration Examples for Bidirectional Forwarding Detection

Example: Configuring BFD in an EIGRP Network with Echo Mode Enabled by Default

In the following example, the EIGRP network contains RouterA, RouterB, and RouterC. Fast Ethernet interface 1/0 on RouterA is connected to the same network as Fast Ethernet interface 1/0 on Router B. Fast Ethernet interface 1/0 on RouterB is connected to the same network as Fast Ethernet interface 1/0 on RouterC.

RouterA and RouterB are running BFD Version 1, which supports echo mode, and RouterC is running BFD Version 0, which does not support echo mode. The BFD sessions between RouterC and its BFD neighbors are said to be running echo mode with asymmetry because echo mode will run on the forwarding path for RouteA and RouterB, and their echo packets will return along the same path for BFD sessions and failure detections, while their BFD neighbor RouterC runs BFD Version 0 and uses BFD controls packets for BFD sessions and failure detections.

The figure below shows a large EIGRP network with several routers, three of which are BFD neighbors that are running EIGRP as their routing protocol.



The example, starting in global configuration mode, shows the configuration of BFD.

Configuration for RouterA

```
interface Fast Ethernet0/0
 no shutdown
 ip address 10.4.9.14 255.255.255.0
 duplex auto
 speed auto
!
interface Fast Ethernet1/0
 ip address 172.16.1.1 255.255.255.0
 bfd interval 50 min_rx 50 multiplier 3
 no shutdown
 duplex auto
 speed auto
!
router eigrp 11
```

```
 network 172.16.0.0
 bfd all-interfaces
 auto-summary
!
ip default-gateway 10.4.9.1
ip default-network 0.0.0.0
ip route 0.0.0.0 0.0.0.0 10.4.9.1
ip route 172.16.1.129 255.255.255.255 10.4.9.1
!
no ip http server
!
logging alarm informational
!
control-plane
!
line con 0
 exec-timeout 30 0
 stopbits 1
line aux 0
 stopbits 1
line vty 0 4
 login
!
!
end
```

Configuration for RouterB

```
!
interface Fast Ethernet0/0
 no shutdown
 ip address 10.4.9.34 255.255.255.0
 duplex auto
 speed auto
!
interface Fast Ethernet1/0
 ip address 172.16.1.2 255.255.255.0
 bfd interval 50 min_rx 50 multiplier 3
 no shtdown
 duplex auto
 speed auto
!
router eigrp 11
 network 172.16.0.0
 bfd all-interfaces
 auto-summary
!
ip default-gateway 10.4.9.1
ip default-network 0.0.0.0
ip route 0.0.0.0 0.0.0.0 10.4.9.1
ip route 172.16.1.129 255.255.255.255 10.4.9.1
!
no ip http server
!
logging alarm informational
!
control-plane
!
line con 0
 exec-timeout 30 0
 stopbits 1
line aux 0
 stopbits 1
line vty 0 4
 login
!
!
end
```

Configuration for RouterC

```
!
!
interface Fast Ethernet0/0
 no shutdown
 ip address 10.4.9.34 255.255.255.0
 duplex auto
 speed auto
!
interface Fast Ethernet1/0
 ip address 172.16.1.2 255.255.255.0
 bfd interval 50 min_rx 50 multiplier 3
 no shutdown
 duplex auto
 speed auto
!
router eigrp 11
 network 172.16.0.0
 bfd all-interfaces
 auto-summary
!
ip default-gateway 10.4.9.1
ip default-network 0.0.0.0
ip route 0.0.0.0 0.0.0.0 10.4.9.1
ip route 172.16.1.129 255.255.255.255 10.4.9.1
!
no ip http server
!
logging alarm informational
!
control-plane
!
line con 0
 exec-timeout 30 0
 stopbits 1
line aux 0
 stopbits 1
line vty 0 4
 login
!
!
end
```

The output from the **show bfd neighbors details** command from RouterA verifies that BFD sessions have been created among all three routers and that EIGRP is registered for BFD support. The first group of output shows that RouterC with the IP address 172.16.1.3 runs BFD Version 0 and therefore does not use the echo mode. The second group of output shows that RouterB with the IP address 172.16.1.2 does run BFD Version 1, and the 50 millisecond BFD interval parameter had been adopted. The relevant command output is shown in bold in the output.

```
RouterA# show bfd neighbors details

OurAddr
       NeighAddr
      LD/RD  RH/RS    Holdown(mult)  State     Int
172.16.1.1    172.16.1.3
     5/3    1(RH)    150 (3 )       Up   Fa1/0
Session state is UP and not using echo function.
Local Diag: 0, Demand mode: 0, Poll bit: 0
MinTxInt: 50000, MinRxInt: 50000, Multiplier: 3
Received MinRxInt: 50000, Received Multiplier: 3
Holdown (hits): 150(0), Hello (hits): 50(1364284)
Rx Count: 1351813, Rx Interval (ms) min/max/avg: 28/64/49 last: 4 ms ago
Tx Count: 1364289, Tx Interval (ms) min/max/avg: 40/68/49 last: 32 ms ago
Registered protocols: EIGRP
Uptime: 18:42:45
Last packet: Version: 0
            - Diagnostic: 0
```

```
            I Hear You bit: 1     - Demand bit: 0
            Poll bit: 0           - Final bit: 0
            Multiplier: 3         - Length: 24
            My Discr.: 3          - Your Discr.: 5
            Min tx interval: 50000    - Min rx interval: 50000
            Min Echo interval: 0
OurAddr       NeighAddr
     LD/RD  RH/RS   Holdown(mult)  State     Int
172.16.1.1    172.16.1.2

    6/1    Up        0    (3 )   Up        Fa1/0
Session state is UP and using echo function with 50 ms interval.
Local Diag: 0, Demand mode: 0, Poll bit: 0
MinTxInt: 1000000, MinRxInt: 1000000, Multiplier: 3
Received MinRxInt: 1000000, Received Multiplier: 3
Holdown (hits): 3000(0), Hello (hits): 1000(317)
Rx Count: 305, Rx Interval (ms) min/max/avg: 1/1016/887 last: 448 ms ago
Tx Count: 319, Tx Interval (ms) min/max/avg: 1/1008/880 last: 532 ms ago
Registered protocols: EIGRP
Uptime: 00:04:30
Last packet: Version: 1

         - Diagnostic: 0
            State bit: Up         - Demand bit: 0
            Poll bit: 0           - Final bit: 0
            Multiplier: 3         - Length: 24
            My Discr.: 1          - Your Discr.: 6
            Min tx interval: 1000000    - Min rx interval: 1000000
            Min Echo interval: 50000
```

The output from the **show bfd neighbors details** command on Router B verifies that BFD sessions have been created and that EIGRP is registered for BFD support. As previously noted, RouterA runs BFD Version 1, therefore echo mode is running, and RouterC runs BFD Version 0, so echo mode does not run. The relevant command output is shown in bold in the output.

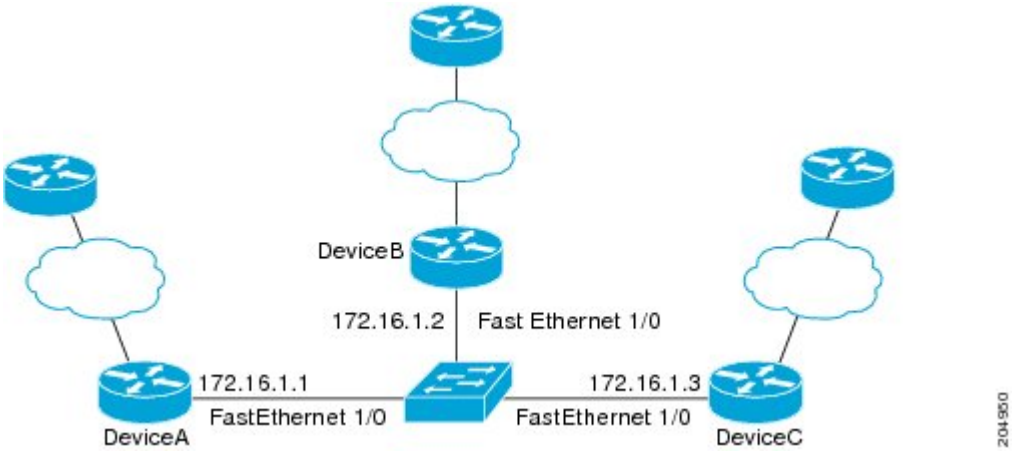
```
RouterB# show bfd neighbors details

OurAddr       NeighAddr
     LD/RD  RH/RS   Holdown(mult)  State     Int
172.16.1.2    172.16.1.1
    1/6    Up        0    (3 )   Up        Fa1/0
Session state is UP and using echo function with 50 ms interval.
Local Diag: 0, Demand mode: 0, Poll bit: 0
MinTxInt: 1000000, MinRxInt: 1000000, Multiplier: 3
Received MinRxInt: 1000000, Received Multiplier: 3
Holdown (hits): 3000(0), Hello (hits): 1000(337)
Rx Count: 341, Rx Interval (ms) min/max/avg: 1/1008/882 last: 364 ms ago
Tx Count: 339, Tx Interval (ms) min/max/avg: 1/1016/886 last: 632 ms ago
Registered protocols: EIGRP
Uptime: 00:05:00
Last packet: Version: 1
           - Diagnostic: 0
             State bit: Up         - Demand bit: 0
             Poll bit: 0           - Final bit: 0
             Multiplier: 3         - Length: 24
             My Discr.: 6          - Your Discr.: 1
             Min tx interval: 1000000    - Min rx interval: 1000000
             Min Echo interval: 50000
OurAddr       NeighAddr

 LD/RD  RH/RS   Holdown(mult)  State     Int
172.16.1.2    172.16.1.3
     3/6    1(RH)     118  (3 )   Up        Fa1/0
Session state is UP and not using echo function.
Local Diag: 0, Demand mode: 0, Poll bit: 0
MinTxInt: 50000, MinRxInt: 50000, Multiplier: 3
Received MinRxInt: 50000, Received Multiplier: 3
Holdown (hits): 150(0), Hello (hits): 50(5735)
Rx Count: 5731, Rx Interval (ms) min/max/avg: 32/72/49 last: 32 ms ago
Tx Count: 5740, Tx Interval (ms) min/max/avg: 40/64/50 last: 44 ms ago
```

```
Registered protocols: EIGRP
Uptime: 00:04:45
Last packet: Version: 0
             - Diagnostic: 0
              I Hear You bit: 1      - Demand bit: 0
              Poll bit: 0            - Final bit: 0
              Multiplier: 3          - Length: 24
              My Discr.: 6           - Your Discr.: 3
              Min tx interval: 50000    - Min rx interval: 50000
              Min Echo interval: 0
```

The figure below shows that Fast Ethernet interface 1/0 on RouterB has failed. When Fast Ethernet interface 1/0 on RouterB is shut down, the BFD statistics of the corresponding BFD sessions on RouterA and RouterB are reduced.



When Fast Ethernet interface 1/0 on RouterB fails, BFD will no longer detect Router B as a BFD neighbor for RouterA or for RouterC. In this example, Fast Ethernet interface 1/0 has been administratively shut down on RouterB.

The following output from the **show bfd neighbors** command on RouterA now shows only one BFD neighbor for RouterA in the EIGRP network. The relevant command output is shown in bold in the output.

```
RouterA# show bfd neighbors
OurAddr       NeighAddr

    LD/RD  RH/RS   Holdown(mult)  State     Int
172.16.1.1    172.16.1.3

    5/3    1(RH)     134  (3 )   Up        Fa1/0
```

The following output from the **show bfd neighbors** command on RouterC also now shows only one BFD neighbor for RouterC in the EIGRP network. The relevant command output is shown in bold in the output.

```
RouterC# show bfd neighbors

OurAddr       NeighAddr

   LD/RD RH  Holdown(mult)  State     Int
172.16.1.3    172.16.1.1

    3/5  1   114  (3 )      Up        Fa1/0
```

Example: Configuring BFD in an OSPF Network

In the following example, the simple OSPF network consists of Router A and Router B. Fast Ethernet interface 0/1 on Router A is connected to the same network as Fast Ethernet interface 6/0 in Router B. The example, starting in global configuration mode, shows the configuration of BFD. For both Routers A and B, BFD is configured globally for all interfaces associated with the OSPF process.

Configuration for Router A

```
!
interface Fast Ethernet 0/1
 ip address 172.16.10.1 255.255.255.0
 bfd interval 50 min_rx 50 multiplier 3
!
interface Fast Ethernet 3/0.1
ip address 172.17.0.1 255.255.255.0
!
router ospf 123
 log-adjacency-changes detail
 network 172.16.0.0 0.0.0.255 area 0
 network 172.17.0.0 0.0.0.255 area 0
 bfd all-interfaces
```

Configuration for Router B

```
!
interface Fast Ethernet 6/0
 ip address 172.16.10.2 255.255.255.0
 bfd interval 50 min_rx 50 multiplier 3
!
interface Fast Ethernet 6/1
 ip address 172.18.0.1 255.255.255.0
!
router ospf 123
 log-adjacency-changes detail
 network 172.16.0.0 0.0.255.255 area 0
 network 172.18.0.0 0.0.255.255 area 0
 bfd all-interfaces
```

The output from the **show bfd neighbors details** command verifies that a BFD session has been created and that OSPF is registered for BFD support. The relevant command output is shown in bold in the output.

Router A

```
RouterA# show bfd neighbors details
OurAddr       NeighAddr     LD/RD RH  Holdown(mult)  State     Int
172.16.10.1   172.16.10.2    1/2  1   532  (3 )      Up        Fa0/1
Local Diag: 0, Demand mode: 0, Poll bit: 0
MinTxInt: 200000, MinRxInt: 200000, Multiplier: 5
Received MinRxInt: 1000, Received Multiplier: 3
Holdown (hits): 600(22), Hello (hits): 200(84453)
Rx Count: 49824, Rx Interval (ms) min/max/avg: 208/440/332 last: 68 ms ago
Tx Count: 84488, Tx Interval (ms) min/max/avg: 152/248/196 last: 192 ms ago
Registered protocols: OSPF

Uptime: 02:18:49
Last packet: Version: 0
            - Diagnostic: 0
             I Hear You bit: 1     - Demand bit: 0
             Poll bit: 0           - Final bit: 0
             Multiplier: 3         - Length: 24
             My Discr.: 2          - Your Discr.: 1
```

```
             Min tx interval: 50000    - Min rx interval: 1000
             Min Echo interval: 0
```

The output from the **show bfd neighbors details** command from the line card on Router B verifies that a BFD session has been created:

Router B

```
RouterB# attach 6
Entering Console for 8 Port Fast Ethernet in Slot: 6
Type "exit" to end this session
Press RETURN to get started!
Router> show bfd neighbors details
Cleanup timer hits: 0
OurAddr       NeighAddr     LD/RD RH  Holdown(mult)  State     Int
172.16.10.2   172.16.10.1    8/1  1   1000 (5 )      Up        Fa6/0
Local Diag: 0, Demand mode: 0, Poll bit: 0
MinTxInt: 50000, MinRxInt: 1000, Multiplier: 3
Received MinRxInt: 200000, Received Multiplier: 5
Holdown (hits): 1000(0), Hello (hits): 200(5995)
Rx Count: 10126, Rx Interval (ms) min/max/avg: 152/248/196 last: 0 ms ago
Tx Count: 5998, Tx Interval (ms) min/max/avg: 204/440/332 last: 12 ms ago
Last packet: Version: 0            - Diagnostic: 0
             I Hear You bit: 1     - Demand bit: 0
             Poll bit: 0           - Final bit: 0
             Multiplier: 5         - Length: 24
             My Discr.: 1          - Your Discr.: 8
             Min tx interval: 200000    - Min rx interval: 200000
             Min Echo interval: 0
Uptime: 00:33:13
SSO Cleanup Timer called: 0
SSO Cleanup Action Taken: 0
Pseudo pre-emptive process count: 239103 min/max/avg: 8/16/8 last: 0 ms ago
 IPC Tx Failure Count: 0
 IPC Rx Failure Count: 0
 Total Adjs Found: 1
```

The output of the **show ip ospf** command verifies that BFD has been enabled for OSPF. The relevant command output is shown in bold in the output.

Router A

```
RouterA# show ip ospf

 Routing Process "ospf 123" with ID 172.16.10.1
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x000000
 Number of opaque AS LSA 0. Checksum Sum 0x000000
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 External flood list length 0
 BFD is enabled

    Area BACKBONE(0)
        Number of interfaces in this area is 2 (1 loopback)
        Area has no authentication
        SPF algorithm last executed 00:00:08.828 ago
        SPF algorithm executed 9 times
```

```
        Area ranges are
        Number of LSA 3. Checksum Sum 0x028417
        Number of opaque link LSA 0. Checksum Sum 0x000000
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
```

Router B

```
RouterB# show ip ospf

 Routing Process "ospf 123" with ID 172.18.0.1
 Supports only single TOS(TOS0) routes
 Supports opaque LSA
 Supports Link-local Signaling (LLS)
 Supports area transit capability
 Initial SPF schedule delay 5000 msecs
 Minimum hold time between two consecutive SPFs 10000 msecs
 Maximum wait time between two consecutive SPFs 10000 msecs
 Incremental-SPF disabled
 Minimum LSA interval 5 secs
 Minimum LSA arrival 1000 msecs
 LSA group pacing timer 240 secs
 Interface flood pacing timer 33 msecs
 Retransmission pacing timer 66 msecs
 Number of external LSA 0. Checksum Sum 0x0
 Number of opaque AS LSA 0. Checksum Sum 0x0
 Number of DCbitless external and opaque AS LSA 0
 Number of DoNotAge external and opaque AS LSA 0
 Number of areas in this router is 1. 1 normal 0 stub 0 nssa
 Number of areas transit capable is 0
 External flood list length 0
 BFD is enabled

    Area BACKBONE(0)
        Number of interfaces in this area is 2 (1 loopback)
        Area has no authentication
        SPF algorithm last executed 02:07:30.932 ago
        SPF algorithm executed 7 times
        Area ranges are
        Number of LSA 3. Checksum Sum 0x28417
        Number of opaque link LSA 0. Checksum Sum 0x0
        Number of DCbitless LSA 0
        Number of indication LSA 0
        Number of DoNotAge LSA 0
        Flood list length 0
```

The output of the **show ip ospf interface** command verifies that BFD has been enabled for OSPF on the interfaces connecting Router A and Router B. The relevant command output is shown in bold in the output.

Router A

```
RouterA# show ip ospf interface Fast Ethernet 0/1
show ip ospf interface Fast Ethernet 0/1
Fast Ethernet0/1 is up, line protocol is up
  Internet Address 172.16.10.1/24, Area 0
  Process ID 123, Router ID 172.16.10.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State BDR, Priority 1, BFD enabled
  Designated Router (ID) 172.18.0.1, Interface address 172.16.10.2
  Backup Designated router (ID) 172.16.10.1, Interface address 172.16.10.1
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:03
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
```

```
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 172.18.0.1  (Designated Router)
  Suppress hello for 0 neighbor(s)
```

Router B

```
RouterB# show ip ospf interface Fast Ethernet 6/1
Fast Ethernet6/1 is up, line protocol is up
  Internet Address 172.18.0.1/24, Area 0
  Process ID 123, Router ID 172.18.0.1, Network Type BROADCAST, Cost: 1
  Transmit Delay is 1 sec, State DR, Priority 1, BFD enabled
  Designated Router (ID) 172.18.0.1, Interface address 172.18.0.1
  No backup designated router on this network
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:01
  Supports Link-local Signaling (LLS)
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
```

Example: Configuring BFD in a BGP Network

In the following example, the simple BGP network consists of Router A and Router B. Fast Ethernet interface 0/1 on Router A is connected to the same network as Fast Ethernet interface 6/0 in Router B. The example, starting in global configuration mode, shows the configuration of BFD.

Configuration for Router A

```
!
interface Fast Ethernet 0/1
 ip address 172.16.10.1 255.255.255.0
 bfd interval 50 min_rx 50 multiplier 3
!
interface Fast Ethernet 3/0.1
ip address 172.17.0.1 255.255.255.0
!
!
router bgp 40000
 bgp log-neighbor-changes
 neighbor 172.16.10.2 remote-as 45000
 neighbor 172.16.10.2 fall-over bfd
 !
 address-family ipv4
 neighbor 172.16.10.2 activate
 no auto-summary
 no synchronization
 network 172.18.0.0 mask 255.255.255.0
 exit-address-family
!
```

Configuration for Router B

```
!
interface Fast Ethernet 6/0
 ip address 172.16.10.2 255.255.255.0
 bfd interval 50 min_rx 50 multiplier 3
!
interface Fast Ethernet 6/1
 ip address 172.18.0.1 255.255.255.0
```

```
!
router bgp 45000
 bgp log-neighbor-changes
 neighbor 172.16.10.1 remote-as 40000
 neighbor 172.16.10.1 fall-over bfd
 !
 address-family ipv4
 neighbor 172.16.10.1 activate
 no auto-summary
 no synchronization
 network 172.17.0.0 mask 255.255.255.0
 exit-address-family
!
```

The output from the **show bfd neighbors details** command from Router A verifies that a BFD session has been created and that BGP is registered for BFD support. The relevant command output is shown in bold in the output.

Router A

```
RouterA# show bfd neighbors details

OurAddr       NeighAddr     LD/RD RH  Holdown(mult)  State     Int
172.16.10.1   172.16.10.2    1/8  1   332  (3 )      Up        Fa0/1
Local Diag: 0, Demand mode: 0, Poll bit: 0
MinTxInt: 200000, MinRxInt: 200000, Multiplier: 5
Received MinRxInt: 1000, Received Multiplier: 3
Holdown (hits): 600(0), Hello (hits): 200(15491)
Rx Count: 9160, Rx Interval (ms) min/max/avg: 200/440/332 last: 268 ms ago
Tx Count: 15494, Tx Interval (ms) min/max/avg: 152/248/197 last: 32 ms ago
Registered protocols: BGP
Uptime: 00:50:45
Last packet: Version: 0            - Diagnostic: 0
             I Hear You bit: 1     - Demand bit: 0
             Poll bit: 0           - Final bit: 0
             Multiplier: 3         - Length: 24
             My Discr.: 8          - Your Discr.: 1
             Min tx interval: 50000    - Min rx interval: 1000
             Min Echo interval: 0
```

The output from the **show bfd neighbors details** command from the line card on Router B verifies that a BFD session has been created:

Router B

```
RouterB# attach 6
Entering Console for 8 Port Fast Ethernet in Slot: 6
Type "exit" to end this session
Press RETURN to get started!
Router> show bfd neighbors details
Cleanup timer hits: 0
OurAddr       NeighAddr     LD/RD RH  Holdown(mult)  State     Int
172.16.10.2   172.16.10.1    8/1  1   1000 (5 )      Up        Fa6/0
Local Diag: 0, Demand mode: 0, Poll bit: 0
MinTxInt: 50000, MinRxInt: 1000, Multiplier: 3
Received MinRxInt: 200000, Received Multiplier: 5
Holdown (hits): 1000(0), Hello (hits): 200(5995)
Rx Count: 10126, Rx Interval (ms) min/max/avg: 152/248/196 last: 0 ms ago
Tx Count: 5998, Tx Interval (ms) min/max/avg: 204/440/332 last: 12 ms ago
Last packet: Version: 0            - Diagnostic: 0
             I Hear You bit: 1     - Demand bit: 0
             Poll bit: 0           - Final bit: 0
             Multiplier: 5         - Length: 24
             My Discr.: 1          - Your Discr.: 8
             Min tx interval: 200000    - Min rx interval: 200000
             Min Echo interval: 0
Uptime: 00:33:13
SSO Cleanup Timer called: 0
SSO Cleanup Action Taken: 0
```

```
Pseudo pre-emptive process count: 239103 min/max/avg: 8/16/8 last: 0 ms ago
 IPC Tx Failure Count: 0
 IPC Rx Failure Count: 0
 Total Adjs Found: 1
```

The output of the **show ip bgp neighbors** command verifies that BFD has been enabled for the BGP neighbors:

Router A

```
RouterA# show ip bgp neighbors
BGP neighbor is 172.16.10.2,  remote AS 45000, external link
 Using BFD to detect fast fallover
.
.
.
```

Router B

```
RouterB# show ip bgp neighbors
BGP neighbor is 172.16.10.1,  remote AS 40000, external link
 Using BFD to detect fast fallover
.
.
.
```

Example: Configuring BFD in an IS-IS Network

In the following example, the simple IS-IS network consists of Router A and Router B. Fast Ethernet interface 0/1 on Router A is connected to the same network as Fast Ethernet interface 6/0 for Router B. The example, starting in global configuration mode, shows the configuration of BFD.

Configuration for Router A

```
!
interface Fast Ethernet 0/1
 ip address 172.16.10.1 255.255.255.0
ip router isis
 bfd interval 50 min_rx 50 multiplier 3
!
interface Fast Ethernet 3/0.1
ip address 172.17.0.1 255.255.255.0
ip router isis
!
router isis
 net 49.0001.1720.1600.1001.00
 bfd all-interfaces
!
```

Configuration for Router B

```
!
interface Fast Ethernet 6/0
 ip address 172.16.10.2 255.255.255.0
ip router isis
 bfd interval 50 min_rx 50 multiplier 3
!
interface Fast Ethernet 6/1
 ip address 172.18.0.1 255.255.255.0
ip router isis
!
router isis
 net 49.0000.0000.0002.00
```

```
 bfd all-interfaces
!
```

The output from the **show bfd neighbors details** command from Router A verifies that a BFD session has been created and that IS-IS is registered for BFD support:

```
RouterA# show bfd neighbors details

OurAddr       NeighAddr     LD/RD RH  Holdown(mult)  State     Int
172.16.10.1   172.16.10.2    1/8  1   536  (3 )      Up        Fa0/1
Local Diag: 0, Demand mode: 0, Poll bit: 0
MinTxInt: 200000, MinRxInt: 200000, Multiplier: 5
Received MinRxInt: 1000, Received Multiplier: 3
Holdown (hits): 600(0), Hello (hits): 200(23543)
Rx Count: 13877, Rx Interval (ms) min/max/avg: 200/448/335 last: 64 ms ago
Tx Count: 23546, Tx Interval (ms) min/max/avg: 152/248/196 last: 32 ms ago
Registered protocols: ISIS
Uptime: 01:17:09
Last packet: Version: 0            - Diagnostic: 0
             I Hear You bit: 1     - Demand bit: 0
             Poll bit: 0           - Final bit: 0
             Multiplier: 3         - Length: 24
             My Discr.: 8          - Your Discr.: 1
             Min tx interval: 50000    - Min rx interval: 1000
             Min Echo interval: 0
```

The output from the **show bfd neighbors details** command from the line card on Router B verifies that a BFD session has been created:

```
RouterB# attach 6

Entering Console for 8 Port Fast Ethernet in Slot: 6
Type "exit" to end this session
Press RETURN to get started!
Router> show bfd neighbors details
Cleanup timer hits: 0
OurAddr       NeighAddr     LD/RD RH  Holdown(mult)  State     Int
172.16.10.2   172.16.10.1    8/1  1   1000 (5 )      Up        Fa6/0
Local Diag: 0, Demand mode: 0, Poll bit: 0
MinTxInt: 50000, MinRxInt: 1000, Multiplier: 3
Received MinRxInt: 200000, Received Multiplier: 5
Holdown (hits): 1000(0), Hello (hits): 200(5995)
Rx Count: 10126, Rx Interval (ms) min/max/avg: 152/248/196 last: 0 ms ago
Tx Count: 5998, Tx Interval (ms) min/max/avg: 204/440/332 last: 12 ms ago
Last packet: Version: 0            - Diagnostic: 0
             I Hear You bit: 1     - Demand bit: 0
             Poll bit: 0           - Final bit: 0
             Multiplier: 5         - Length: 24
             My Discr.: 1          - Your Discr.: 8
             Min tx interval: 200000    - Min rx interval: 200000
             Min Echo interval: 0
Uptime: 00:33:13
SSO Cleanup Timer called: 0
SSO Cleanup Action Taken: 0
Pseudo pre-emptive process count: 239103 min/max/avg: 8/16/8 last: 0 ms ago
 IPC Tx Failure Count: 0
 IPC Rx Failure Count: 0
 Total Adjs Found: 1
```

Example: Configuring BFD in an HSRP Network

In the following example, the HSRP network consists of Router A and Router B. Fast Ethernet interface 2/0 on Router A is connected to the same network as Fast Ethernet interface 2/0 on Router B. The example, starting in global configuration mode, shows the configuration of BFD.

Note In the following example, the **standby bfd** and the **standby bfd all-interfaces** commands are not displayed. HSRP support for BFD peering is enabled by default when BFD is configured on the router or interface using the **bfd interval** command. The **standby bfd**and **standby bfd all-interfaces** commands are needed only if BFD has been manually disabled on a router or interface.

Router A

```
ip cef
interface Fast Ethernet2/0
 no shutdown
 ip address 10.0.0.2 255.0.0.0
 ip router-cache cef
 bfd interval 200 min_rx 200 multiplier 3
 standby 1 ip 10.0.0.11
 standby 1 preempt
 standby 1 priority 110

 standby 2 ip 10.0.0.12
 standby 2 preempt
 standby 2 priority 110
```

Router B

```
interface Fast Ethernet2/0
 ip address 10.1.0.22 255.255.0.0
 no shutdown
 bfd interval 200 min_rx 200 multiplier 3
 standby 1 ip 10.0.0.11
 standby 1 preempt
 standby 1 priority 90
 standby 2 ip 10.0.0.12
 standby 2 preempt
 standby 2 priority 80
```

The output from the **show standby neighbors** command verifies that a BFD session has been created:

```
RouterA#show standby neighbors

HSRP neighbors on Fast Ethernet2/0
  10.1.0.22
    No active groups
    Standby groups: 1
    BFD enabled !
RouterB# show standby neighbors

HSRP neighbors on Fast Ethernet2/0
  10.0.0.2
    Active groups: 1
    No standby groups
    BFD enabled !
```

Example: Configuring BFD Support for Static Routing

In the following example, the network consists of Device A and Device B. Serial interface 2/0 on Device A is connected to the same network as serial interface 2/0 on Device B. In order for the BFD session to come up, Device B must be configured.

Device A

```
configure terminal
interface Serial 2/0
ip address 10.201.201.1 255.255.255.0
bfd interval 500 min_rx 500 multiplier 5
ip route static bfd Serial 2/0 10.201.201.2
ip route 10.0.0.0 255.0.0.0 Serial 2/0 10.201.201.2
```

Device B

```
configure terminal
interface Serial 2/0
ip address 10.201.201.2 255.255.255.0
bfd interval 500 min_rx 500 multiplier 5
ip route static bfd Serial 2/0 10.201.201.1
ip route 10.1.1.1 255.255.255.255 Serial 2/0 10.201.201.1
```

Note that the static route on Device B exists solely to enable the BFD session between 10.201.201.1 and 10.201.201.2. If there is no useful static route that needs to be configured, select a prefix that will not affect packet forwarding, for example, the address of a locally configured loopback interface.

In the following example, there is an active static BFD configuration to reach 209.165.200.225 through Ethernet interface 0/0 in the BFD group testgroup. As soon as the static route is configured that is tracked by the configured static BFD, a single hop BFD session is initiated to 209.165.200.225 through Ethernet interface 0/0. The prefix 10.0.0.0/8 is added to the RIB if a BFD session is successfully established.

```
configure terminal
ip route static bfd Ethernet 0/0 209.165.200.225 group testgroup
ip route 10.0.0.0 255.255.255.224 Ethernet 0/0 209.165.200.225
```

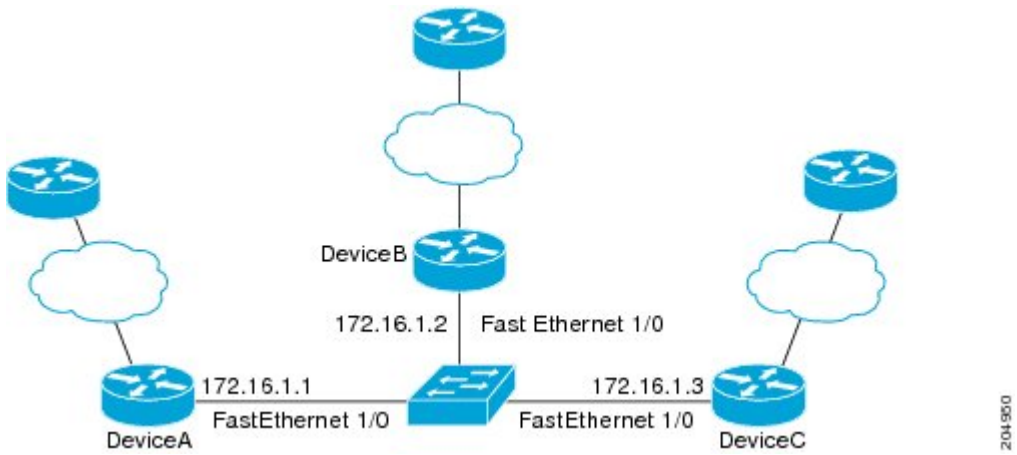
In the following example, a BFD session to 209.165.200.226 through Ethernet interface 0/0.1001 is marked to use the group testgroup. That is, this configuration is a passive static BFD. Though there are static routes to be tracked by the second static BFD configuration, a BFD session is not triggered for 209.165.200.226 through Ethernet interface 0/0.1001. The existence of the prefixes 10.1.1.1/8 and 10.2.2.2/8 is controlled by the active static BFD session (Ethernet interface 0/0 209.165.200.225).

```
configure terminal
ip route static bfd Ethernet 0/0 209.165.200.225 group testgroup
ip route 10.0.0.0 255.255.255.224 Ethernet 0/0 209.165.200.225
ip route static bfd Ethernet 0/0.1001 209.165.200.226 group testgroup passive
ip route 10.1.1.1 255.255.255.224 Ethernet 0/0.1001 209.165.200.226
ip route 10.2.2.2 255.255.255.224 Ethernet 0/0.1001 209.165.200.226
```

Example: Configuring BFD Control Channel over VCCV--Support for ATM Pseudowire

The figure below shows a typical ATM pseudowire configuration. The network consists of a MPLS pseudowire carrying an ATM payload between two terminating provider edge (T-PE) devices: T-PE1 and T-PE2. BFD monitoring of the pseudowire occurs between the T-PE1 device and the switching providing edge (S-PE) device, and between the S-PE device and the T-PE2 device. BFD also monitors the signal status of the ACs between the customer edge (CE) devices and the T-PE devices.

Note No configuration specific to BFD control channel over VCCV is required for the S-PEs.



CE1

```
interface ATM 0/0
 description connect to mfi6 atm9/0/0
 no ip address
 no ip directed-broadcast
 atm clock INTERNAL
 atm sonet stm-1
 no atm enable-ilmi-trap
 no atm ilmi-keepalive
!
interface ATM 0/0.2 point-to-point
 ip address 10.25.1.1 255.255.255.0
 no ip directed-broadcast
 no atm enable-ilmi-trap
 pvc 0/100
  encapsulation aal5snap
```

T-PE1

```
interface Loopback 0
 ip address 10.0.0.6 255.255.255.255
bfd-template single-hop nsn
 interval min-tx 500 min-rx 500 multiplier 3
pseudowire-class vccv-bfd1
 encapsulation mpls
 vccv bfd template nsn raw-bfd
 vccv bfd status signaling
interface ATM 9/0/0
 description connect mfr4 atm0/0
 no ip address
 atm asynchronous
 atm clock INTERNAL
 no atm ilmi-keepalive
 no atm enable-ilmi-trap
 pvc 0/100 l2transport
  xconnect 10.0.0.7 100 pw-class vccv-bfd1
```

T-PE2

```
interface Loopback 0
 ip address 10.54.0.1 255.255.255.255
bfd-template single-hop nsn
 interval min-tx 500 min-rx 500 multiplier 3
!
pseudowire-class vccv-bfd1
```

```
 encapsulation mpls
 vccv bfd template nsn raw-bfd
 vccv bfd status signaling
interface ATM 2/0
 no ip address
 atm asynchronous
 no atm ilmi-keepalive
 no atm enable-ilmi-trap
 pvc 0/100 l2transport
  xconnect 10.0.0.7 102 pw-class vccv-bfd1
 !
```

CE2

```
interface ATM 4/0.2 point-to-point
 ip address 10.25.1.2 255.255.255.0
 no snmp trap link-status
 pvc 0/100
  encapsulation aal5snap
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	*Cisco IOS Master Commands List, All Releases*
Configuring and monitoring BGP	"Cisco BGP Overview" module of the *Cisco IOS IP Routing Protocols Configuration Guide*
BFD hardware offload	"Configuring Synchronous Ethernet on the Cisco 7600 Router with ES+ Line Card" section of the *Cisco 7600 Series Ethernet Services Plus (ES+) and Ethernet Services Plus T (ES+T) Line Card Configuration Guide*
Configuring and monitoring EIGRP	"Configuring EIGRP" module of the *Cisco IOS IP Routing Protocols Configuration Guide*
Configuring and monitoring HSRP	"Configuring HSRP" module of the *Cisco IOS IP Application Services Configuration Guide*
Configuring and monitoring IS-IS	"Configuring Integrated IS-IS" module of the *Cisco IOS IP Routing Protocols Configuration Guide*
Configuring and monitoring OSPF	"Configuring OSPF" module of the *Cisco IOS IP Routing Protocols Configuration Guide*
BFD commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	*Cisco IOS IP Routing: Protocol-Independent Command Reference*

Related Topic	Document Title
BGP commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	*Cisco IOS IP Routing: Protocol-Independent Command Reference*
EIGRP commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	*Cisco IOS IP Routing: Protocol-Independent Command Reference*
HSRP commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	*Cisco IOS IP Application Services Command Reference*
IS-IS commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	*Cisco IOS IP Routing: Protocol-Independent Command Reference*
OSPF commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	*Cisco IOS IP Routing: Protocol-Independent Command Reference*
BFD IPv6 Encapsulation Support	"*BFD IPv6 Encapsulation Support*" module
OSPFv3 for BFD	"*OSPFv3 for BFD*" module
Static Route Support for BFD over IPv6	"*Static Route Support for BFD over IPv6*" module

Standards and RFCs

Standard/RFC	Title
IETF Draft	*Bidirectional Forwarding Detection*, February 2009 (http://tools.ietf.org/html/draft-ietf-bfd-base-09)
IETF Draft	*BFD for IPv4 and IPv6 (Single Hop)*, February 2009 (http://tools.ietf.org/html/draft-ietf-bfd-v4v6-1hop-09

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for Bidirectional Forwarding Detection

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1: Feature Information for Bidirectional Forwarding Detection

Feature Name	Releases	Feature Information
BFD Control Channel over VCCV—Support for ATM Pseudowire	15.0(1)S	VCCV provides a control channel that is associated with an ATM pseudowire to perform operations and management functions over the pseudowire. BFD uses the VCCV control channel to detect dataplane failures for pseudowires. In Cisco IOS Release 15.0(1)S the BFD control channel over VCCV Support for ATM Pseudowire feature is supported for VCCV type-1 (without an IP/UDP header) only. The following commands were introduced or modified by this feature: **bfd-template**, **debug mpls l2transport vc vccv**, **interval**(BFD), **vccv**, **vccv bfd template**, **vccv bfd status signaling**.

Feature Name	Releases	Feature Information
BFD Echo Mode	12.2(33)SRB 12.4(9)T 15.0(1)S	BFD echo mode works with asynchronous BFD. Echo packets are sent by the forwarding engine and forwarded back along the same path in order to perform detection--the BFD session at the other end does not participate in the actual forwarding of the echo packets. The echo function and the forwarding engine are responsible for the detection process, therefore the number of BFD control packets that are sent out between two BFD neighbors is reduced. And since the forwarding engine is testing the forwarding path on the remote (neighbor) system without involving the remote system, there is an opportunity to improve the interpacket delay variance, thereby achieving quicker failure detection times than when using BFD Version 0 with BFD control packets for the BFD session.
BFD—BFD Hardware Offload Support	15.1(2)S 15.1(1)SG	This feature supports offloading BFD sessions to ES+ line cards on Cisco 7600 series routers. The following command was introduced or modified: **show bfd neighbors** .
BFD IPv6 Encapsulation Support	Cisco IOS XE Release 3.11S	This feature extends IPv6 support for BFD. The following command was introduced or modified: **bfd interval**

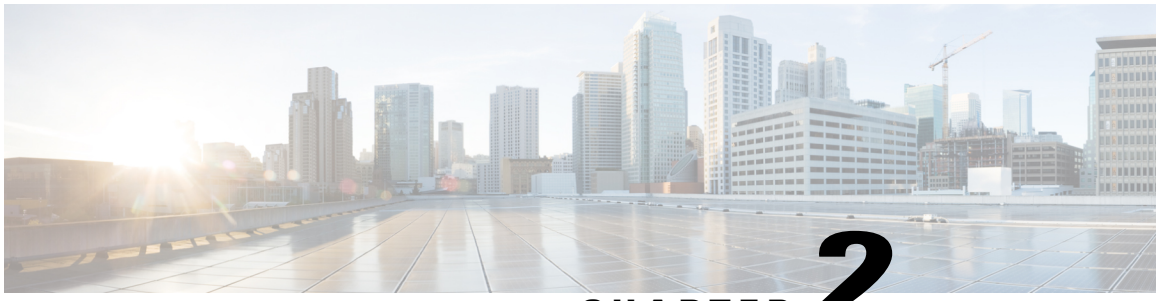
Feature Name	Releases	Feature Information
BFD Multihop	15.1(3)S 15.4(1)S	This feature supports multihop BFD for IPv4 and IPv6 addresses. In Cisco IOS Release 15.4(1)S, support was added for the Cisco ASR 901S Series Routers. The following commands were introduced or modified: **authentication**, **bfd map**, **bfd-template**, **interval**, **show bfd neighbors**, **show bfd neighbor drops**.
BFD—Static Route Support	12.2(33)SRC 15.0(1)M 15.0(1)S 15.0(1)SY 15.1(2)S 15.1(1)SG 15.4(1)S	Unlike dynamic routing protocols, such as OSPF and BGP, static routing has no method of peer discovery. Therefore, when BFD is configured, the reachability of the gateway is completely dependent on the state of the BFD session to the specified neighbor. Unless the BFD session is up, the gateway for the static route is considered unreachable, and therefore the affected routes will not be installed in the appropriate RIB. A single BFD session can be used by an IPv4 static client to track the reachability of next hops through a specific interface. A BFD group can be assigned for a set of BFD-tracked static routes. In Cisco IOS Release 15.4(1)S, support was added for the Cisco ASR 901S Series Routers. The following commands were introduced or modified: **ip route static bfd** and **show ip static route bfd**.
BFD Support for IP Tunnel (GRE, with IP address)	15.1(1)SY	This feature supports BFD forwarding on point-to-point IPv4, IPv6, and GRE tunnels. The following commands were introduced or modified: **bfd** .

Feature Name	Releases	Feature Information
BFD Support over Port Channel	15.1(1)SY 15.1(2)SY	This feature supports configuring BFD timers on port channel interface. The following commands were introduced or modified: **bfd** .
BFD—VRF Support	12.2(33)SRC 15.0(1)M 15.0(1)S 15.1(1)SY	The BFD feature support is extended to be VPN Routing and Forwarding (VRF) aware to provide fast detection of routing protocol failures between provider edge (PE) and customer edge (CE) devices.
BFD—WAN Interface Support	12.2(33)SRC 15.0(1)M 15.0(1)S	The BFD feature is supported on nonbroadcast media interfaces including ATM, POS, serial, and VLAN interfaces. BFD support also extends to ATM, FR, POS, and serial subinterfaces. The **bfd interval** command must be configured on the interface to initiate BFD monitoring.

Feature Name	Releases	Feature Information
Bidirectional Forwarding Detection (standard implementation, Version 1)	12.0(31)S 12.0(32)S 12.2(33)SRB 12.2(33)SRC 12.2(18)SXE 12.2(33)SXH 12.4(9)T 12.4(11)T 12.4(15)T 15.0(1)S 15.4(1)S	This document describes how to enable the Bidirectional Forwarding Detection (BFD) protocol. BFD is a detection protocol designed to provide fast forwarding path failure detection times for all media types, encapsulations, topologies, and routing protocols. In addition to fast forwarding path failure detection, BFD provides a consistent failure detection method for network administrators. Because the network administrator can use BFD to detect forwarding path failures at a uniform rate, rather than the variable rates for different routing protocol hello mechanisms, network profiling and planning will be easier, and reconvergence time will be consistent and predictable. In Release 12.0(31)S, support was added for the Cisco 12000 series Internet router. In Release 12.0(32)S, support was added for the Cisco 10720 Internet router and IP Services Engine (Engine 3) and Engine 5 shared port adapters (SPAs) and SPA interface processors (SIPs) on the Cisco 12000 series Internet router. In Cisco IOS Release 15.4(1)S, support was added for the Cisco ASR 901S Series Routers.

Feature Name	Releases	Feature Information
HSRP Support for BFD	12.2(33)SRC 12.4(11)T 12.4(15)T	In Release 12.4(11)T, support for HSRP was added. In Release 12.4(15)T, BFD is supported on the Integrated Services Router (ISR) family of Cisco routers, for example, the Cisco 3800 ISR series routers. In Release 12.2(33)SRC, the number of BFD sessions that can be created has been increased, BFD support has been extended to ATM, FR, POS, and serial subinterfaces, the BFD feature has been extended to be VRF-aware, BFD sessions are placed in an "Admin Down" state during a planned switchover, and BFD support has been extended to static routing.
IS-IS Support for BFD over IPv4	12.0(31)S 12.2(18)SXE 12.2(33)SRA 12.4(4)T 15.0(1)S 15.4(1)S	BFD support for OSPF can be configured globally on all interfaces or configured selectively on one or more interfaces. When BFD support is configured with IS-IS as a registered protocol with BFD, IS-IS receives forwarding path detection failure messages from BFD. In Cisco IOS Release 15.4(1)S, support was added for the Cisco ASR 901S Series Routers.
OSPF Support for BFD over IPv4	12.0(31)S 12.2(18)SXE 12.2(33)SRA 12.4(4)T 15.0(1)S 15.1(1)SG	BFD support for OSPF can be configured globally on all interfaces or configured selectively on one or more interfaces. When BFD support is configured with OSPF as a registered protocol with BFD, OSPF receives forwarding path detection failure messages from BFD.

Feature Name	Releases	Feature Information
SSO—BFD	12.2(33)SRE 12.2(33)SXI2 12.2(33)XNE 15.0(1)S 15.1(1)SG	Network deployments that use dual RP routers and switches have a graceful restart mechanism to protect forwarding states across a switchover. This feature enables BFD to maintain sessions in a up state across switchovers.
SSO—BFD (Admin Down)	12.2(33)SRC 15.0(1)S	To support SSO, BFD sessions are placed in an “Admin Down” state during a planned switchover. The BFD configuration is synched from the active to standby processor, and all BFD clients re-register with the BFD process on the standby processor.



CHAPTER 2

BFD IPv6 Encapsulation Support

Bidirectional Forwarding Detection for IPv6 encapsulations are described within a session information structure. These session information structures are defined by BFDv6 for the protocols supported. BFDv6 uses information from the session information structures to determine the correct encapsulation for BFDv6 packets on that session.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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Prerequisites for BFD IPv6 Encapsulation Support

When using Bidirectional Forwarding Detection over IPv6 (BFDv6), IPv6 Cisco Express Forwarding and IPv6 unicast routing must be enabled on all participating routers.

Restrictions for BFD IPv6 Encapsulation Support

- BFDv6 supports only global IPv6 neighbor addresses if a global IPv6 address is configured on the interface.
- Only asynchronous mode is supported. In asynchronous mode, either BFDv6 peer can initiate a BFDv6 session.

Information About BFD IPv6 Encapsulation Support

Overview of the BFDv6 Protocol

This section describes the BFDv6 protocol, how it is different from BFD for IPv4, and how it works with BFD for IPv4. BFD is a detection protocol designed to provide fast forwarding path failure detection times for all media types, encapsulations, topologies, and routing protocols. In addition to fast forwarding path failure detection, BFD provides a consistent failure detection method for network administrators. BFDv6 provides IPv6 support by accommodating IPv6 addresses and provides the ability to create BFDv6 sessions.

BFDv6 Registration

BFD clients register with BFD using a registry application program interface (API). The registry arguments include protocol type and the address and interface description block (IDB) of the route to be monitored. These APIs and arguments are all assumed by BFD to be IPv4.

BFDv6 has registries from which these arguments have been removed, and the protocol and encapsulation are described within a session information structure. These session information structures are defined by BFDv6 for the protocols supported. BFDv6 uses information from the session information structures to determine the correct encapsulation for BFDv6 packets on that session.

BFDv6 Global and Link-Local Addresses

BFDv6 supports both global and link-local IPv6 addresses for neighbor creation. BFDv6 sessions select source addresses to match the neighbor address types (for example, global IPv6 address neighbors must be paired with global IPv6 source addresses and link-local IPv6 address neighbors must be paired with link-local IPv6 source addresses). The table below shows the address pairings that BFDv6 supports.

Table 2: BFDv6 Address Pairings for Neighbor Creation

Source Address	Destination Address	Status
Global	Global	Supported
Global	Link local	Not supported
Link local	Global	Not supported

Source Address	Destination Address	Status
Link local	Link local	Supported

Because all IPv6-enabled interfaces have a link-local address and BFDv6 selects the source address, link-local address neighbors are always paired with a link-local interface address. The link-local source address with global destination address is not supported by Cisco Express Forwarding. Therefore, a global IPv6 address must be configured on an interface before a session with a global address neighbor may be established in BFDv6. BFDv6 rejects any sessions in which the neighbor address is global and no global address is configured on the interface.

Note The behavior of a unique local address (ULA) in BFDv6 is the same as a global address.

BFD for IPv4 and IPv6 on the Same Interface

BFD supports multiple IPv4 and IPv6 sessions per interface, with no restriction on the protocol of those sessions.

How to Configure BFD IPv6 Encapsulation Support

Configuring BFD Session Parameters on the Interface

The steps in this procedure show how to configure BFD on the interface by setting the baseline BFD session parameters on an interface. Repeat the steps in this procedure for each interface over which you want to run BFD sessions to BFD neighbors.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. Perform one of the following steps:
   - **ip address** *ipv4-address mask*
   - **ipv6 address** *ipv6-address*/*mask*
4. **bfd interval** *milliseconds* **min_rx** *milliseconds* **multiplier** *interval-multiplier*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

Step 3	Perform one of the following steps:
	• **ip address** *ipv4-address mask*
	• **ipv6 address** *ipv6-address*/*mask*
	
	Example:
	Configuring an IPv4 address for the interface:
	`Device(config-if)# ip address 10.201.201.1 255.255.255.0`
	Configuring an IPv6 address for the interface:
	`Device(config-if)# ipv6 address 2001:db8:1:1::1/32`
		Configures an IP address for the interface.

Step 4	**bfd interval** *milliseconds* **min_rx** *milliseconds* **multiplier** *interval-multiplier* **Example:** `Device(config-if)# bfd interval 50 min_rx 50 multiplier 5`	Enables BFD on the interface. The bfd interval configuration is removed when the subinterface on which it is configured is removed. The bfd interval configuration is not removed when: • an IPv4 address is removed from an interface • an IPv6 address is removed from an interface • IPv6 is disabled from an interface • an interface is shutdown • IPv4 CEF is disabled globally or locally on an interface • IPv6 CEF is disabled globally or locally on an interface
Step 5	**end** **Example:** `Device(config-if)# end`	Exits interface configuration mode and returns to privileged EXEC mode.

Configuration Examples for BFD IPv6 Encapsulation Support

Example: Configuring BFD Session Parameters on the Interface

```
Device# show ipv6 ospf neighbor detail

 Neighbor 172.16.4.4
    In the area 0 via interface POS4/0
    Neighbor: interface-id 14, link-local address FE80::205:5FFF:FED3:5406
    Neighbor priority is 1, State is FULL, 6 state changes
    Options is 0x63AD1B0D
    Dead timer due in 00:00:33
    Neighbor is up for 00:48:56
    Index 1/1/1, retransmission queue length 0, number of retransmission 1
    First 0x0(0)/0x0(0)/0x0(0) Next 0x0(0)/0x0(0)/0x0(0)
    Last retransmission scan length is 1, maximum is 1
    Last retransmission scan time is 0 msec, maximum is 0 msec
 Neighbor 172.16.3.3
    In the area 1 via interface FastEthernet0/0
    Neighbor: interface-id 3, link-local address FE80::205:5FFF:FED3:5808
    Neighbor priority is 1, State is FULL, 6 state changes
    DR is 172.16.6.6 BDR is 172.16.3.3
    Options is 0x63F813E9
    Dead timer due in 00:00:33
    Neighbor is up for 00:09:00
    Index 1/1/2, retransmission queue length 0, number of retransmission 2
    First 0x0(0)/0x0(0)/0x0(0) Next 0x0(0)/0x0(0)/0x0(0)
    Last retransmission scan length is 1, maximum is 2
    Last retransmission scan time is 0 msec, maximum is 0 msec
 Neighbor 172.16.5.5
    In the area 2 via interface ATM3/0
    Neighbor: interface-id 13, link-local address FE80::205:5FFF:FED3:6006
    Neighbor priority is 1, State is FULL, 6 state changes
    Options is 0x63F7D249
    Dead timer due in 00:00:38
    Neighbor is up for 00:10:01
    Index 1/1/3, retransmission queue length 0, number of retransmission 0
    First 0x0(0)/0x0(0)/0x0(0) Next 0x0(0)/0x0(0)/0x0(0)
    Last retransmission scan length is 0, maximum is 0
    Last retransmission scan time is 0 msec, maximum is 0 msec
```

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	*Cisco IOS IPv6 Configuration Guide*
Cisco IOS commands	*Cisco IOS Master Commands List, All Releases*

Related Topic	Document Title
IPv6 commands	*Cisco IOS IPv6 Command Reference*
Cisco IOS IPv6 features	*Cisco IOS IPv6 Feature Mapping*
OSPFv3 for BFD	"*Bidirectional Forwarding Detection*" module

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	IPv6 RFCs

MIBs

MIB	MIBs Link
	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

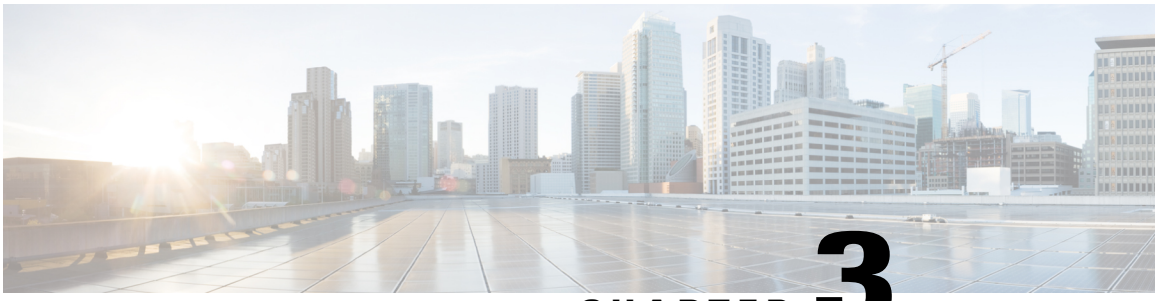
Feature Information for BFD IPv6 Encapsulation Support

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 3: Feature Information for BFD IPv6 Encapsulation Support

Feature Name	Releases	Feature Information
BFD IPv6 Encapsulation Support	12.2(33)SRE 15.0(1)SY 15.1(1)SG 15.1(1)SY 15.1(2)T	BFDv6 encapsulations are described within a session information structure. These session information structures are defined by BFDv6 for the protocols supported. BFDv6 uses information from the session information structures to determine the correct encapsulation for BFDv6 packets on that session. The following commands were introduced or modified: **bfd interval**, **show ipv6 ospf neighbor**.



CHAPTER 3

OSPFv3 for BFD

The Bidirectional Forwarding Detection protocol supports OSPFv3.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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Information About OSPFv3 for BFD

The Bidirectional Forwarding Detection (BFD) protocol supports Open Shortest Path First version 3 (OSPFv3).

How to Configure OSPFv3 for BFD

Configuring BFD Support for OSPFv3

This section describes the procedures for configuring BFD support for OSPFv3, so that OSPFv3 is a registered protocol with BFD and will receive forwarding path detection failure messages from BFD. You can either configure BFD support for OSPFv3 globally on all interfaces or configure it selectively on one or more interfaces.

There are two methods for enabling BFD support for OSPFv3:

- You can enable BFD for all of the interfaces for which OSPFv3 is routing by using the **bfd all-interfaces** command in router configuration mode. You can disable BFD support on individual interfaces using the **ipv6 ospf bfd disable** command in interface configuration mode.
- You can enable BFD for a subset of the interfaces for which OSPFv3 is routing by using the **ipv6 ospf bfd** command in interface configuration mode.

Note OSPF will only initiate BFD sessions for OSPF neighbors that are in the FULL state.

Configuring Baseline BFD Session Parameters on the Interface

Repeat this task for each interface over which you want to run BFD sessions to BFD neighbors.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **bfd interval** *milliseconds* **min_rx** *milliseconds* **multiplier** *interval-multiplier*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface GigabitEthernet 0/0/0`	Specifies an interface type and number, and places the device in interface configuration mode.
Step 4	**bfd interval** *milliseconds* **min_rx** *milliseconds* **multiplier** *interval-multiplier* **Example:** `Device(config-if)# bfd interval 50 min_rx 50 multiplier 5`	Enables BFD on the interface.

Configuring BFD Support for OSPFv3 for All Interfaces

Before You Begin

OSPFv3 must be running on all participating devices. The baseline parameters for BFD sessions on the interfaces over which you want to run BFD sessions to BFD neighbors must be configured.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 router ospf** *process-id* [**vrf** *vpn-name*]
4. **bfd all-interfaces**
5. **exit**
6. **show bfd neighbors** [**vrf** *vrf-name*] [**client** {**bgp** | **eigrp** | **isis** | **ospf** | **rsvp** | **te-frr**}] [*ip-address* | **ipv6** *ipv6-address*] [**details**]
7. **show ipv6 ospf** [*process-id*] [*area-id*] [**rate-limit**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Device> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 router ospf** *process-id* [**vrf** *vpn-name*] **Example:** `Device(config)# ipv6 router ospf 2`	Configures an OSPFv3 routing process.
Step 4	**bfd all-interfaces** **Example:** `Device(config-router)# bfd all-interfaces`	Enables BFD for all interfaces participating in the routing process.
Step 5	**exit** **Example:** `Device(config-router)# exit`	Enter this command twice to go to privileged EXEC mode.
Step 6	**show bfd neighbors** [**vrf** *vrf-name*] [**client** {**bgp** | **eigrp** | **isis** | **ospf** | **rsvp** | **te-frr**}] [*ip-address* | **ipv6** *ipv6-address*] [**details**] **Example:** `Device# show bfd neighbors detail`	(Optional) Displays a line-by-line listing of existing BFD adjacencies.
Step 7	**show ipv6 ospf** [*process-id*] [*area-id*] [**rate-limit**] **Example:** `Device# show ipv6 ospf`	(Optional) Displays general information about OSPFv3 routing processes.

Configuring OSPF Support for BFD over IPv4 for One or More Interfaces

To configure BFD on one or more OSPF interfaces, perform the steps in this section.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **ip ospf bfd** [**disable**]
5. **end**
6. **show bfd neighbors** [**details**]
7. **show ip ospf**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface fastethernet 6/0`	Enters interface configuration mode.
Step 4	**ip ospf bfd** [**disable**] **Example:** `Device(config-if)# ip ospf bfd`	Enables or disables BFD on a per-interface basis for one or more interfaces associated with the OSPF routing process. **Note** Use the **disable** keyword only if you enable BFD on all of the interfaces that OSPF is associated with using the **bfd all-interfaces** command in router configuration mode.
Step 5	**end** **Example:** `Device(config-if)# end`	Exits interface configuration mode and returns the device to privileged EXEC mode.
Step 6	**show bfd neighbors** [**details**] **Example:** `Device# show bfd neighbors details`	(Optional) Displays information that can help verify if the BFD neighbor is active and displays the routing protocols that BFD has registered.

	Command or Action	Purpose
		Note If hardware-offloaded BFD sessions are configured with Tx and Rx intervals that are not multiples of 50 ms, the hardware intervals are changed. However, output from the **show bfd neighbors details** command displays only the configured intervals, not the interval values that change.
Step 7	**show ip ospf** **Example:** `Device# show ip ospf`	(Optional) Displays information that can help verify if BFD support for OSPF has been enabled.

Retrieving BFDv6 Information for Monitoring and Troubleshooting

SUMMARY STEPS

1. **enable**
2. **monitor event ipv6 static** [**enable** | **disable**]
3. **show ipv6 static** [*ipv6-address* | *ipv6-prefix/prefix-length*] [**interface** *type number* | **recursive**] [**vrf** *vrf-name*] [**bfd**] [**detail**
4. **show ipv6 static** [*ipv6-address* | *ipv6-prefix/prefix-length*] [**interface** *type number* | **recursive**] [**vrf** *vrf-name*] [**bfd**] [**detail**]
5. **debug ipv6 static**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**monitor event ipv6 static** [**enable**	**disable**] **Example:** `Device# monitor event ipv6 static enable`	Enables the use of event trace to monitor the operation of the IPv6 static and IPv6 static BFDv6 neighbors.

	Command or Action	Purpose
Step 3	**show ipv6 static** [*ipv6-address* | *ipv6-prefix/prefix-length*] [**interface** *type number* | **recursive**] [**vrf** *vrf-name*] [**bfd**] [**detail** **Example:** `Device# show ipv6 static vrf vrf1 detail`	Displays the BFDv6 status for a static route associated with a static BFDv6 neighbor.
Step 4	**show ipv6 static** [*ipv6-address* | *ipv6-prefix/prefix-length*] [**interface** *type number* | **recursive**] [**vrf** *vrf-name*] [**bfd**] [**detail**] **Example:** `Device# show ipv6 static vrf vrf1 bfd`	Displays static BFDv6 neighbors and associated static routes.
Step 5	**debug ipv6 static** **Example:** `Device# debug ipv6 static`	Enables BFDv6 debugging.

Configuration Examples for OSPFv3 for BFD

Example: Displaying OSPF Interface Information about BFD

The following display shows that the OSPF interface is enabled for BFD:

```
Device# show ipv6 ospf interface

Serial10/0 is up, line protocol is up
  Link Local Address FE80::A8BB:CCFF:FE00:6500, Interface ID 42
  Area 1, Process ID 1, Instance ID 0, Router ID 10.0.0.1
  Network Type POINT_TO_POINT, Cost: 64
  Transmit Delay is 1 sec, State POINT_TO_POINT, BFD enabled
  Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
    Hello due in 00:00:07
  Index 1/1/1, flood queue length 0
  Next 0x0(0)/0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 1
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
    Adjacent with neighbor 10.1.0.1
  Suppress hello for 0 neighbor(s)
```

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	*Cisco IOS IPv6 Configuration Guide*
Cisco IOS commands	*Cisco IOS Master Commands List, All Releases*
IPv6 commands	*Cisco IOS IPv6 Command Reference*
Cisco IOS IPv6 features	*Cisco IOS IPv6 Feature Mapping*
OSPFv3 for BFD	"*Bidirectional Forwarding Detection*" module

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	IPv6 RFCs

MIBs

MIB	MIBs Link
	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

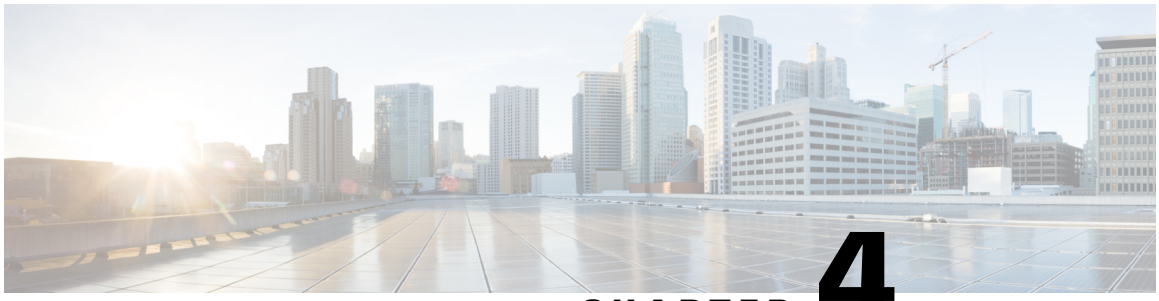
Feature Information for OSPFv3 for BFD

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 4: Feature Information for OSPFv3 for BFD

Feature Name	Releases	Feature Information
OSPFv3 for BFD	15.1(2)T 12.2(33)SRE 15.0(1)SY 15.2(1)E	BFD supports the dynamic routing protocol OSPFv3. The following commands were introduced or modified: **bfd**, **bfd all-interfaces**, **debug bfd**, **ipv6 router ospf**, **show bfd neighbors**, **show ipv6 ospf**, **show ipv6 ospf interface**, **show ospfv3**, **show ospfv3 interface**.



CHAPTER 4

Bidirectional Forwarding Detection MIB

The Bidirectional Forwarding Detection (BFD) MIB, Version 2 feature enables Simple Network Management Protocol (SNMP) agent support in Cisco IOS software for BFD management, as implemented in the Bidirectional Forwarding Detection Management Information Base (draft-ietf-bfd-mib-02.txt). The SNMP agent code operating with the BFD MIB enables a standardized, SNMP-based approach to be used in managing the BFD features in Cisco IOS software. The BFD MIB feature introduces the CISCO-IETF-BFD-MIB. The BFD MIB is also VPN-aware, which allows SNMP to differentiate incoming packets from different VPNs.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for the Bidirectional Forwarding Detection MIB

The following restrictions apply to the BFD MIB for Cisco IOS releases:

- This MIB supports read-only (RO) permission for MIB objects, except for ciscoBfdSessNotificationsEnable, which has read-write access to enable or disable BFD traps via SNMP set commands.
- The BFD Session Mapping Table (ciscoBfdSessMapTable) maps the complex indexing of the BFD sessions to the flat BFDIndex used in the ciscoBfdSessionTable.
- BFD does not support 64-bit counters. The session performance table (ciscoBfdSessionPerfTable) collects BFD performance counts on a per session basis. This table augments the ciscoBfdSessionTable.
- The VRF-Aware functionality of BFD MIB is not supported with IPv6 addresses.

Information About the Bidirectional Forwarding Detection MIB

BFD MIB Cisco Implementation

The BFD MIB is based on the Internet Engineering Task Force (IETF) draft MIB entitled draft-ietf-bfd-mib-02.txt which includes objects describing features that support BFD.

Slight differences between the IETF draft MIB and the implementation of the BFD capabilities within Cisco IOS software require some minor translations between the BFD MIB and the internal data structures of Cisco IOS software. These translations are made by the SNMP agent code that is installed and operating on various hosts within the network. This SNMP agent code, running in the background as a low priority process, provides a management interface to Cisco IOS software.

The SNMP objects defined in the BFD MIB can be displayed by any standard SNMP utility. All BFD MIB objects are based on the IETF draft MIB; thus, no specific Cisco SNMP application is required to support the functions and operations pertaining to the BFD MIB.

Capabilities Supported by the BFD MIB

The following functionality is supported in the BFD MIB:

- The ability to generate and queue notification messages that signal changes in the operational status of BFD sessions.
- The ability to make the BFD MIB VPN aware.
- Extensions to existing SNMP commands that provide the ability to enable, disable, and configure notification messages for BFD sessions.
- The ability to specify the name or the IP address of a network management station (NMS) in the operating environment to which notification messages are to be sent.
- The ability to write notification configurations into nonvolatile memory.

Notification Generation Events

When BFD notifications are enabled with the **snmp-serverenabletrapsbfd** command with the **session-up** and **session-down** keywords, notification messages relating to specific events within Cisco IOS software are generated and sent to a specified NMS in the network.

For example, a bfdSessUp notification is sent to an NMS when BFD is configured.

Conversely, a bfdSessDown notification is generated and sent to an NMS when BFD is disabled.

Benefits of Bidirectional Forwarding Detection MIB

The BFD MIB provides the following benefits:

- Provides a standards-based SNMP interface for retrieving information about BFD.
- Forwards notification messages to a designated NMS for evaluation or action by network administrators.

Features and Technologies Related to BFD MIB

The BFD MIB feature is used in conjunction with the following features and technologies:

- Standards-based SNMP network management application
- BFD

Supported Objects in the BFD MIB

BFD General Variables (scalars)

The following parameters apply globally to the router's BFD process:

- ciscoBfdAdminStatus is The global administrative status of BFD in this router. The value enabled denotes that the BFD Process is active on at least one interface; disabled means it is not enabled on any interface.
- ciscoBfdVersionNumber is the current default version number of the BFD protocol.
- ciscoBfdSessNotificationsEnable enables the emission of ciscoBfdSessUp and ciscoBfdSessDown notifications when set to true (1); otherwise these notifications are not emitted.

BFD Session Table

The BFD Session Table specifies BFD session specific information and contains the following entries:

- ciscoBfdSessTable describes the BFD sessions.
- ciscoBfdSessEntry describes BFD session.

- ciscoBfdSessIndex contains an index used to represent a unique BFD session on this device. This is an Index and it does not show up in the MIB walk as an object.
- ciscoBfdSessApplicationId contains an index used to indicate a local application which owns or maintains this BFD session. This application ID provides a convenient way to segregate sessions by the applications that maintain them. The value corresponds to the ClientID in the output of the **showbfdclient** command.
- ciscoBfdSessDiscriminator specifies the local discriminator for this BFD session, used to uniquely identify it.
- ciscoBfdSessRemoteDiscr specifies the session discriminator chosen by the remote system for this BFD session.
- ciscoBfdSessUdpPort specifies the UDP Port for BFD. The default value is the well-known value for this port.
- ciscoBfdSessState specifies he perceived state of the BFD session. Valid values are adminDown (1), down (2), init (3), and up (4).
- ciscoBfdSessRemoteHeardFlag specifies status of BFD packet reception from the remote system. The flag is set to true (1) if the local system is actively receiving BFD packets from the remote system. The flag is set to false (0) if the local system has not received BFD packets recently (within the detection time) or if the local system is attempting to tear down the BFD session. This object is applicable only if the the session is runing at version 0. If the session is running version 1, that value will return false.
- ciscoBfdSessDiag displays a diagnostic code specifying the local system's reason for the last transition of the session from up (1) to some other state. This object is accessible only for notifications and will not display in the MIB walk for the ciscoBfdSessTable. The codes are:
    - BfdInterval—The delay in microseconds.
    - BfdDiag—A diagnostic code:
        - noDiagnostic(0)
        - controlDetectionTimeExpired(1)
        - echoFunctionFailed(2)
        - neighborSignaledSessionDown(3)
        - forwardingPlaneReset(4)
        - pathDown(5)
        - concatenatedPathDown(6)
        - administrativelyDown(7)
        - reverseConcatenatedPathDown (8)

- ciscoBfdSessOperMode specifies the current operating mode of the BFD session. The supported values are:
    - asyncModeWEchoFun (1),
    - asynchModeWOEchoFun (2),

- ciscoBfdSessDemandModeDesiredFlag indicates the local system's desire to use demand mode. It is set to true (1) if the local system wishes to use demand mode or false (0) if not. Demand Mode is not supported and therefore will always return a value of 0.
- ciscoBfdSessEchoFuncModeDesiredFlag indicates that the local system's desire to use echo mode. It is set to true (1) if the local system wishes to use Echo mode or false (0) if not.
- ciscoBfdSessControlPlanIndepFlag indicates if the local system's can function through a disruption of the control plane. It is set to true (1) if the local system BFD implementation is independent of the control plane. Otherwise, the value is set to false (0). This value will always return a value of 0.
- ciscoBfdSessAddrType specifies the IP address of the interface associated with this BFD session. Only values unknown (0), ipv4 (1) or ipv6 (2) are supported. A value of unknown (0) is allowed only when the outgoing interface is of type point-to-point, or when the BFD session is not associated with a specific interface.
- ciscoBfdSessAddr specifies the IP address of the interface associated with this BFD session. The value is set to zero when BFD session is not associated with a specific interface.
- ciscoBfdSessDesiredMinTxInterval specifies the minimum interval, in microseconds, that the local system would like to use when transmitting BFD control packets.
- ciscoBfdSessReqMinRxInterval specifies the minimum interval, in microseconds, between received BFD control packets the local system can support.
- ciscoBfdSessReqMinEchoRxInterval specifies the minimum interval, in microseconds, between received BFD Echo packets that this system can support. If echo mode is disabled for the configured interface for the session, this object will return value of 0.
- ciscoBfdSessDetectMult specifies the detect time multiplier.
- ciscoBfdSessStorType indicates the storage type for this object. The storage type for this entry is a read-only implementation that is always volatile.
- ciscoBfdSessRowStatus This object is a read-only implementation that is always active.
- ciscoBfdSessAuthPresFlag indicates the local system's desire to use Authentication. It is set to true (1) if the local system wishes the session to be authenticated or false (0) if not. Authentication is not supported and this object will always return a value of 0.
- ciscoBfdSessAuthenticationType specifies the authentication type used for this BFD session. This field is valid only when the authentication present bit is set. This object is not valid in BFD in Cisco IOS.

BFD Session Performance Table

ciscoBfdSessPerfTable specifies BFD session performance counters and augments the ciscoBfdSessionTable. This table contains the following entries:

- ciscoBfdSessPerfEntry includes an entry created by a BFD-enabled node for every BFD session. ciscoBfdCounterDiscontinuityTime is used to indicate potential discontinuity for all counter objects in this table.
- ciscoBfdSessPerfPktIn specifies the total number of BFD messages received for this BFD session.
- ciscoBfdSessPerfPktOut specifies the total number of BFD messages sent for this BFD session.
- ciscoBfdSessUpTime specifies the value of sysUpTime on the most recent occasion at which the session came up. If no such up event exists, the value is zero.

- ciscoBfdSessPerfLastSessDownTime specifies the value of sysUpTime on the most recent occasion at which the last time communication was lost with the neighbor. If no such down event exists, the value is zero.
- ciscoBfdSessPerfLastCommLostDiag specifies the BFD diag code for the last time communication was lost with the neighbor. This object is not supported.
- ciscoBfdSessPerfSessUpCount specifies the number of times this session has gone into the up state since the router last rebooted.
- ciscoBfdSessPerfDiscTime indicates the value of sysUpTime on the most recent occasion at which any one or more of the session counters suffered a discontinuity. The relevant counters are the specific instances associated with this BFD session of any Counter32 object contained in the BfdSessPerfTable. If no such discontinuities have occurred since the last re-initialization of the local management subsystem, then the value is zero. This object is not supported.
- ciscoBfdSessPerfPktInHC represents the total number of BFD messages received for this BFD session. It must be equal to the least significant 32 bits of ciscoBfdSessPerfPktIn if ciscoBfdSessPerfPktInHC is supported according to the rules spelled out in RFC2863.
- ciscoBfdSessPerfPktOutHC represents the total number of BFD messages transmitted for this BFD session. It must be equal to the least significant 32 bits of ciscoBfdSessPerfPktIn if ciscoBfdSessPerfPktOutHC is supported according to the rules spelled out in RFC2863.

BFD Session Mapping Table

The BFD Session Mapping Table maps the complex indexing of the BFD sessions to the flat BFDIndex used in the ciscoBfdSessionTable. If the value of the ciscoBfdSessAddr (an OID) has more that 111 sub-identifiers, then OIDs of column instances in this table have more than 128 sub-identifiers and cannot be accessed using SNMPv1, SNMPv2c, or SNMPv3. The BFD Session Mapping table contains the following entries:

- ciscoBfdSessMapEntry describes BFD session that is mapped to this index. If the value of the mplsInSegmentMapLabelPtrIndex (an OID) has more that 111 sub-identifiers, then OIDs of column instances in this table have more than 128 sub-identifiers and cannot be accessed using SNMPv1, SNMPv2c, or SNMPv3.
- ciscoBfdSessMapBfdIndex specifies the BfdIndex referred to by the indexes of this row. In essence, a mapping is provided between these indexes and the ciscoBfdSessTable. This is Index and does not show up in the MIB walk as an object.

See the MIB Walk for BFD MIB: Example in the configuration example section for an example of the mapping.

BFD Notifications

Notification contains the following entries. The range mode for this notification is not supported. Therefore, only a single notification is sent for one of the ciscoBfdSessTable entries representing this session.

- ciscoBfdSessUp generates a notfication when the ciscoBfdSessState object for one or more entries in ciscoBfdSessTable is about to enter the up (4) state from some other state. The value of ciscoBfdSessDiag is set equal to noDiagnostic(0).
- ciscoBfdSessDown generates a notification when the ciscoBfdSessState object for one or more entries in ciscoBfdSessTable is about to enter the down (2) or adminDown (1) states from some other state.

The values of ciscoBfdSessDiag returns the Diag code providing the reason for this new state (that is, pathDown (5) or administrativelyDown (7)).

How to Configure the Bidirectional Forwarding Detection MIB

Enabling the SNMP Agent for BFD MIB Notifications

The SNMP agent for the BFD MIB is disabled by default. To enable the SNMP agent for BFD MIB notifications, perform the following steps.

SUMMARY STEPS

1. **enable**
2. **show running-config** | **includesnmp**
3. **configure terminal**
4. **snmp-server community** *string* [**view***view-name*] [**ro** | **rw**] [**ipv6***nacl*] [*access-list-number*]
5. **snmp-server enable traps bfd** [**session-up**] [**session-down**]
6. **exit**
7. **write memory**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router# enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show running-config**	**includesnmp** **Example:** `Router# show running-config | include snmp`	Displays the running configuration to determine if an SNMP agent is already running. • If no SNMP information is displayed, go to Step 4 . If any SNMP information is displayed, you can modify the information or change it as needed.
Step 3	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 4	**snmp-server community** *string* [**view***view-name*] [**ro**	**rw**] [**ipv6***nacl*] [*access-list-number*]	Enables the community string. • The example enables snmp with community string comaccess and read-only access.

	Command or Action	Purpose
	Example: `Router(config)# snmp-server community comaccess ro 4`	
Step 5	**snmp-server enable traps bfd** [**session-up**] [**session-down**] **Example:** `Router(config)# snmp-server enable traps bfd`	Enables a router to send SNMP notifications or informs to an SNMP host. **Note** This command is optional. After SNMP is enabled, all MIBs are available for the user to query.
Step 6	**exit** **Example:** `Router(config)# exit`	Exits global configuration mode and returns to privileged EXEC mode.
Step 7	**write memory** **Example:** `Router# write memory`	Writes the modified configuration to NVRAM, permanently saving the settings.

Verifying the Status of the SNMP Agent

To verify that the SNMP agent has been enabled on a host network device, perform the following steps.

SUMMARY STEPS

1. **enable**
2. **show running-config** | **includesnmp**
3. show bfd neighbors detail

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router# enable`	Enables privileged EXEC mode • Enter your password if prompted

	Command or Action	Purpose
Step 2	**show running-config | includesnmp** **Example:** `Router# show running-config | include snmp`	Displays the running configuration on the target device and is used to examine the output for displayed SNMP information.
Step 3	show bfd neighbors detail **Example:** `Router# show bfd neighbors detail`	Displays BFD protocol parameters and timers for each neighbor.

Example

The follows example displays the running configuration on the target device and its SNMP information.

```
Router# show running-config | include snmp
.
.
.
snmp-server community public rw
snmp-server community private ro
```

Any **snmp-server** statement that appears in the output and takes the form shown here verifies that SNMP has been enabled on that device.

Configuration Examples for the Bidirectional Forwarding Detection MIB

Enabling the SNMP Agent to Enable BFD Notifications Example

The following example shows how to enable an SNMP agent on a host network device:

```
Router# configure terminal
Router(config)# snmp-server community
privatero
```

The following example shows how to allow read-only access to all BFD MIB objects relating to members of access list 4 that specify the comaccess community string. No other SNMP agents will have access to any BFD MIB objects.

```
Router(config)# snmp-server community comaccess ro 4
```

The following example shows how to enable a router to send BFD-related SNMP notifications or informs to an SNMP host.

```
Router(config)# snmp-server enable traps bfd
```

Viewing BFD Sessions Example

The following example show the output of the **show bfd neighbors** command, which displays BFD sessions and timers for each neighbor.

```
Router# show bfd neighbors

NeighAddr                          LD/RD    RH/RS     State     Int
10.0.0.2                            7/7     Up        Up        Et1/2.2
10.1.0.2                            6/6     Up        Up        Et1/2.5
DDDD::1                             1/1     Up        Up        Et1/3

Router# show bfd neighbors detail

NeighAddr                          LD/RD    RH/RS     State     Int
10.0.0.2                            9/8     Up        Up        Gi3/8.1
Session state is UP and using echo function with 50 ms interval.
OurAddr: 10.0.0.1
Local Diag: 0, Demand mode: 0, Poll bit: 0
MinTxInt: 1000000, MinRxInt: 1000000, Multiplier: 5
Received MinRxInt: 1000000, Received Multiplier: 5
Holddown (hits): 0(0), Hello (hits): 1000(350)
Rx Count: 352, Rx Interval (ms) min/max/avg: 1/1000/874 last: 464 ms ago
Tx Count: 351, Tx Interval (ms) min/max/avg: 756/1000/876 last: 524 ms ago
Elapsed time watermarks: 0 0 (last: 0)
Registered protocols: CEF OSPF
Uptime: 00:05:07
Last packet: Version: 1                - Diagnostic: 0
State bit: Up              - Demand bit: 0
Poll bit: 0                - Final bit: 0
Multiplier: 5              - Length: 24
My Discr.: 8               - Your Discr.: 9
Min tx interval: 1000000   - Min rx interval: 1000000
Min Echo interval: 50000
NeighAddr                          LD/RD    RH/RS     State     Int
10.1.0.2                            6/6     Up        Up        Gi3/8.2
Session state is UP and using echo function with 50 ms interval.
OurAddr: 10.1.0.1
Local Diag: 0, Demand mode: 0, Poll bit: 0
MinTxInt: 1000000, MinRxInt: 1000000, Multiplier: 5
Received MinRxInt: 1000000, Received Multiplier: 5
Holddown (hits): 0(0), Hello (hits): 1000(352)
Rx Count: 352, Rx Interval (ms) min/max/avg: 1/1000/880 last: 248 ms ago
Tx Count: 354, Tx Interval (ms) min/max/avg: 1/1000/875 last: 244 ms ago
Elapsed time watermarks: 0 0 (last: 0)
Registered protocols: CEF OSPF
Uptime: 00:05:09
Last packet: Version: 1                - Diagnostic: 0
State bit: Up              - Demand bit: 0
Poll bit: 0                - Final bit: 0
Multiplier: 5              - Length: 24
My Discr.: 6               - Your Discr.: 6
Min tx interval: 1000000   - Min rx interval: 1000000
Min Echo interval: 50000
```

MIB Walk for BFD MIB Example

This example shows sample output from a MIB walk of the BFD MIB:

ciscoBfdSessMapTable

```
ciscoBfdSessMapBfdIndex.1.7.1.4.10.1.0.1 = 65543
ciscoBfdSessMapBfdIndex.3.1.2.16.221.221.0.0.0.0.0.0.0.0.0.0.0.2 = 196609
ciscoBfdSessMapBfdIndex.4.6.1.4.40.4.0.1 = 262150
```

```
The MapTable index includes the following information about BFD sessions and clients:
Index example: 1.7.1.4.10.1.0.1
1 – Client id
7 – Local discriminator
1 – IP address type (1 – IPv4, 2- IPv6)
4 – Length of next string (4 for IPv4 addresses or 16 for IPv6 addresses)
10.1.0.1 – IP address of the BFD session
```

ciscoBfdSessTable

```
ciscoBfdSessApplicationId.65543 = 1
ciscoBfdSessApplicationId.196609 = 3
ciscoBfdSessApplicationId.262150 = 4
ciscoBfdSessDiscriminator.65543 = 7
ciscoBfdSessDiscriminator.196609 = 1
ciscoBfdSessDiscriminator.262150 = 6
ciscoBfdSessRemoteDiscr.65543 = 7
ciscoBfdSessRemoteDiscr.196609 = 1
ciscoBfdSessRemoteDiscr.262150 = 6
ciscoBfdSessUdpPort.65543 = 3785
ciscoBfdSessUdpPort.196609 = 3784
ciscoBfdSessUdpPort.262150 = 3785
ciscoBfdSessState.65543 = up
ciscoBfdSessState.196609 = up
ciscoBfdSessState.262150 = up
ciscoBfdSessRemoteHeardFlag.65543 = false
ciscoBfdSessRemoteHeardFlag.196609 = false
ciscoBfdSessRemoteHeardFlag.262150 = false
ciscoBfdSessOperMode.65543 = asyncModeWEchoFun
ciscoBfdSessOperMode.196609 = asynchModeWOEchoFun
ciscoBfdSessOperMode.262150 = asyncModeWEchoFun
ciscoBfdSessDemandModeDesiredFlag.65543 = false
ciscoBfdSessDemandModeDesiredFlag.196609 = false
ciscoBfdSessDemandModeDesiredFlag.262150 = false
ciscoBfdSessEchoFuncModeDesiredFlag.65543 = true
ciscoBfdSessEchoFuncModeDesiredFlag.196609 = false
ciscoBfdSessEchoFuncModeDesiredFlag.262150 = true
ciscoBfdSessControlPlanIndepFlag.65543 = false
ciscoBfdSessControlPlanIndepFlag.196609 = false
ciscoBfdSessControlPlanIndepFlag.262150 = false
ciscoBfdSessAddrType.65543 = ipv4
ciscoBfdSessAddrType.196609 = ipv6
ciscoBfdSessAddrType.262150 = ipv4
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ciscoBfdSessAddr.196609 = DD:DD:00:00:00:00:00:00:00:00:00:00:00:00:00:02
ciscoBfdSessAddr.262150 = 10:04:00:01
ciscoBfdSessDesiredMinTxInterval.65543 = 1000000
ciscoBfdSessDesiredMinTxInterval.196609 = 50000
ciscoBfdSessDesiredMinTxInterval.262150 = 1000000
ciscoBfdSessReqMinRxInterval.65543 = 1000000
ciscoBfdSessReqMinRxInterval.196609 = 50000
ciscoBfdSessReqMinRxInterval.262150 = 1000000
ciscoBfdSessReqMinEchoRxInterval.65543 = 50000
ciscoBfdSessReqMinEchoRxInterval.196609 = 0
ciscoBfdSessReqMinEchoRxInterval.262150 = 50000
ciscoBfdSessDetectMult.65543 = 5
ciscoBfdSessDetectMult.196609 = 5
ciscoBfdSessDetectMult.262150 = 5
ciscoBfdSessStorType.65543 = volatile
ciscoBfdSessStorType.196609 = volatile
ciscoBfdSessStorType.262150 = volatile
ciscoBfdSessRowStatus.65543 = active
ciscoBfdSessRowStatus.196609 = active
ciscoBfdSessRowStatus.262150 = active
ciscoBfdSessAuthPresFlag.65543 = false
ciscoBfdSessAuthPresFlag.196609 = false
ciscoBfdSessAuthPresFlag.262150 = false
ciscoBfdSessAuthenticationType.65543 = 0
ciscoBfdSessAuthenticationType.196609 = 0
ciscoBfdSessAuthenticationType.262150 = 0
```

ciscoBfdSessPerfTable

```
ciscoBfdSessPerfPktIn.65543 = 246
ciscoBfdSessPerfPktIn.196609 = 5159
ciscoBfdSessPerfPktIn.262150 = 290
ciscoBfdSessPerfPktOut.65543 = 247
ciscoBfdSessPerfPktOut.196609 = 5416
ciscoBfdSessPerfPktOut.262150 = 291
ciscoBfdSessUpTime.65543 = 43376
ciscoBfdSessUpTime.196609 = 39781
ciscoBfdSessUpTime.262150 = 39736
ciscoBfdSessPerfLastSessDownTime.65543 = 0
ciscoBfdSessPerfLastSessDownTime.196609 = 0
ciscoBfdSessPerfLastSessDownTime.262150 = 0
ciscoBfdSessPerfLastCommLostDiag.65543 = 0
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ciscoBfdSessPerfLastCommLostDiag.262150 = 0
ciscoBfdSessPerfSessUpCount.65543 = 1
ciscoBfdSessPerfSessUpCount.196609 = 1
ciscoBfdSessPerfSessUpCount.262150 = 1
ciscoBfdSessPerfDiscTime.65543 = 0
ciscoBfdSessPerfDiscTime.196609 = 0
ciscoBfdSessPerfDiscTime.262150 = 0
ciscoBfdSessPerfPktInHC.65543 = 247
ciscoBfdSessPerfPktInHC.196609 = 5179
ciscoBfdSessPerfPktInHC.262150 = 291
ciscoBfdSessPerfPktOutHC.65543 = 248
ciscoBfdSessPerfPktOutHC.196609 = 5440
ciscoBfdSessPerfPktOutHC.262150 = 292
```

Additional References

Related Documents

Related Topic	Document Title
BFD	*IP Routing Bidirectional Forwarding Detection Configuration Guide*
Configuring SNMP support for a VPN	*SNMP Support over VPNs—Context-Based Access*

Standards and RFCs

Standard/RFC	Title
draft-ietf-bfd-mib-03	Bidirectional Forwarding Detection MIB
RFC 2026	The Internet Standards Process

MIBs

MIB	MIBs Link
BFD MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

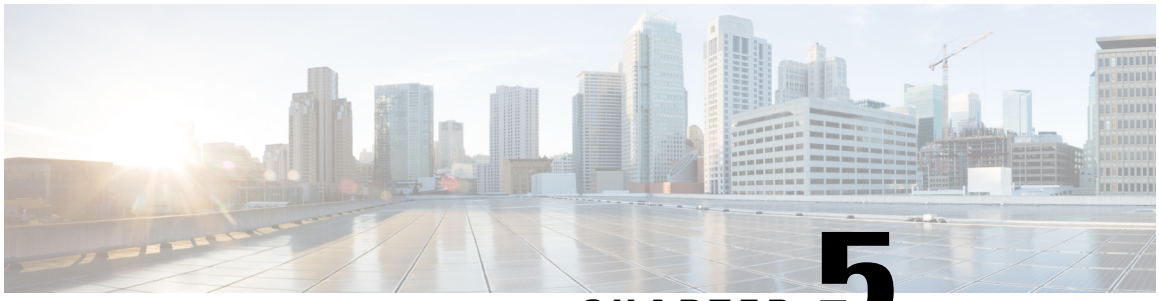
Feature Information for the Bidirectional Forwarding Detection MIB

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 5: Feature Information for the Bidirectional Forwarding Detection MIB

Feature Name	Releases	Feature Information
Bidirectional Forwarding Detection MIB, Version 2	12.2(33)SRE 15.1(1)SG 15.1(1)SY	The Bidirectional Forwarding Detection MIB feature enables the SNMP agent support in Cisco IOS software for BFD management, as implemented in the CISCO-IETF-BFD-MIB. The following commands were introduced or modified: • **snmp-server enable traps bfd** • **snmp-server host**



CHAPTER 5

IS-IS Client for BFD C-Bit Support

The Bidirectional Forwarding Detection (BFD) protocol provides short-duration detection of failures in the path between adjacent forwarding engines while maintaining low networking overheads. The BFD IS-IS Client Support feature enables Intermediate System-to-Intermediate System (IS-IS) to use Bidirectional Forwarding Detection (BFD) support, which improves IS-IS convergence as BFD detection and failure times are faster than IS-IS convergence times in most network topologies. The IS-IS Client for BFD C-Bit Support feature enables the network to identify whether a BFD session failure is genuine or is the result of a control plane failure due to a router restart. When planning a router restart, you should configure this feature on all neighboring routers.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for IS-IS Client for BFD C-Bit Support

- IS-IS must be running on all participating devices.

- The baseline parameters for BFD sessions must be configured on the interfaces that run BFD sessions to BFD neighbors.

Information About IS-IS Client for BFD C-Bit Support

IS-IS Restarts and BFD Sessions

The IS-IS Client for BFD C-Bit Support feature provides BFD with a way to signal to its peers whether the BFD implementation shares the same status as the control plane. When a neighboring router's control plane restarts, a BFD session failure may occur, which does not actually represent a true forwarding failure. If this happens, you do not want the neighbors of the restarting router to react to the BFD session failure.

IS-IS does not have protocol extensions that allow it to signal in advance that it will be restarting. This means that the system cannot distinguish between a real forwarding failure and a restart. The IS-IS Client for BFD C-Bit Support feature allows you to configure the device to ignore control-plane related BFD session failures. We recommend that you configure this feature on the neighbors of a restarting device just prior to the planned restart of that device and that you remove the configuration after the restart has been completed.

The table below shows how the control plane independent failure status received from BFD on a session down event impacts IS-IS handling of that event.

Table 6: Control Plane Failure and Session Down Events

IS-IS Check Control Plane Failure	BFD Control Plane Independent Failure Status	IS-IS Action on BFD session 'DOWN' Event
Enabled	True	Accept session DOWN
Enabled	False	Ignore session DOWN
Disabled	True	Accept session DOWN
Disabled	False	Accept session DOWN

How to Configure IS-IS Client for BFD C-Bit Support

Configuring IS-IS Client for BFD C-Bit Support

Perfrom this task to enable control plane failure checking.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router isis**
4. **bfd check-control-plane-failure**
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**router isis** **Example:** `Device(config)# router isis`	Enables the IS-IS routing protocol and enters router configuration mode.
Step 4	**bfd check-control-plane-failure** **Example:** `Device(config-router)# bfd check-control-plane-failure`	Enables BFD control plane failure checking for the IS-IS routing protocol.
Step 5	**end** **Example:** `Device(config-router)# end`	Exits router configuration mode and returns to privileged EXEC mode.

Configuration Examples for IS-IS Client for BFD C-Bit Support

Example: Configuring IS-IS Client for BFD C-Bit Support

The following example configures control plane failure detection on a router running the IS-IS protocol.

```
Device> enable
Device# configure terminal
Device(config)# router isis
Device(config-router)# bfd check-ctrl-plane-failure
Device(config-router)# end
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	*Cisco IOS Master Command List, All Releases*
BFD commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	*Cisco IOS IP Routing: Protocol-Independent Command Reference*
Configuring and monitoring IS-IS	"Configuring Integrated IS-IS" module of the *Cisco IOS IP Routing Protocols Configuration Guide*
Cisco IOS IPv6 features	*Cisco IOS IPv6 Feature Mapping*

Standards and RFCs

Standard/RFC	Title
RFC 5882	*Generic Application of Bidirectional Forwarding Detection (BFD)*

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

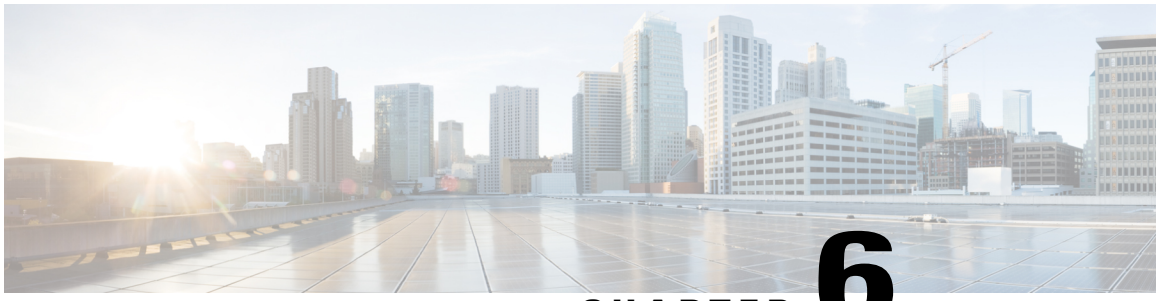
Feature Information for IS-IS Client for BFD C-Bit Support

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 7: Feature Information for IS-IS Client for BFD C-Bit Support

Feature Name	Releases	Feature Information
IS-IS Client for BFD C-Bit Support	15.1(1)SY 15.3(1)T	The IS-IS Client for BFD C-Bit Support feature enables the network to identify whether a BFD session failure is genuine or is the result of a control plane failure due to a router restart. The following command was introduced: **bfd check-ctrl-plane-failure**.



CHAPTER 6

IS-IS IPv6 Client for BFD

When Bidirectional Forwarding Detection (BFD) support is configured with Intermediate System To Intermediate System (IS-IS) as a registered protocol with BFD, IS-IS receives forwarding path detection failure messages from BFD.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for IS-IS IPv6 Client for BFD

- IS-IS must be running on all participating devices.
- The baseline parameters for BFD sessions must be configured on the interfaces that run BFD sessions to BFD neighbors.

Information About IS-IS IPv6 Client for BFD

IS-IS BFD Topology

When BFD support is configured with IS-IS as a registered protocol with BFD, IS-IS receives forwarding path detection failure messages from BFD. BFD support for IS-IS can be configured in either router address-family configuration mode or interface configuration mode. IS-IS IPv6 can run in single-topology or in Multi-Topology (MT) mode.

IS-IS BFD supports both IPv4 and IPv6 on the same adjacency for single-topology or multi-topology mode. If BFD is enabled for both IPv4 and IPv6, IS-IS sends two BFD session creation requests to BFD. For single-topology mode, the IS-IS adjacency state can only be UP if both BFD sessions are UP. If either of the BFD sessions is DOWN, the associated IS-IS adjacency state is also DOWN. For MT mode, the IS-IS adjacency state can be UP as long as one of topologies has a BFD session in an UP state.

IS-IS BFD IPv6 Session Creation

IS-IS requests a BFD session for the interface and IPv6 address of the neighboring device when all of the following conditions are met:

- An IS-IS adjacency entry exists.
- The Address Family Identifier (AFI) specific peer interface address is known.
- IS-IS BFD is enabled for that AFI on an interface.
- IS-IS is enabled for that AFI on the local interface.
- If the neighboring device supports RFC 6213, BFD must be enabled for the specified Multi-Topology Identifier (MTID) or Network Layer Protocol Identifier (NLPID).

IS-IS BFD IPv6 Session Deletion

When IS-IS BFD IPv6 is disabled on an interface, IS-IS removes related BFD sessions for IPv6 from the adjacent device. When the IS-IS adjacency entry is deleted, all BFD sessions are also deleted. IS-IS requests BFD to remove each BFD session that it has requested when any of the following events occur:

- The IS-IS instance is deleted or un-configured.
- The IS-IS adjacency entry is deleted.
- IS-IS BFD is disabled on the next hop interface for an address-family.
- The neighboring device supports RFC 6213 and indicates that it no longer supports BFD for the specified MTID or NLPID.

How to Configure ISIS IPv6 Client for BFD

Configuring IS-IS IPv6 Client Support for BFD on an Interface

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **isis ipv6 bfd**
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:** `Device(config)# interface gigabitethernet 6/0/0`	Enters interface configuration mode.
Step 4	**isis ipv6 bfd** **Example:** `Device(config-if)# isis ipv6 bfd`	Enables IPv6 BFD on a specific interface that is configured for IS-IS.
Step 5	**end** **Example:** `Device(config-if)# end`	Exits interface configuration mode and returns to privileged EXEC mode.

Configuring IS-IS IPv6 Client Support for BFD on All Interfaces

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router isis**
4. **metric-style wide**
5. **address-family ipv6**
6. **multi-topology**
7. **bfd all-interfaces**
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**router isis** **Example:** `Device(config)# router isis`	Enables the IS-IS routing protocol and enters router configuration mode.
Step 4	**metric-style wide** **Example:** `Device(config-router)# metric-style wide`	(Optional) Configures a device that is running IS-IS so that it generates and accepts only new-style type, length, value objects (TLVs).
Step 5	**address-family ipv6** **Example:** `Device(config-router)# address-family ipv6`	Enters address family configuration mode for configuring IS-IS routing sessions that use standard IPv6 address prefixes.

	Command or Action	Purpose
Step 6	**multi-topology** **Example:** `Device(config-router-af)# multi-topology`	(Optional) Enables multi-topology IS-IS for IPv6.
Step 7	**bfd all-interfaces** **Example:** `Device(config-router-af)# bfd all-interfaces`	Enables BFD for all interfaces participating in the routing process.
Step 8	**end** **Example:** `Device(config-router-af)# end`	Exits address family configuration mode and returns to privileged EXEC mode.

Configuration Examples for ISIS IPv6 Client for BFD

Example: IS-IS IPv6 Client Support for BFD on a Single Interface

```
Device> enable
Device# configure terminal
Device(config)# interface gigabitethernet 6/0/0
Device(config-if)# isis ipv6 bfd
Device(config-if)# end

Device> enable
Device# configure terminal
Device(config)# interface gigabitethernet 6/0
Device(config-if)# isis ipv6 bfd
Device(config-if)# end
```

Example: IS-IS IPv6 Client Support for BFD on All Interfaces

```
Device> enable
Device# configure terminal
Device(config)# router isis
Device(config-router)# metric-style wide
Device(config-router)# address-family ipv6
Device(config-router-af)# multi-topology
Device(config-router-af)# bfd all-interfaces
Device(config-router-af)# end
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	*Cisco IOS Master Command List, All Releases*
BFD commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples.	*Cisco IOS IP Routing: Protocol-Independent Command Reference*
Configuring and monitoring IS-IS	"Configuring Integrated IS-IS" module of the *IP Routing Protocols Configuration Guide*
Cisco IOS IPv6 features	*Cisco IOS IPv6 Feature Mapping*
IPv6 commands	*Cisco IOS IPv6 Command Reference*

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

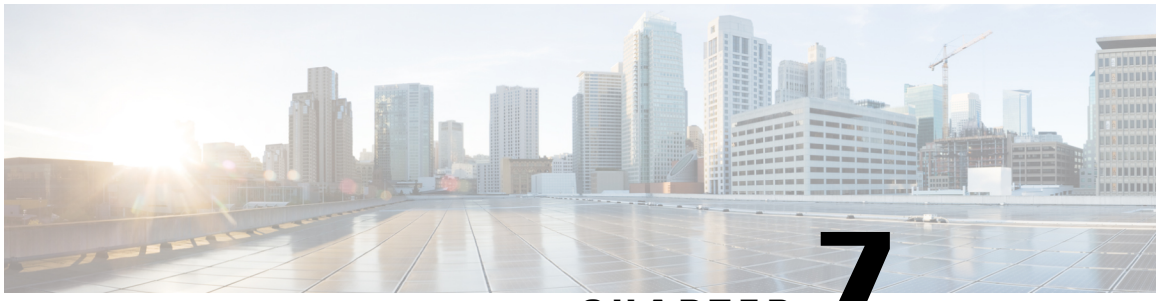
Feature Information for IS-IS IPv6 Client for BFD

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 8: Feature Information for IS-IS IPv6 Client for BFD

Feature Name	Releases	Feature Information
IS-IS IPv6 Client for BFD	15.1(1)SY 15.2(4)S 15.3(1)T	When BFD support is configured with IS-IS as a registered protocol with BFD, IS-IS receives forwarding path detection failure messages from BFD. The following commands were introduced or modified: **bfd all-interfaces**, **isis ipv6 bfd**.



CHAPTER 7

Static Route Support for BFD over IPv6

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Information About Static Route Support for BFD over IPv6

Using the BFDv6 protocol to reach the static route next hop ensures that an IPv6 static route is inserted only in the IPv6 Routing Information Base (RIB) when the next-hop neighbor is reachable. Using the BFDv6 protocol also can remove the IPv6 static route from the IPv6 RIB when the next hop becomes unreachable.

A user can configure IPv6 static BFDv6 neighbors. These neighbor can operate in one of two modes: associated (which is the default) and unassociated. A neighbor can be transitioned between the two modes without interrupting the BFDv6 session associated with the neighbor.

BFDv6 Associated Mode

In Bidirectional Forwarding Detection for IPv6 (BFDv6) associated mode, an IPv6 static route is automatically associated with an IPv6 static BFDv6 neighbor if the static route next hop exactly matches the static BFDv6 neighbor.

An IPv6 static route requests a BFDv6 session for each static BFDv6 neighbor that has one or more associated IPv6 static routes and is configured over an interface on which BFD has been configured. The state of the BFDv6 session will be used to determine whether the associated IPv6 static routes are inserted in the IPv6 RIB. For example, static routes are inserted in the IPv6 RIB only if the BFDv6 neighbor is reachable, and the static route is removed from the IPv6 RIB if the BFDv6 neighbor subsequently becomes unreachable.

BFDv6 associated mode requires you to configure a BFD neighbor and static route on both the device on which the BFD-monitored static route is required and on the neighboring device.

BFDv6 Unassociated Mode

An IPv6 static BFD neighbor may be configured as unassociated. In this mode, the neighbor is not associated with static routes, and the neighbor always requests a BFDv6 session if the interface has been configured for BFDv6.

Unassociated mode is useful in the following situations:

- Bringing up a BFDv6 session in the absence of an IPv6 static route—This case occurs when a static route is on router A, with router B as the next hop. Associated mode requires you to create both a static BFD neighbor and static route on both routers in order to bring up the BFDv6 session from B to A. Specifying the static BFD neighbor in unassociated mode on router B avoids the need to configure an unwanted static route.
- Transition to BFD monitoring of a static route—This case occurs when existing IPv6 static routes are inserted in the IPv6 RIB. Here, you want to enable BFD monitoring for these static routes without any interruption to traffic. If you configure an attached IPv6 static BFD neighbor, then the static routes will immediately be associated with the new static BFD neighbor. However, because a static BFD neighbor starts in a down state, the associated static routes are then removed from the IPv6 RIB and are reinserted when the BFDv6 session comes up. Therefore, you will see an interruption in traffic. This interruption can be avoided by configuring the static BFD neighbor as unassociated, waiting until the BFDv6 session has come up, and then reconfiguring the static BFD neighbor as associated.
- Transition from BFD monitoring of a static route—In this case, IPv6 static routes are monitored by BFD and inserted in the RIB. Here, you want to disable BFD monitoring of the static routes without interrupting traffic flow. This scenario can be achieved by first reconfiguring the static BFD neighbor as detached (thus disassociating the neighbor from the static routes) and then deconfiguring the static BFD neighbor.

How to Configure Bidirectional Forwarding Detection for IPv6

Specifying a Static BFDv6 Neighbor

An IPv6 static BFDv6 neighbor is specified separately from an IPv6 static route. An IPv6 static BFDv6 neighbor must be fully configured with the interface and neighbor address and must be directly attached to the local router.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 route static bfd** [**vrf** *vrf-name*] *interface-type interface-number ipv6-address* [**unassociated**]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 route static bfd** [**vrf** *vrf-name*] *interface-type interface-number ipv6-address* [**unassociated**] **Example:** `Device(config)# ipv6 route static bfd gigabitethernet 0/0/0 2001::1`	Specifies static route IPv6 BFDv6 neighbors.

Associating an IPv6 Static Route with a BFDv6 Neighbor

IPv6 static routes are automatically associated with a static BFDv6 neighbor. A static neighbor is associated with a BFDv6 neighbor if the static next-hop explicitly matches the BFDv6 neighbor.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ipv6 route static bfd** [**vrf** *vrf-name*] *interface-type interface-number ipv6-address* [**unassociated**]
4. **ipv6 route** [**vrf** *vrf-name*] *ipv6-prefix/prefix-length prefix-length* {*ipv6-address* | *interface-type* [*interface-number ipv6-address*]} [**nexthop-vrf** [*vrf-name1* | **default**]] [*administrative-distance*] [*administrative-multicast-distance* | **unicast** | **multicast**] [*next-hop-address*] [**tag** *tag*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ipv6 route static bfd** [**vrf** *vrf-name*] *interface-type interface-number ipv6-address* [**unassociated**] **Example:** `Device(config)# ipv6 route static bfd ethernet 0/0 2001::1`	Specifies static route BFDv6 neighbors.
Step 4	**ipv6 route** [**vrf** *vrf-name*] *ipv6-prefix/prefix-length prefix-length* {*ipv6-address* | *interface-type* [*interface-number ipv6-address*]} [**nexthop-vrf** [*vrf-name1* | **default**]] [*administrative-distance*] [*administrative-multicast-distance* | **unicast** | **multicast**] [*next-hop-address*] [**tag** *tag*] **Example:** `Device(config)# ipv6 route 2001:DB8::/64 ethernet 0/0 2001::1`	Establishes static IPv6 routes.

Configuration Examples for Static Route Support for BFD over IPv6

Example: Specifying an IPv6 Static BFDv6 Neighbor

The following example shows how to specify a fully configured IPv6 static BFDv6 neighbor. The interface is Ethernet 0/0 and the neighbor address is 2001::1.

```
Device(config)# ipv6 route static bfd ethernet 0/0 2001::1
```

Example: Associating an IPv6 Static Route with a BFDv6 Neighbor

In this example, the IPv6 static route 2001:DB8::/32 is associated with the BFDv6 neighbor 2001::1 over the Ethernet 0/0 interface:

```
Device(config)# ipv6 route static bfd ethernet 0/0 2001::1
Device(config)# ipv6 route 2001:DB8::/32 ethernet 0/0 2001::1
```

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	*IPv6 Configuration Guide*
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IPv6 commands	Cisco IOS IPv6 Command Reference
Cisco IOS IPv6 features	Cisco IOS IPv6 Feature Mapping
Static Route Support for BFD over IPv6	"*Bidirectional Forwarding Detection*" module

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	IPv6 RFCs

MIBs

MIB	MIBs Link
	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

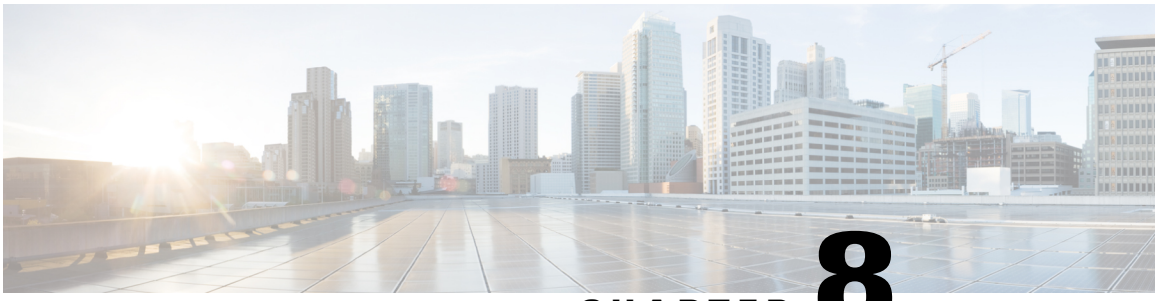
Feature Information for Static Route Support for BFD over IPv6

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 9: Feature Information for Static Route Support for BFD over IPv6

Feature Name	Releases	Feature Information
Static Route Support for BFD over IPv6	15.1(1)SG 15.1(1)SY 15.1(2)T 15.2(1)E 15.4(1)S	Using the BFDv6 protocol to reach the static route next hop ensures that an IPv6 static route is inserted only in the IPv6 Routing Information Base (RIB) when the next-hop neighbor is reachable. Using the BFDv6 protocol also can remove the IPv6 static route from the IPv6 RIB when the next hop becomes unreachable. The following commands were introduced or modified: **debug bfd**, **debug ipv6 static**, **ipv6 route**, **ipv6 route static bfd**, **monitor event ipv6 static**, **show ipv6 static**. In Cisco IOS 15.4(1)S Release, support was added for the Cisco ASR 901S router.



CHAPTER 8

BFD Multihop Support for IPv4 Static Routes

The BFD Multihop Support for IPv4 Static Routes feature enables detection of IPv4 network failure between paths that are not directly connected. If a Bidirectional Forwarding Detection (BFD) session is up (that is, the next-hop destination is reachable), IPv4 static routes that are associated with IPv4 static BFD configuration are added to a routing table. If the BFD session is down, the routing table removes all associated static routes from the routing table.

This feature is applicable on different kinds of interfaces such as physical, subinterface, and virtual tunnels and across intra-area and interarea topologies.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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Prerequisites for BFD Multihop Support for IPv4 Static Routes

- The BFD destination for which an IPv4 static route has to be configured must be reachable by all devices.
- The configured device must have at least one static route with the next-hop destination as a BFD destination for an associated session. If not, the BFD session is not created on the device.

Information About BFD Multihop Support for IPv4 Static Routes

BFDv4 Associated Mode

In Bidirectional Forwarding Detection for IPv4 (BFDv4) associated mode, an IPv4 static route is automatically associated with an IPv4 static BFDv4 multihop destination address if the static route next hop exactly matches the static BFDv4 multihop destination address.

The state of the BFDv4 session is used to determine whether the associated IPv4 static routes are added in the IPv4 routing information base (RIB). For example, static routes are added in the IPv4 RIB only if the BFDv4 multihop destination is reachable, and the static routes are removed from the IPv4 RIB if the BFDv4 multihop destination subsequently becomes unreachable.

BFDv4 Unassociated Mode

In Bidirectional Forwarding Detection for IPv4 (BFDv4), an IPv4 static BFD multihop destination can be configured in unassociated mode. In unassociate mode, a BFD neighbor is not associated with a static route, and the BFD sessions are requested if the IPv4 static BFD is configured.

Unassociated mode is useful in the following scenario:

- Absence of an IPv4 static route—This scenario occurs when a static route is on device A, and device B is the next hop. In associated mode, you must create both a static BFD multihop destination address and a static route on both devices to bring up the BFDv4 session from device B to device A. Specifying the static BFD multihop destination in unassociated mode on device B avoids the need to configure an unwanted static route.

How to Configure BFD Multihop Support for IPv4 Static Routes

Configuring BFD Multihop IPv4 Static Routes

Before You Begin

- Specify a BFD destination address which is same as the IPv4 static route next hop or gateway address.

- Configure a BFD map and a BFD multihop template for an interface on the device. The destination address and source address configured for a BFD map must match the BFD static multihop configuration and the source address must be a valid IP address configured for an interface in the routing table.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip route** *prefix mask ip-address*
4. **ip route static bfd** *multihop-destination-address multihop-source-address*
5. **ip route static bfd** *multihop-destination-address multihop-source-address* **unassociate**
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ip route** *prefix mask ip-address* **Example:** `Device(config)# ip route 192.0.2.0 255.255.255.0 10.1.1.2`	Configures an IPv4 static route that BFD multihop uses to monitor static routes.
Step 4	**ip route static bfd** *multihop-destination-address multihop-source-address* **Example:** `Device(config)# ip route static bfd 192.0.2.1 10.1.1.1`	Configures the static IPv4 BFD multihop to be associated with a static IPv4 route.
Step 5	**ip route static bfd** *multihop-destination-address multihop-source-address* **unassociate** **Example:** `Device(config)# ip route static bfd 192.0.2.1 10.1.1.1 unassociate`	(Optional) Configures the static IPv4 BFD multihop to be associated with a static IPv4 route in unassociated mode.
Step 6	**end** **Example:** `Device(config)# end`	Exits global configuration mode and returns to privileged EXEC mode.

Verifying BFD Multihop Support for IPv4 Static Routes

The following show commands can be used to verify IPv4 static routes for BFD multihop:

SUMMARY STEPS

1. **show bfd neighbor**
2. **show ip static route bfd**

DETAILED STEPS

Step 1 **show bfd neighbor**
Displays a line-by-line listing of existing BFD adjacencies.

Step 2 **show ip static route bfd**
Displays information about the IPv4 static BFD configured parameters.

Configuration Examples for BFD Multihop Support for IPv4 Static Routes

Additional References for BFD Multihop Support for IPv4 Static Routes

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Command List, All Releases
IP Routing: Protocol Independent commands	IP Routing Protocol-Independent Command Reference

Standards and RFCs

Standard/RFC	Title
RFC 5883	*BFD for Multihop Paths*

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/support

Example: Configuring BFD Multihop for IPv4 Static Routes in Associated Mode

```
Device> enable
Device# configure terminal
Device(config)# bfd map ipv4 192.0.2.1/32  10.1.1.1/32 test
Device(config)# bfd-template multi-hop test
Device(config-bfd)# interval min-tx 51 min-rx 51 multiplier 3
Device(config-bfd)# exit
Device(config)# ip route 192.0.2.0 255.255.255.0 10.1.1.2
Device(config)# interface GigabitEthernet 1/1
Device(config-if)# ip address 10.1.1.1 255.255.0.0
Device(config-if)# exit
Device(config)# ip route static bfd 192.0.2.1 10.1.1.1
Device(config)# end
```

Example: Configuring IPv4 Static Multihop for BFD in Unassociated Mode

```
Device> enable
Device# configure terminal
Device(config)# bfd map ipv4 192.0.2.1/32  10.1.1.1/32 test
Device(config)# bfd-template multi-hop test
Device(config-bfd)# interval min-tx 51 min-rx 51 multiplier 3
Device(config-bfd)# exit
Device(config)# ip route 192.0.2.0 255.255.255.0 10.1.1.2
Device(config)# interface GigabitEthernet 1/1
Device(config-if)# ip address 10.1.1.1 255.255.0.0
Device(config-if)# exit
Device(config)# ip route static bfd 192.0.2.1 10.1.1.1 unassociate
Device(config)# end
```

Feature Information for BFD Multihop Support for IPv4 Static Routes

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Table 10: Feature Information for BFD Multihop Support for IPv4 Static Routes

Feature Name	Releases	Feature Information
BFD Multihop Support for IPv4 Static Routes	15.2(3)S 15.3(3)M 15.2(1)SY	The BFD Multihop Support for IPv4 Static Routes feature enables detection of IPv4 network failure between paths that are not directly connected. If a Bidirectional Forwarding Detection (BFD) session is up (that is, the next-hop destination is reachable), IPv4 static routes that are associated with IPv4 static BFD configuration are added to a routing table. If the BFD session is down, the routing table removes all associated static routes from the routing table. The following commands were modified: **ip route static bfd** and **show ip static route bfd**.