



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.

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Prerequisites for Bidirectional Forwarding Detection

- Cisco Express Forwarding and IP routing must be enabled on all participating routers

Restrictions for Bidirectional Forwarding Detection

- Minimum value supported on **bfd interval** command is 50ms.
- BFD templates must be used to configure 3.3ms BFD. For more information, see [Creating and Configuring BFD Templates, on page 12](#).
- Moving from echo to non-echo and non-echo to echo multiple times without any delay between each iteration may cause a few BFD sessions to flap. So multiple times echo to non-echo/non-echo to echo transition is not recommended and if this scenario is required then it should be done with a delay of at least 20 seconds at each step.
- The loopback packets are not prioritized for BFD echo sessions. Apply QoS policy to increase the priority of the packets.

- BFD packets for both, echo and non-echo sessions are not subjected to the Egress QoS. These packets are sent in the high-priority queue.
- BFD flaps on enabling internal loopback and traffic looped back with line rate as both the traffic passes through the HPCT queue.
- When 300 plus scaled BFD sessions are configured with 1 second BFD timers, few sessions may take time to come up or some times sessions do not come up. This is an expected behavior on the router when the peer node is Cisco ASR 920.
- BFD with authentication is supported only in software. Hardware offload is not supported for BFD with authentication.
- The minimum timer value supported for the BFD software session is 200 ms.
- BFD over IPv4 unicast GRE tunnel is not supported.

Information About Bidirectional Forwarding Detection

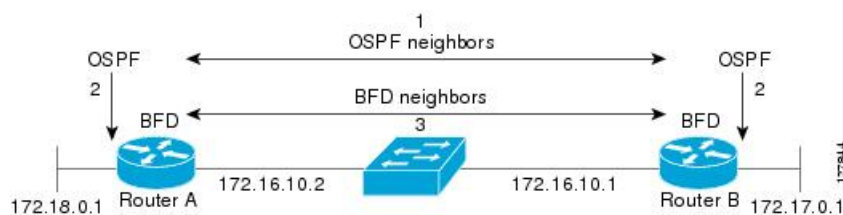
BFD Operation

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 is enabled at the interface and 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, BFD must be configured on both systems (or BFD peers). Once BFD has been enabled on the interfaces and at the router level for the appropriate protocols (NHRP and the routing protocol on overlay), 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.

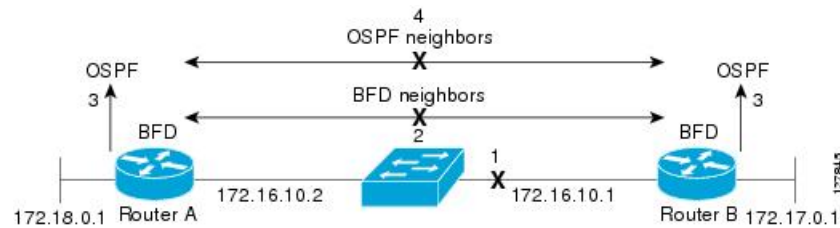
Neighbor Relationships

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.



Note A single BFD session notifies all protocols. For example, if OSPF and PIM neighbors exist, then a single BFD session notifies both the protocols.

BFD Detection of Failures

Once a BFD session has been established and timer negotiations are complete, BFD peers send BFD control packets that act in the same manner as an IGP hello protocol to detect liveness, 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.
- Typically, BFD can be used at any protocol layer. However, the Cisco implementation of BFD for Cisco IOS Releases 12.0(31)S, and 12.4(4)T supports only Layer 3 clients, in particular, the BGP, EIGRP, IS-IS, and OSPF routing protocols. For Cisco IOS Release 12.2(33)SRC, BFD is supported for static routing.
- The Cisco implementation of BFD for Cisco IOS Release 12.2(18)SXE also supports only Layer 3 clients and the EIGRP, IS-IS, and OSPF routing protocols. It does not support the BGP routing protocol.

BFD Version Interoperability

Cisco IOS Release 12.4(9)T supports BFD Version 1 as well as BFD Version 0.

Cisco IOS Release 12.2EY and Cisco IOS Release 15.S support BFD Version 1 and BFD Version 0.

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.



Note RSP3 supports only Version 1 and do not support BFD version interoperability.

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

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 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.

In Cisco IOS Release 12.2(33)SRC, 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.

In Cisco IOS Release 12.2(33)SB, BFD is not SSO-aware, and it is not supported with NSF/SSO. These features should not be used together. Enabling BFD along with NSF/SSO causes the nonstop forwarding capability to break during failover because BFD adjacencies are not maintained and the routing clients are forced to mark down adjacencies and reconverge.

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.

Timer values are different based on the number of BFD sessions and the platform.

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 on Multiple Hops

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.

Multi-hop BFD over IPv6 is supported in software mode only.

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:

- BFD on the CPU operates under interrupt like CEF switched traffic. EIGRP, IS-IS and OSPF protocol hellos are handled in the process switching path. This provides BFD greater scalability and reliability over protocol hellos.
- 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.

**Note**

RSP3 Module supports only the following BFD interval timers:

3.3ms, 6.6ms, 10ms, 20ms, 50ms, 100ms, 200ms, 999ms. It is recommended that peer should also configure the same timer values.

Procedure**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 **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 **interface** *type number*

Example:

```
Device(config)# interface FastEthernet 6/0
```

Enters interface configuration mode.

Step 6 **interface gigabitethernet** *number*

Example:

```
Device(config)# interface gigabitethernet 0/0/0
```

Specifies the Gigabit Ethernet interface and enters interface configuration mode.

Step 7 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 8 **bfd template** *template name*

Enables the BFD template.

Step 9 **end**

Example:

```
Device(config-if)# end
```


Exits interface configuration mode and returns to privileged EXEC mode.

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.

Procedure

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 **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 **interface** *type number*

Example:

```
Device(config)# interface GigabitEthernet 0/0/0
```

Configures an interface and enters interface configuration mode.

Step 6 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 7

bfd template *template name*

Enables the BFD template.

Step 8

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
- IPv6 CEF is disabled globally or locally on an interface

Step 9

exit

Example:

```
Device(config-if)# exit
```

Exits interface configuration mode and returns to global configuration mode.

Step 10

Perform one of the following steps:

- **ip route static bfd** *interface-type interface-number ip-address* [**group** *group-name* [**passive**]]
- **ipv6 route static bfd** *interface-type interface-number ip-address* [**unaasosiated**]

Example:

```
Device(config)# ip route static bfd GigabitEthernet 0/0/0 10.1.1.1 group group1 passive
```

```
Device(config)# ipv6 route static bfd TenGigabitEthernet 0/0/7 19:1:1::2
```

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 11 Perform one of the following steps:

- **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*]
- **ipv6 route** [**vrf** *vrf-name*] *ipv6 prefix/mask* {*ipv6-address* | *interface-type interface-number* [*ipv6-address*] } [**name** *next-hop-name*] [**track** *number*] [**tag** *tag*]

Example:

```
Device(config)# ip route 10.0.0.0 255.0.0.0
```

```
Device(config)# ipv6 route 19:1:1::/64 TenGigabitEthernet0/0/7 19:1:1::2
```

Specifies a static route BFD neighbor.

Step 12 **exit**

Example:

```
Device(config)# exit
```

Exits global configuration mode and returns to privileged EXEC mode.

Step 13 Perform one of the following steps:

- **show ip static route**
- **show ipv6 static**

Example:

```
Device# show ipv6 static
```

(Optional) Displays static route database information.

Step 14 Perform one of the following steps:

- **show ip static route bfd**
- **show ipv6 static bfd**

Example:

```
Device # show ipv6 static bfd
```

(Optional) Displays information about the static BFD configuration from the configured BFD groups and nongroup entries.

Step 15 **exit**

Example:

```
Device# exit
```

Exits privileged EXEC mode and returns to user 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.



Note Cisco IOS Release 15.0(1)S introduced the concept of BFD templates that allow BFD interval timers to be configured independently of an interface. BFD templates are required to provide support for the BFD Control Channel over VCCV-Support for ATM Pseudowires feature.

Procedure

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.



Note Cisco IOS Release 15.1(3)S and later releases support BFD on multiple network hops. After you have configured interval timers and authentication in a template, you can configure a map to associate the template with unique source-destination address pairs for multihop BFD sessions.



Note See “Xconnect as a Client of BFD” for information on configuring xconnect as a client of BFD and detecting failure with the **monitor peer bfd** command.

Procedure

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-templatel
```

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.

Step 6 **end**

Example:

```
Router(bfd-config)# end
```

Exits BFD configuration mode and returns the router to privileged EXEC mode.

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.

Procedure

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 map ipv4 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-templatel
```

Configures a BFD map and associates it with the template.

Step 4 Perform one of the following steps:

- **bfd map ipv4** *destination length source-address length template-name*
- **bfd map ipv4 vrf** *vrf-name destination length vrf vrfname source-address length template-name*

Example:

```
Router(config)# bfd map ipv4 192.168.0.0/24 192.168.42.5/32 mh-templatel
```

```
Router(config)# bfd map ipv4 vrf vpn1 192.168.0.0/24 vrf vpn2 192.168.42.5/32 BFD_RPW_MH
```

Configures a BFD map and associates it with the template.

Mention the VRF name for the source-address as well, if source address is part of a VRF.

Step 5 **end**

Example:

```
Router(config)# end
```

Exits BFD configuration mode and returns the router to privileged EXEC mode.

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. The Gigabit Ethernet interface 0/0/1 on RouterA is connected to the same network as Gigabit Ethernet interface 0/0/1 on Router B. The Gigabit Ethernet interface 0/0/1 on RouterB is connected to the same network as Gigabit Ethernet interface 0/0/1 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 RouterA 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 control packets for BFD sessions and failure detections.

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

Configuration for RouterA

```
interface GigabitEthernet0/0/0
no shutdown
ip address 10.4.9.14 255.255.255.0
```

```

duplex auto
speed auto
!
interface GigabitEthernet0/0/1
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
!

```

Configuration for RouterB

```

!
interface GigabitEthernet0/0/0
no shutdown
ip address 10.4.9.34 255.255.255.0
duplex auto
speed auto
!
interface GigabitEthernet0/0/1
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
!

```

Configuration for RouterC

```

!
!
interface GigabitEthernet0/0/0
no shutdown
ip address 10.4.9.51 255.255.255.0
duplex auto
speed auto
!
interface GigabitEthernet0/0/1
ip address 172.16.1.3 255.255.255.0
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
!

```


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     Gig0/0/1
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     Gig0/0/1
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.

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

```

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      Gig0/0/1
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      Gig0/0/1
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

```

When Gigabit ethernet interface 0/0/1 on RouterB fails, BFD will no longer detect Router B as a BFD neighbor for RouterA or for RouterC. In this example, Gigabit Ethernet interface 0/0/1 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      Gig0/0/1

```

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    Gig0/0/1
```

Example: Configuring BFD in an OSPF Network

In the following example, the simple OSPF network consists of Router A and Router B. Gigabit Ethernet interface 0/0/1 on Router A is connected to the same network as Gigabit Ethernet interface 0/0/1 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 GigabitEthernet 0/0/1
 ip address 172.16.10.1 255.255.255.0
 bfd interval 50 min_rx 50 multiplier 3
!
interface GigabitEthernet 0/0/0
 ip address 172.17.0.1 255.255.255.0
!
router ospf 123
 log-adjacency-changes detail
 network 172.16.10.0 0.0.0.255 area 0
 network 172.17.10.0 0.0.0.255 area 0
 bfd all-interfaces
```

Configuration for Router B

```
!
interface GigabitEthernet 0/0/1
 ip address 172.16.10.2 255.255.255.0
 bfd interval 50 min_rx 50 multiplier 3
!
interface GigabitEthernet 0/0/0
 ip address 172.18.0.1 255.255.255.0
!
router ospf 123
 log-adjacency-changes detail
 network 172.16.10.0 0.0.0.255 area 0
 network 172.18.10.0 0.0.0.255 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         Gig0/0/0
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 Router B verifies that a BFD session has been created:

Router B

```
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         Gig0/0/0
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 SPF's 10000 msecs
Maximum wait time between two consecutive SPF's 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 SPF's 10000 msecs
Maximum wait time between two consecutive SPF's 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 GigabitEthernet 0/0/1
```

```

GigabitEthernet0/0/1 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 Gigabit Ethernet 0/0/0
```

```

GigabitEthernet0/0/1 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. The Gigabit Ethernet interface 0/0/1 on Router A is connected to the same network as Gigabit Ethernet interface 0/0/1 in Router B. The example, starting in global configuration mode, shows the configuration of BFD.

Configuration for Router A

```
!  
interface GigabitEthernet 0/0/1  
  ip address 172.16.10.1 255.255.255.0  
  bfd interval 50 min_rx 50 multiplier 3  
!  
interface GigabitEthernet 0/0/0  
  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 GigabitEthernet 0/0/1  
  ip address 172.16.10.2 255.255.255.0  
  bfd interval 50 min_rx 50 multiplier 3  
!  
interface GigabitEthernet 0/0/0  
  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       Gig0/0/1
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 on Router B verifies that a BFD session has been created:

Router B

```
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       Gig0/0/0
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. The Gigabit Ethernet interface 0/0/1 on Router A is connected to the same network as Gigabit Ethernet interface 0/0/0 for Router B. The example, starting in global configuration mode, shows the configuration of BFD.

Configuration for Router A

```
!
interface GigabitEthernet 0/0/1
 ip address 172.16.10.1 255.255.255.0
 ip router isis
  bfd interval 50 min_rx 50 multiplier 3
!
interface GigabitEthernet 0/0/0
 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 GigabitEthernet 0/0/0
 ip address 172.16.10.2 255.255.255.0
 ip router isis
  bfd interval 50 min_rx 50 multiplier 3
!
interface GigabitEthernet 0/0/1
 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     Gig0/0/1
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:

```

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     Gig0/0/0
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. The Gigabit Ethernet interface 2/0 on Router A is connected to the same network as Gigabit 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

```
interface GigabitEthernet0/0/1
 no shutdown
 ip address 10.0.0.1 255.0.0.0
 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 GigabitEthernet0/0/1
 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 GigabitEthernet0/0/0
 10.1.0.22
   No active groups
   Standby groups: 1
   BFD enabled !
RouterB# show standby neighbors

HSRP neighbors on GigabitEthernet0/0/1
 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 Gigabit Ethernet interface 0/0/0 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 GigabitEthernet 0/0/0 209.165.200.225 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 Gigabit Ethernet interface 0/0/0. The existence of the prefixes 10.1.1.1/8 and 10.2.2.2/8 is controlled by the active static BFD session (Gigabit Ethernet interface 0/0/0 209.165.200.225).

```

configure terminal
ip route static bfd GigabitEthernet 0/0/0 209.165.200.225 group testgroup
ip route 10.0.0.0 255.255.255.224 GigabitEthernet 0/0/0 209.165.200.225
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 GigabitEthernet 0/0/0 209.165.200.226
ip route 10.2.2.2 255.255.255.224 GigabitEthernet 0/0/0 209.165.200.226

```

BFD Dampening

Table 1: Feature History

Feature Name	Release	Description
BFD Dampening	Cisco IOS XE Amsterdam 17.3.1	<p>Bidirectional Forwarding Detection (BFD) is a detection protocol that is designed to provide fast forwarding path failure detection for encapsulations, topologies, and routing protocols. BFD provides a consistent failure detection method.</p> <p>BFD detects forwarding path failures at a uniform rate, rather than the variable rates for different routing protocol.</p> <p>This feature is supported on the RSP2 module.</p>

The BFD Dampening feature introduces a configurable exponential delay mechanism. This mechanism is designed to suppress the excessive effect of remote node reachability events flapping with BFD. The BFD Dampening feature allows the network operator to automatically dampen a given BFD session to prevent excessive notification to BFD clients, thus preventing unnecessary instability in the network. Dampening the notification to a BFD client suppresses BFD notification until the time the session under monitoring stops flapping and becomes stable.

Configuring the BFD Dampening feature, especially on a high-speed interface with routing clients, improves convergence time and stability throughout the network. (For routing client: minimize route recomputation, prefix flushing and learning due to stop or restart of routing protocol, translating in turn into reduced utilization of system processing resources by other devices in the network).

When reachability to the node under monitoring is flapping, penalty is assigned to that session. Penalty is gradually increased as long as the session state is not stable. Penalty is suppressed when next hop reachability becomes stable (during less flapping). There are different configuration parameters that are introduced in addressing this requirement namely Suppress Threshold, Half-Life period, Reuse Threshold and maximum suppress time.

BFD session dampening can be applied to all types of BFD sessions including IPv4 or IPv6 single-hop or multihop and so on. BFD session dampening is configured through `bfd-template` CLI at global level.

Restriction

- BFD Dampening is not supported on BFD multihop client and Micro BFD.
- BFD Dampening with down monitoring, does not work for multihop sessions.

Configuring BFD Dampening

Procedure

- | | |
|---------------|--|
| Step 1 | <code>enable</code>
Example:
<code>Router> enable</code>
Enables privileged EXEC mode. <ul style="list-style-type: none">• Enter your password if prompted. |
| Step 2 | <code>configure terminal</code>
Example:
<code>Router# configure terminal</code>
Enters global configuration mode. |
| Step 3 | <code>bfd-template multi-hop <i>template-name</i></code>
Example:
<code>Router(config)# bfd-template multi-hop doctemplate</code>
Creates a Bidirectional Forwarding Detection (BFD) template and enters BFD configuration mode. |

Step 4 interval min-tx *milliseconds* min-rx *milliseconds* multiplier *multiplier-value*

Example:

```
Router(config-bfd)# 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 dampening [*half-life-period reuse-threshold suppress-threshold max-suppress-time stability-threshold down-monitoring*]

Example:

```
Router(config-bfd)# dampening 2 1000 3000 8
Router(config-bfd)# dampening 4 200 1000 10 60 down-monitoring
```

Configures a device to dampen a flapping session.

Note Enable *down monitoring* to implement the BFD dampening with down monitoring feature.

Step 6 end

Example:

```
Router(config-bfd)# end
```

Exits BFD configuration mode and returns to privileged EXEC mode.

Examples for BFD Dampening

show bfd neighbor detail

Following command shows the dampening specific details if enabled for the session.

```
IPv4 Sessions
NeighAddr                      LD/RD          RH/RS          State          Int
10.0.0.2                        1/0            Up             Up            Et0/0
Session Host: Software
OurAddr: 10.0.0.1
Handle: 1
Local Diag: 0, Demand mode: 0, Poll bit: 0
MinTxInt: 1000000, MinRxInt: 1000000, Multiplier: 3
Received MinRxInt: 0, Received Multiplier: 0
Holddown (hits): 0(0), Hello (hits): 1000(0)
Rx Count: 0, Rx Interval (ms) min/max/avg: 0/0/0 last: 1257099 ms ago
Tx Count: 0, Tx Interval (ms) min/max/avg: 0/0/0 last: 1257099 ms ago
Elapsed time watermarks: 0 0 (last: 0)
Dampening:  penalty: 0                    - not dampened
              flap count: 0              - halflife: 2 sec
              reuse threshold: 2000       - suppress threshold: 3000
              max suppress time: 6 sec
Registered protocols: BGP CEF
Last packet: Version: 1                - Diagnostic: 0
              State bit: AdminDown       - Demand bit: 0
              Poll bit: 0                 - Final bit: 0
              C bit: 0
              Multiplier: 0               - Length: 0
              My Discr.: 0                - Your Discr.: 0
              Min tx interval: 0          - Min rx interval: 0
```

```
Min Echo interval: 0
```

show bfd neighbor dampening

Following command displays the dampening information about the BFD sessions configured with BFD dampening.

```
IPv4 Multihop Sessions
NeighAddr[vrf]                LD/RD          RH/RS          State
20.0.0.1                       1/0           Up             Up
Dampening:  penalty: 0         - not dampened
              flap count: 0     - half-life: 2 sec
              reuse threshold: 2000 - suppress threshold: 3000
              max suppress time: 6 sec
```

show bfd neighbor dampened

Following command displays the dampening information about the BFD sessions that are dampened.

```
IPv4 Sessions
NeighAddr[vrf]                LD/RD          RH/RS          State
20.0.0.1                       1/0           Down          Down
Dampening:  penalty: 4500      - dampened
              flap count: 10    - half-life: 2 sec
              reuse threshold: 2000 - suppress threshold: 3000
              max suppress time: 6 sec
```

Use detail keyword to view the entire session information.

```
IPv4 Sessions
NeighAddr                LD/RD          RH/RS          State          Int
1.1.1.2                   1/1           Up             Up             Et0/0
Session state is UP and using echo function with 50 ms interval.
Session Host: Software
OurAddr: 1.1.1.1
Handle: 1
Local Diag: 0, Demand mode: 0, Poll bit: 0
MinTxInt: 1000000, MinRxInt: 1000000, Multiplier: 3
Received MinRxInt: 1000000, Received Multiplier: 3
Holddown (hits): 0(0), Hello (hits): 1000(181)
Rx Count: 259, Rx Interval (ms) min/max/avg: 1/1000/663 last: 58 ms ago
Tx Count: 297, Tx Interval (ms) min/max/avg: 1/1000/578 last: 58 ms ago
Elapsed time watermarks: 0 0 (last: 0)
Dampening: Penalty: 4999         - dampened
              Flap Count: 38     - Half Life: 2 sec
              Reuse Threshold: 1000 - Suppress Threshold: 3000
              Max suppress time: 5 sec
Registered protocols: BGP CEF
Template: damp
Uptime: 00:00:00
Last packet: Version: 1         - Diagnostic: 0
              State bit: Up      - Demand bit: 0
              Poll bit: 0        - Final bit: 0
              C bit: 0
              Multiplier: 3       - Length: 24
              My Discr.: 1        - Your Discr.: 1
              Min tx interval: 1000000 - Min rx interval: 1000000
```

show bfd neighbor dampened (down-monitoring output)

```
Router# show bfd neigh dampened
```

```
IPv4 Sessions
NeighAddr          LD/RD          RH/RS          State          Int
1.1.1.2            3/3            Down           Down           BD10
Dampening: Penalty: 353          - dampened(down monitoring)
                Flap Count: 3          - Half Life: 4 seconds
                Reuse Threshold: 200      - Suppress Threshold: 1000
                Max suppress time : 10 seconds
                Time to unsuppress : 4 seconds
                Stability threshold: 60 seconds
                Exponential Backoff counter: 0
```

show bfd neighbor dampening (down-monitoring output)

```
Router# show bfd neigh dampening
```

```
IPv4 Sessions
NeighAddr          LD/RD          RH/RS          State          Int
1.1.1.2            3/3            Up             Up             BD10
Dampening: Penalty: 1           - not dampened(down monitoring)
                Flap Count: 3          - Half Life: 4 seconds
                Reuse Threshold: 200    - Suppress Threshold: 1000
                Max suppress time : 10 seconds
                Time to unsuppress : 0 seconds
                Stability threshold: 60 seconds
                Exponential Backoff counter: 1
```

Micro BFD

The BFD feature on ASR 920 supports micro BFD sessions on individual port channel member links to monitor Layer 3 connectivity on those links. With micro BFD feature, BFD is able to verify the ability of each member link to be able to forward Layer 3 packets and appropriately update the load balance.

Features of Micro BFD

- Micro BFD is supported both in hardware offloaded and software offloaded.
- Timers supported on micro BFD hardware offloaded session are from 3.3 ms to 200 ms.
- Timers supported on micro BFD hardware offloaded session are from 3.3 milli seconds to 1000 milli seconds.
- Micro BFD software offloaded sessions supported from 200 milli seconds to 1000 milli seconds.
- Maximum tested values include 24 sessions.
- Interior gateway protocol is not necessary for the micro BFD sessions to be up between the LAG.
- The client for micro BFD sessions is port-channel.
- Micro BFD is supported on port-channel with member links from different ASICs.
- Micro BFD is supported with LACP minimum links and LACP maximum links enabled on the port-channel.

- The convergence achieved with this feature is less than 50 ms with BFD timers configured to 3.3ms with multiplier value as 3.

Functions of Micro BFD

- Runs BFD session over each Link Aggregation Group (LAG) member link.
- Verifies link continuity for every member link.
- Makes BFD to control the LAG member link to be part of the Layer 2 load-balancing table of the LAG interface in the presence or the absence of Link Aggregation Control Protocol (LACP).
- Offloads the continuity check messages.

Restrictions for Micro BFD

- Micro BFD supports single hop only.
- Micro BFD works only with IPv4.
- Micro BFD is only supported on L3 port-channel; it is not supported on sub-interfaces or EVC of port-channel.
- Micro BFD does not support ECHO mode.
- Maximum tested scale is 24sessions .
- Micro BFD is not supported on any of the video templates.

Steps to Configure Micro BFD

Perform the following steps to configure micro BFD:

1. Configure port channel. See [Configure Port-Channel, on page 33](#).
2. If Micro BFD needs to be enabled on an Active/Active SDM template, enable port channel, then enable the SDM template for the port channel ID before configuring the port-channel. See [Configuring QoS Support on Port Channel Active Active](#) and [Selecting the SDM template](#).
3. Micro BFD supported on non-video template. See [Configure the SDM Template](#).
4. Configure BFD template. See [Configure Micro BFD on Port Channel, on page 35](#).
5. Configure Micro BFD over port-channel with the template configured. See [Configure Micro BFD on Port Channel, on page 35](#).

Configure Port-Channel

Procedure

Step 1	enable
---------------	--------

Example:

```
Router> enable
```

Enables privileged EXEC mode.

Enter your password if prompted.

Step 2 `configure terminal`**Example:**

```
Router# configure terminal
```

Enters the global configuration mode.

Step 3 `Interface port channel number`**Example:**

```
Router(config)#interface port-channel 48
```

Configures the port channel and enters the interface mode.

Step 4 `ip address ip-address mask`**Example:**

```
Router(config-if)# ip address 10.201.201.1 255.255.255.0
```

Configures an IP address for the interface.

Step 5 `Interface interface type interface name`**Example:**

```
Router(config)#interface gigabitethernet 0/0/0-6
```

Specifies the ethernet interface.

Step 6 `channel group channel group number mode mode name`**Example:**

```
Router(config)#channel group 48 mode active
```

The following types of port channel modes can be configured:

- active
- passive
- on

Step 7 `end`

Exits the interface range configuration mode and returns to the configuration mode.

Verify Port Channel

Use the commands below to verify the port channel summary details:

```
Device#show etherchannel summary
```

```
Flags: D - down          P/bndl - bundled in port-channel
```

```

I - stand-alone s/susp - suspended
H - Hot-standby (LACP only)
R - Layer3      S - Layer2
U - in use      f - failed to allocate aggregator

M - not in use, minimum links not met
u - unsuitable for bundling
w - waiting to be aggregated
d - default port

Number of channel-groups in use: 1
Number of aggregators:          1

Group  Port-channel  Protocol    Ports
-----+-----+-----+-----
10     Po10 (RU)        LACP        Te0/4/0 (bndl)

```

Configure Micro BFD on Port Channel

Procedure

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 *MicroBFD_template name*

Example:

```
Router(config)#bfd-template single-hop MicroBFD_template
```

Configures the 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 100 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.

Step 6 **configure terminal**

Example:

```
Router# configure terminal
```

Enters global configuration mode.

Step 7 **Interface port channel *number***

Example:

```
Router(config)#interface port channel 48
```

Configures the port channel and enters the interface mode.

Step 8 **port channel bfd destination ipv4 *ip address* MicroBFD_ *template***

Example:

```
Router(config-if)#port-channel bfd destination ipv4 48.48.48.2 MicroBFD_template
```

Configures micro BFD under the port channel.

Use the no form of the command to delete the Micro BFD session from the port channel.

Step 9 **End**

Exits interface configuration mode and returns to global configuration mode.

Verify Micro BFD Session

Use the following commands to verify that the BFD sessions established are in UP state.

```
router#show etherchannel summary
Flags: D - down          P/bndl - bundled in port-channel
       I - stand-alone  s/susp - suspended
       H - Hot-standby (LACP only)
       R - Layer3       S - Layer2
       U - in use       f - failed to allocate aggregator

       M - not in use, minimum links not met
       u - unsuitable for bundling
       w - waiting to be aggregated
       d - default port

Number of channel-groups in use: 1
Number of aggregators:          1

Group  Port-channel  Protocol    Ports
-----+-----+-----+-----
1      Po1(RU)         LACP        Gi0/3/2(bndl) Gi0/3/3(bndl)

RU - L3 port-channel UP State
SU - L2 port-channel UP state
```

P/bndl - Bundled
S/susp - Suspended

router#show bfd summary

Session	Up	Down	
Total	8	8	0

router#show bfd neighbors

IPv4 Sessions

NeighAddr	LD/RD	RH/RS	State	Int
209.165.202.129	8/2148073631		Up	Up Gi0/2/0
209.165.202.138	1028/2148073764		Up	Up Gi0/2/1
209.165.202.139	45/108		Up	Up Gi0/2/2
209.165.202.142	48/3		Up	Up Te0/1/0
209.165.202.156	50/5		Up	Up BD1000

IPv6 Sessions

NeighAddr	LD/RD	RH/RS	State	Int
FE80::F278:16FF:FE85:CA91	46/1		Up	Up Te0/1/0

Port Channel IPv4 Sessions

NeighAddr	LD/RD	RH/RS	State	Int
Parent Int				
209.165.202.132	53/112	Up	Up	Gi0/3/2
Po1				
209.165.202.132	54/111	Up	Up	Gi0/3/3
Po1				

router#show bfd neighbors poch-ipv4

Port Channel IPv4 Sessions

NeighAddr	LD/RD	RH/RS	State	Int	Parent	Int
209.165.202.132	53/112	Up	Up	Gi0/3/2	Po1	
209.165.202.132	54/111	Up	Up	Gi0/3/3	Po1	

