Engineering Simplicity

Junos® OS

High Availability User Guide Test

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Junos® OS High Availability User Guide Test

The information in this document is current as of the date on the title page.

YEAR 2000 NOTICE

Juniper Networks hardware and software products are Year 2000 compliant. Junos OS has no known time-related limitations through the year 2038. However, the NTP application is known to have some difficulty in the year 2036.

END USER LICENSE AGREEMENT

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Junos OS High Availability Library for Routing Devices

Documentation and Release Notes

To obtain the most current version of all Juniper Networks® technical documentation, see the product documentation page on the Juniper Networks website at https://www.juniper.net/documentation/.

If the information in the latest release notes differs from the information in the documentation, follow the product Release Notes.

Juniper Networks Books publishes books by Juniper Networks engineers and subject matter experts. These books go beyond the technical documentation to explore the nuances of network architecture, deployment, and administration. The current list can be viewed at https://www.juniper.net/books.

Using the Examples in This Manual

If you want to use the examples in this manual, you can use the **load merge** or the **load merge relative** command. These commands cause the software to merge the incoming configuration into the current candidate configuration. The example does not become active until you commit the candidate configuration.

If the example configuration contains the top level of the hierarchy (or multiple hierarchies), the example is a *full example*. In this case, use the **load merge** command.

If the example configuration does not start at the top level of the hierarchy, the example is a *snippet*. In this case, use the **load merge relative** command. These procedures are described in the following sections.

Merging a Full Example

To merge a full example, follow these steps:

1. From the HTML or PDF version of the manual, copy a configuration example into a text file, save the file with a name, and copy the file to a directory on your routing platform.

   For example, copy the following configuration to a file and name the file **ex-script.conf**. Copy the **ex-script.conf** file to the **/var/tmp** directory on your routing platform.

   ```
   system {
       scripts {
           commit {
               file ex-script.xsl;
           }
       }
   }
   interfaces {
       fxp0 {
           disable;
           unit 0 {
               family inet {
                   address 10.0.0.1/24;
               }
           }
       }
   }
   ```

2. Merge the contents of the file into your routing platform configuration by issuing the **load merge** configuration mode command:

   ```
   [edit]
   user@host# load merge /var/tmp/ex-script.conf
   load complete
   ```

Merging a Snippet

To merge a snippet, follow these steps:

1. From the HTML or PDF version of the manual, copy a configuration snippet into a text file, save the file with a name, and copy the file to a directory on your routing platform.

   For example, copy the following snippet to a file and name the file **ex-script-snippet.conf**. Copy the **ex-script-snippet.conf** file to the **/var/tmp** directory on your routing platform.

```
commit {
   file ex-script-snippet.xsl; }
```

2. Move to the hierarchy level that is relevant for this snippet by issuing the following configuration mode command:

```
[edit]
user@host# edit system scripts
[edit system scripts]
```

3. Merge the contents of the file into your routing platform configuration by issuing the **load merge relative** configuration mode command:

```
[edit system scripts]
user@host# load merge relative /var/tmp/ex-script-snippet.conf
load complete
```

For more information about the **load** command, see CLI Explorer.

Documentation Conventions

Table 1 on page ix defines notice icons used in this guide.

Table 1: Notice Icons

Icon	Meaning	Description
	Informational note	Indicates important features or instructions.
	Caution	Indicates a situation that might result in loss of data or hardware damage.
	Warning	Alerts you to the risk of personal injury or death.
	Laser warning	Alerts you to the risk of personal injury from a laser.
	Tip	Indicates helpful information.
	Best practice	Alerts you to a recommended use or implementation.

Table 2 on page ix defines the text and syntax conventions used in this guide.

Table 2: Text and Syntax Conventions

Convention	Description	Examples
Bold text like this	Represents text that you type.	To enter configuration mode, type the **configure** command: user@host> **configure**
`Fixed-width text like this`	Represents output that appears on the terminal screen.	`user@host>` **show chassis alarms** `No alarms currently active`
Italic text like this	• Introduces or emphasizes important new terms. • Identifies guide names. • Identifies RFC and Internet draft titles.	• A policy *term* is a named structure that defines match conditions and actions. • *Junos OS CLI User Guide* • RFC 1997, *BGP Communities Attribute*

Table 2: Text and Syntax Conventions *(continued)*

<table>
<tr><th>Convention</th><th>Description</th><th>Examples</th></tr>
<tr><td>Italic text like this</td><td>Represents variables (options for which you substitute a value) in commands or configuration statements.</td><td>Configure the machine's domain name:
[edit]
root@# set system domain-name
domain-name</td></tr>
<tr><td>Text like this</td><td>Represents names of configuration statements, commands, files, and directories; configuration hierarchy levels; or labels on routing platform components.</td><td>• To configure a stub area, include the stub statement at the [edit protocols ospf area area-id] hierarchy level.
• The console port is labeled CONSOLE.</td></tr>
<tr><td>< > (angle brackets)</td><td>Encloses optional keywords or variables.</td><td>stub <default-metric <i>metric</i>>;</td></tr>
<tr><td>| (pipe symbol)</td><td>Indicates a choice between the mutually exclusive keywords or variables on either side of the symbol. The set of choices is often enclosed in parentheses for clarity.</td><td>broadcast | multicast

(string1 | string2 | string3)</td></tr>
<tr><td># (pound sign)</td><td>Indicates a comment specified on the same line as the configuration statement to which it applies.</td><td>rsvp { # Required for dynamic MPLS only</td></tr>
<tr><td>[ ] (square brackets)</td><td>Encloses a variable for which you can substitute one or more values.</td><td>community name members [community-ids]</td></tr>
<tr><td>Indention and braces ({ })</td><td>Identifies a level in the configuration hierarchy.</td><td rowspan="2">[edit]
routing-options {
  static {
    route default {
      nexthop address;
      retain;
    }
  }
}</td></tr>
<tr><td>; (semicolon)</td><td>Identifies a leaf statement at a configuration hierarchy level.</td></tr>
</table>

GUI Conventions

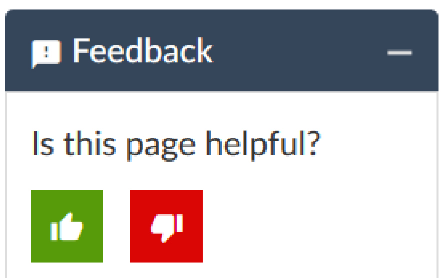
Table 2: Text and Syntax Conventions *(continued)*

Convention	Description	Examples
Bold text like this	Represents graphical user interface (GUI) items you click or select.	• In the Logical Interfaces box, select **All Interfaces**. • To cancel the configuration, click **Cancel**.
> (bold right angle bracket)	Separates levels in a hierarchy of menu selections.	In the configuration editor hierarchy, select **Protocols>Ospf**.

Documentation Feedback

We encourage you to provide feedback so that we can improve our documentation. You can use either of the following methods:

- Online feedback system—Click TechLibrary Feedback, on the lower right of any page on the Juniper Networks TechLibrary site, and do one of the following:



  - Click the thumbs-up icon if the information on the page was helpful to you.
  - Click the thumbs-down icon if the information on the page was not helpful to you or if you have suggestions for improvement, and use the pop-up form to provide feedback.
- E-mail—Send your comments to techpubs-comments@juniper.net. Include the document or topic name, URL or page number, and software version (if applicable).

Requesting Technical Support

Technical product support is available through the Juniper Networks Technical Assistance Center (JTAC). If you are a customer with an active Juniper Care or Partner Support Services support contract, or are covered under warranty, and need post-sales technical support, you can access our tools and resources online or open a case with JTAC.

- JTAC policies—For a complete understanding of our JTAC procedures and policies, review the *JTAC User Guide* located at https://www.juniper.net/us/en/local/pdf/resource-guides/7100059-en.pdf.
- Product warranties—For product warranty information, visit https://www.juniper.net/support/warranty/.
- JTAC hours of operation—The JTAC centers have resources available 24 hours a day, 7 days a week, 365 days a year.

Self-Help Online Tools and Resources

For quick and easy problem resolution, Juniper Networks has designed an online self-service portal called the Customer Support Center (CSC) that provides you with the following features:

- Find CSC offerings: https://www.juniper.net/customers/support/
- Search for known bugs: https://prsearch.juniper.net/
- Find product documentation: https://www.juniper.net/documentation/
- Find solutions and answer questions using our Knowledge Base: https://kb.juniper.net/
- Download the latest versions of software and review release notes: https://www.juniper.net/customers/csc/software/
- Search technical bulletins for relevant hardware and software notifications: https://kb.juniper.net/InfoCenter/
- Join and participate in the Juniper Networks Community Forum: https://www.juniper.net/company/communities/
- Create a service request online: https://myjuniper.juniper.net

To verify service entitlement by product serial number, use our Serial Number Entitlement (SNE) Tool: https://entitlementsearch.juniper.net/entitlementsearch/

Creating a Service Request with JTAC

You can create a service request with JTAC on the Web or by telephone.

- Visit https://myjuniper.juniper.net.
- Call 1-888-314-JTAC (1-888-314-5822 toll-free in the USA, Canada, and Mexico).

For international or direct-dial options in countries without toll-free numbers, see https://support.juniper.net/support/requesting-support/.

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PART

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CHAPTER 1

High Availability Overview

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Understanding High Availability Features on Juniper Networks Routers

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For Juniper Networks routing platforms running the Junos operating system (Junos OS), *high availability* refers to the hardware and software components that provide redundancy and reliability for packet-based communications. This topic provides brief overviews of the following high availability features:

Routing Engine Redundancy

Redundant Routing Engines are two Routing Engines that are installed in the same routing platform. One functions as the master, while the other stands by as a backup should the master Routing Engine fail. On routing platforms with dual Routing Engines, network reconvergence takes place more quickly than on routing platforms with a single Routing Engine.

Graceful Routing Engine Switchover

Graceful Routing Engine switchover (GRES) enables a routing platform with redundant Routing Engines to continue forwarding packets, even if one Routing Engine fails. Graceful Routing Engine switchover preserves interface and kernel information. Traffic is not interrupted. However, graceful Routing Engine switchover does not preserve the control plane. Neighboring routers detect that the router has experienced a restart and react to the event in a manner prescribed by individual routing protocol specifications.

NOTE: To preserve routing during a switchover, graceful Routing Engine switchover must be combined with either graceful restart protocol extensions or nonstop active routing. For more information, see *Understanding Graceful Routing Engine Switchover* and *Nonstop Active Routing Concepts*.

NOTE: In T Series routers, TX Matrix routers, and TX Matrix Plus routers, the control plane is preserved in case of GRES with NSR, and 75% of line rate worth of traffic per Packet Forwarding Engine remains uninterrupted during GRES.

Nonstop Bridging

Nonstop bridging enables an MX Series 5G Universal Routing Platform with redundant Routing Engines to switch from a primary Routing Engine to a backup Routing Engine without losing Layer 2 Control Protocol (L2CP) information. Nonstop bridging uses the same infrastructure as graceful Routing Engine switchover to preserve interface and kernel information. However, nonstop bridging also saves L2CP information by running the Layer 2 Control Protocol process (l2cpd) on the backup Routing Engine.

NOTE: To use nonstop bridging, you must first enable graceful Routing Engine switchover.

Nonstop bridging is supported for the following Layer 2 control protocols:

- Spanning Tree Protocol (STP)
- Rapid Spanning Tree Protocol (RSTP)
- Multiple Spanning Tree Protocol (MSTP)
- VLAN Spanning Tree Protocol (VSTP)

For more information, see *Nonstop Bridging Concepts*.

Nonstop Active Routing

Nonstop active routing (NSR) enables a routing platform with redundant Routing Engines to switch from a primary Routing Engine to a backup Routing Engine without alerting peer nodes that a change has occurred. Nonstop active routing uses the same infrastructure as graceful Routing Engine switchover to preserve interface and kernel information. However, nonstop active routing also preserves routing information and protocol sessions by running the routing protocol process (rpd) on both Routing Engines. In addition, nonstop active routing preserves TCP connections maintained in the kernel.

NOTE: To use nonstop active routing, you must also configure graceful Routing Engine switchover.

For a list of protocols and features supported by nonstop active routing, see *Nonstop Active Routing Protocol and Feature Support*.

For more information about nonstop active routing, see *Nonstop Active Routing Concepts*.

Graceful Restart

With routing protocols, any service interruption requires an affected router to recalculate adjacencies with neighboring routers, restore routing table entries, and update other protocol-specific information. An unprotected restart of a router can result in forwarding delays, route flapping, wait times stemming from protocol reconvergence, and even dropped packets. To alleviate this situation, graceful restart provides extensions to routing protocols. These protocol extensions define two roles for a router—*restarting* and *helper*. The extensions signal neighboring routers about a router undergoing a restart and prevent the neighbors from propagating the change in state to the network during a graceful restart wait interval. The main benefits of graceful restart are uninterrupted packet forwarding and temporary suppression of all routing protocol updates. Graceful restart enables a router to pass through intermediate convergence states that are hidden from the rest of the network.

When a router is running graceful restart and the router stops sending and replying to protocol liveness messages (hellos), the adjacencies assume a graceful restart and begin running a timer to monitor the restarting router. During this interval, helper routers do not process an adjacency change for the router that they assume is restarting, but continue active routing with the rest of the network. The helper routers assume that the router can continue stateful forwarding based on the last preserved routing state during the restart.

If the router was actually restarting and is back up before the graceful timer period expires in all of the helper routers, the helper routers provide the router with the routing table, topology table, or label table (depending on the protocol), exit the graceful period, and return to normal network routing.

If the router does not complete its negotiation with helper routers before the graceful timer period expires in all of the helper routers, the helper routers process the router's change in state and send routing updates, so that convergence occurs across the network. If a helper router detects a link failure from the router, the topology change causes the helper router to exit the graceful wait period and to send routing updates, so that network convergence occurs.

To enable a router to undergo a graceful restart, you must include the **graceful-restart** statement at the global **[edit routing-options]** or **[edit routing-instances *instance-name* routing-options]** hierarchy level. You can, optionally, modify the global settings at the individual protocol level. When a routing session is started, a router that is configured with graceful restart must negotiate with its neighbors to support it when it undergoes a graceful restart. A neighboring router will accept the negotiation and support helper mode without requiring graceful restart to be configured on the neighboring router.

> **NOTE:** A Routing Engine switchover event on a helper router that is in graceful wait state causes the router to drop the wait state and to propagate the adjacency’s state change to the network.

Graceful restart is supported for the following protocols and applications:

- BGP
- ES-IS
- IS-IS
- OSPF/OSPFv3
- PIM sparse mode
- RIP/RIPng
- MPLS-related protocols, including:
  - Label Distribution Protocol (LDP)
  - Resource Reservation Protocol (RSVP)
  - Circuit cross-connect (CCC)
  - Translational cross-connect (TCC)
- Layer 2 and Layer 3 virtual private networks (VPNs)

For more information, see *Graceful Restart Concepts*.

Nonstop Active Routing Versus Graceful Restart

Nonstop active routing and graceful restart are two different methods of maintaining high availability. Graceful restart requires a router restart. A router undergoing a graceful restart relies on its neighbors (or helpers) to restore its routing protocol information. The restart is the mechanism by which helpers are signaled to exit the wait interval and start providing routing information to the restarting router For more information, see *Graceful Restart Concepts*.

In contrast, nonstop active routing does not involve a router restart. Both the master and backup Routing Engines are running the routing protocol process (rpd) and exchanging updates with neighbors. When one Routing Engine fails, the router simply switches to the active Routing Engine to exchange routing information with neighbors. Because of these feature differences, nonstop routing and graceful restart are mutually exclusive. Nonstop active routing cannot be enabled when the router is configured as a graceful restarting router. If you include the **graceful-restart** statement at any hierarchy level and the **nonstop-routing** statement at the **[edit routing-options]** hierarchy level and try to commit the configuration, the commit request fails. For more information, see *Nonstop Active Routing Concepts*.

Effects of a Routing Engine Switchover

Effects of a Routing Engine Switchover describes the effects of a Routing Engine switchover when no high availability features are enabled and when graceful Routing Engine switchover, graceful restart, and nonstop active routing features are enabled.

VRRP

The Virtual Router Redundancy Protocol (VRRP) enables hosts on a LAN to make use of redundant routing platforms (master and backup pairs) on the LAN, requiring only the static configuration of a single default route on the hosts.

The VRRP routing platform pairs share the IP address corresponding to the default route configured on the hosts. At any time, one of the VRRP routing platforms is the master (active) and the others are backups. If the master fails, one of the backup routers or switches becomes the new master router.

VRRP has advantages in ease of administration and network throughput and reliability:

- It provides a virtual default routing platform.
- It enables traffic on the LAN to be routed without a single point of failure.
- A virtual backup router can take over a failed default router:
  - Within a few seconds.
  - With a minimum of VRRP traffic.

- Without any interaction with the hosts.

Devices running VRRP dynamically elect master and backup routers. You can also force assignment of master and backup routers using priorities from 1 through 255, with 255 being the highest priority.

In VRRP operation, the default master router sends advertisements to backup routers at regular intervals (default 1 second). If a backup router does not receive an advertisement for a set period, the backup router with the next highest priority takes over as master and begins forwarding packets.

As of Junos OS Release 13.2, VRRP nonstop active routing (NSR) is enabled only when you configure the **nonstop-routing** statement at the **[edit routing-options]** or **[edit logical system *logical-system-name* routing-options]** hierarchy level.

For more information, see *Understanding VRRP*.

Unified ISSU

A unified in-service software upgrade (unified ISSU) enables you to upgrade between two different Junos OS Releases with no disruption on the control plane and with minimal disruption of traffic. Unified ISSU is only supported by dual Routing Engine platforms. In addition, graceful Routing Engine switchover (GRES) and nonstop active routing (NSR) must be enabled.

With a unified ISSU, you can eliminate network downtime, reduce operating costs, and deliver higher services levels. For more information, see *Getting Started with Unified In-Service Software Upgrade*.

Interchassis Redundancy for MX Series Routers Using Virtual Chassis

Interchassis redundancy is a high availability feature that can span equipment located across multiple geographies to prevent network outages and protect routers against access link failures, uplink failures, and wholesale chassis failures without visibly disrupting the attached subscribers or increasing the network management burden for service providers. As more high-priority voice and video traffic is carried on the network, interchassis redundancy has become a requirement for providing stateful redundancy on broadband subscriber management equipment such as broadband services routers, broadband network gateways, and broadband remote access servers. Interchassis redundancy support enables service providers to fulfill strict service-level agreements (SLAs) and avoid unplanned network outages to better meet the needs of their customers.

To provide a stateful interchassis redundancy solution for MX Series 5G Universal Routing Platforms, you can configure a Virtual Chassis. A *Virtual Chassis* configuration interconnects two MX Series routers into a logical system that you can manage as a single network element. The member routers in a Virtual Chassis are designated as the *master router* (also known as the *protocol master*) and the *backup router* (also known as the *protocol backup*). The member routers are interconnected by means of dedicated *Virtual Chassis ports* that you configure on Trio Modular Port Concentrator/Modular Interface Card (MPC/MIC) interfaces.

An MX Series Virtual Chassis is managed by the *Virtual Chassis Control Protocol* (*VCCP*), which is a dedicated control protocol based on IS-IS. VCCP runs on the Virtual Chassis port interfaces and is responsible for building the Virtual Chassis topology, electing the Virtual Chassis master router, and establishing the interchassis routing table to route traffic within the Virtual Chassis.

Starting with Junos OS Release 11.2, Virtual Chassis configurations are supported on MX240, MX480, and MX960 Universal Routing Platforms with Trio MPC/MIC interfaces and dual Routing Engines. In addition, graceful Routing Engine switchover (GRES) and nonstop active routing (NSR) must be enabled on both member routers in the Virtual Chassis.

RELATED DOCUMENTATION

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High Availability-Related Features in Junos OS

Related redundancy and reliability features include:

- Redundant power supplies, host modules, host subsystems, and forwarding boards. For more information, see the *Junos OS Administration Library* and the *Junos OS Hardware Network Operations Guide*.
- Additional link-layer redundancy, including Automatic Protection Switching (APS) for SONET interfaces, Multiplex Section Protection (MSP) for SDH interfaces, and DLSw redundancy for Ethernet interfaces. For more information, see the *Junos OS Network Interfaces Library for Routing Devices*.
- Bidirectional Forwarding Detection (BFD) works with other routing protocols to detect failures rapidly. For more information, see the *Junos OS Routing Protocols Library*.
- Redirection of Multiprotocol Label Switching (MPLS) label-switched path (LSP) traffic—Mechanisms such as link protection, node-link protection, and fast reroute recognize link and node failures, allowing MPLS LSPs to select a bypass LSP to circumvent failed links or devices. For more information, see the *MPLS Applications User Guide*.

RELATED DOCUMENTATION

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CHAPTER 2

Understanding How BFD Detects Network Failures

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Understanding BFD for Static Routes for Faster Network Failure Detection

The Bidirectional Forwarding Detection (BFD) protocol is a simple hello mechanism that detects failures in a network. BFD works with a wide variety of network environments and topologies. A pair of routing devices exchanges BFD packets. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the routing device stops receiving a reply after a specified interval. The BFD failure detection timers have shorter time limits than the static route failure detection mechanisms, so they provide faster detection.

The BFD failure detection timers can be adjusted to be faster or slower. The lower the BFD failure detection timer value, the faster the failure detection and vice versa. For example, the timers can adapt to a higher value if the adjacency fails (that is, the timer detects failures more slowly). Or a neighbor can negotiate a higher value for a timer than the configured value. The timers adapt to a higher value when a BFD session flap occurs more than three times in a span of 15 seconds. A back-off algorithm increases the receive (Rx) interval by two if the local BFD instance is the reason for the session flap. The transmission (Tx) interval is increased by two if the remote BFD instance is the reason for the session flap. You can use the **clear bfd adaptation** command to return BFD interval timers to their configured values. The **clear bfd adaptation** command is hitless, meaning that the command does not affect traffic flow on the routing device.

By default, BFD is supported on single-hop static routes.

NOTE: On MX Series devices, multihop BFD is not supported on a static route if the static route is configured with more than one next hop. It is recommended that you avoid using multiple next hops when a multihop BFD is required for a static route.

To enable failure detection, include the **bfd-liveness-detection** statement in the static route configuration.

NOTE: Starting with Junos OS Release 15.1X49-D70 and Junos OS Release 17.3R1, the **bfd-liveness-detection** command includes the description field. The description is an attribute under the **bfd-liveness-detection** object and it is supported only on SRX Series devices. This field is applicable only for the static routes.

In Junos OS Release 9.1 and later, the BFD protocol is supported for IPv6 static routes. Global unicast and link-local IPv6 addresses are supported for static routes. The BFD protocol is not supported on multicast or anycast IPv6 addresses. For IPv6, the BFD protocol supports only static routes and only in Junos OS Release 9.3 and later. IPv6 for BFD is also supported for the eBGP protocol.

NOTE: Inline BFD is supported on PTX5000 routers with third-generation FPCs starting in Junos OS Release 15.1F3 and 16.1R2. Inline BFD is supported on PTX3000 routers with third-generation FPCs starting in Junos OS Release 15.1F6 and 16.1R2.

There are three types of BFD sessions based on the source from which BFD packets are sent to the neighbors. Different types of BFD sessions and their descriptions are:

Type of BFD session	Description
Non-distributed BFD	BFD sessions running completely on the Routing Engine.
Distributed BFD	BFD sessions running completely on the Packet Forwarding Engine.
Inline BFD **NOTE:** Starting in Junos OS Release 13.3, inline BFD is supported only on static MX Series routers with MPCs/MICs that have configured **enhanced-ip**. **NOTE:** Starting in Junos OS Release 16.1R1, the inline BFD sessions are supported on integrated routing and bridging (IRB) interfaces.	BFD sessions running on the FPC hardware.

To configure the BFD protocol for IPv6 static routes, include the **bfd-liveness-detection** statement at the **[edit routing-options rib inet6.0 static route *destination-prefix*]** hierarchy level.

In Junos OS Release 8.5 and later, you can configure a hold-down interval to specify how long the BFD session must remain up before a state change notification is sent.

To specify the hold-down interval, include the **holddown-interval** statement in the BFD configuration.

You can configure a number in the range from 0 through 255,000 milliseconds. The default is 0. If the BFD session goes down and then comes back up during the hold-down interval, the timer is restarted.

> **NOTE:** If a single BFD session includes multiple static routes, the hold-down interval with the highest value is used.

To specify the minimum transmit and receive intervals for failure detection, include the **minimum-interval** statement in the BFD configuration.

This value represents both the minimum interval after which the local routing device transmits hello packets and the minimum interval after which the routing device expects to receive a reply from the neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds. Optionally, instead of using this statement, you can configure the minimum transmit and receive intervals separately using the **transmit-interval minimum-interval** and **minimum-receive-interval** statements.

> **NOTE:** QFX5000 Series switches and EX4600 switches do not support minimum interval values of less than 1 second.

NOTE: BFD is an intensive protocol that consumes system resources. Specifying a minimum interval for BFD of less than 100 ms for Routing Engine-based sessions and 10 ms for distributed BFD sessions can cause undesired BFD flapping.

Depending on your network environment, these additional recommendations might apply:

- For large-scale network deployments with a large number of BFD sessions, specify a minimum interval of 300 ms for Routing Engine-based sessions and 100 ms for distributed BFD sessions.
- For very large-scale network deployments with a large number of BFD sessions, contact Juniper Networks customer support for more information.
- For BFD sessions to remain up during a Routing Engine switchover event when nonstop active routing (NSR) is configured, specify a minimum interval of 2500 ms for Routing Engine-based sessions. For distributed BFD sessions with NSR configured, the minimum interval recommendations are unchanged and depend only on your network deployment.

To specify the minimum receive interval for failure detection, include the **minimum-receive-interval** statement in the BFD configuration. This value represents the minimum interval after which the routing device expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds. Optionally, instead of using this statement, you can configure the minimum receive interval using the **minimum-interval** statement at the **[edit routing-options static route *destination-prefix* bfd-liveness-detection]** hierarchy level.

To specify the number of hello packets not received by the neighbor that causes the originating interface to be declared down, include the **multiplier** statement in the BFD configuration.

The default value is 3. You can configure a number in the range from 1 through 255.

To specify a threshold for detecting the adaptation of the detection time, include the **threshold** statement in the BFD configuration.

When the BFD session detection time adapts to a value equal to or higher than the threshold, a single trap and a system log message are sent. The detection time is based on the multiplier of the **minimum-interval** or the **minimum-receive-interval** value. The threshold must be a higher value than the multiplier for either of these configured values. For example if the **minimum-receive-interval** is 300 ms and the **multiplier** is 3, the total detection time is 900 ms. Therefore, the detection time threshold must have a value higher than 900.

To specify the minimum transmit interval for failure detection, include the **transmit-interval minimum-interval** statement in the BFD configuration.

This value represents the minimum interval after which the local routing device transmits hello packets to the neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds. Optionally, instead of using this statement, you can configure the minimum transmit interval using the **minimum-interval** statement at the **[edit routing-options static route *destination-prefix* bfd-liveness-detection]** hierarchy level.

To specify the threshold for the adaptation of the transmit interval, include the **transmit-interval threshold** statement in the BFD configuration.

The threshold value must be greater than the transmit interval. When the BFD session transmit time adapts to a value greater than the threshold, a single trap and a system log message are sent. The detection time is based on the multiplier of the value for the **minimum-interval** or the **minimum-receive-interval** statement at the **[edit routing-options static route *destination-prefix* bfd-liveness-detection]** hierarchy level. The threshold must be a higher value than the multiplier for either of these configured values.

To specify the BFD version, include the **version** statement in the BFD configuration. The default is to have the version detected automatically.

To include an IP address for the next hop of the BFD session, include the **neighbor** statement in the BFD configuration.

NOTE: You must configure the **neighbor** statement if the next hop specified is an interface name. If you specify an IP address as the next hop, that address is used as the neighbor address for the BFD session.

In Junos OS Release 9.0 and later, you can configure BFD sessions not to adapt to changing network conditions.

To disable BFD adaptation, include the **no-adaptation** statement in the BFD configuration.

NOTE: We recommend that you not disable BFD adaptation unless it is preferable *not* to have BFD adaptation in your network.

NOTE: If BFD is configured only on one end of a static route, the route is removed from the routing table. BFD establishes a session when BFD is configured on both ends of the static route.

BFD is not supported on ISO address families in static routes. BFD does support IS-IS.

If you configure graceful Routing Engine switchover (GRES) at the same time as BFD, GRES does not preserve the BFD state information during a failover.

Release History Table

Release	Description
16.1R1	Starting in Junos OS Release 16.1R1, the inline BFD sessions are supported on integrated routing and bridging (IRB) interfaces.
15.1X49-D70	Starting with Junos OS Release 15.1X49-D70 and Junos OS Release 17.3R1, the **bfd-liveness-detection** command includes the description field. The description is an attribute under the **bfd-liveness-detection** object and it is supported only on SRX Series devices. This field is applicable only for the static routes.
15.1F6	Inline BFD is supported on PTX3000 routers with third-generation FPCs starting in Junos OS Release 15.1F6 and 16.1R2.
15.1F3	Inline BFD is supported on PTX5000 routers with third-generation FPCs starting in Junos OS Release 15.1F3 and 16.1R2.
13.3	Starting in Junos OS Release 13.3, inline BFD is supported only on static MX Series routers with MPCs/MICs that have configured **enhanced-ip**.

RELATED DOCUMENTATION

Enabling Dedicated and Real-Time BFD

Example: Configuring BFD for Static Routes for Faster Network Failure Detection | **34**

Example: Enabling BFD on Qualified Next Hops in Static Routes for Route Selection

Understanding BFD for BGP

The Bidirectional Forwarding Detection (BFD) protocol is a simple hello mechanism that detects failures in a network. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the routing device stops receiving a reply after a specified interval. BFD works with a wide variety of network environments and topologies. The failure detection timers for BFD have shorter time limits than default failure detection mechanisms for BGP, so they provide faster detection.

NOTE: Configuring both BFD and graceful restart for BGP on the same device is counterproductive. When an interface goes down, BFD detects this instantly, stops traffic forwarding and the BGP session goes down whereas graceful restart forwards traffic despite the interface failure, this behavior might cause network issues. Hence we do not recommend configuring both BFD and graceful restart on the same device.

NOTE: QFX5000 Series switches and EX4600 switches do not support minimum interval values of less than 1 second.

NOTE: QFX5110, QFX5120, QFX5200, and QFX5210 switches support multihop Bidirectional Forwarding Detection (BFD) inline keep alive support which will enable sessions to be configured at less than 1 second. Performance may vary depending on the system load. 10 inline BFD sessions are supported and can be configured with a timer of 150 x 3 milliseconds.

The BFD failure detection timers can be adjusted to be faster or slower. The lower the BFD failure detection timer value, the faster the failure detection and vice versa. For example, the timers can adapt to a higher value if the adjacency fails (that is, the timer detects failures more slowly). Or a neighbor can negotiate a higher value for a timer than the configured value. The timers adapt to a higher value when a BFD session flap occurs more than three times in a span of 15 seconds (15000 milliseconds). A back-off algorithm increases the receive (Rx) interval by two if the local BFD instance is the reason for the session flap. The transmission (Tx) interval is increased by two if the remote BFD instance is the reason for the session flap. You can use the **clear bfd adaptation** command to return BFD interval timers to their configured values. The **clear bfd adaptation** command is hitless, meaning that the command does not affect traffic flow on the routing device.

NOTE: On all SRX Series devices, high CPU utilization triggered for reasons such as CPU intensive commands and SNMP walks causes the BFD protocol to flap while processing large BGP updates. (Platform support depends on the Junos OS release in your installation.)

Starting with Junos OS Release 15.1X49-D100, SRX340, SRX345, and SRX1500 devices support dedicated BFD.

Starting with Junos OS Release 15.1X49-D100, SRX300 and SRX320 devices support real-time BFD.

Starting with Junos OS Release 15.1X49-D110, SRX550M devices support dedicated BFD.

In Junos OS Release 8.3 and later, BFD is supported on internal BGP (IBGP) and multihop external BGP (EBGP) sessions as well as on single-hop EBGP sessions. In Junos OS Release 9.1 through Junos OS Release 11.1, BFD supports IPv6 interfaces in static routes only. In Junos OS Release 11.2 and later, BFD supports IPv6 interfaces with BGP.

Release History Table

Release	Description
15.1X49-D100	Starting with Junos OS Release 15.1X49-D100, SRX340, SRX345, and SRX1500 devices support dedicated BFD.
15.1X49-D100	Starting with Junos OS Release 15.1X49-D100, SRX300 and SRX320 devices support real-time BFD.
11.2	In Junos OS Release 11.2 and later, BFD supports IPv6 interfaces with BGP.
9.1	In Junos OS Release 9.1 through Junos OS Release 11.1, BFD supports IPv6 interfaces in static routes only.
8.3	In Junos OS Release 8.3 and later, BFD is supported on internal BGP (IBGP) and multihop external BGP (EBGP) sessions as well as on single-hop EBGP sessions.

RELATED DOCUMENTATION

Enabling Dedicated and Real-Time BFD

Understanding BFD for OSPF

The Bidirectional Forwarding Detection (BFD) protocol is a simple hello mechanism that detects failures in a network. BFD works with a wide variety of network environments and topologies. A pair of routing devices exchange BFD packets. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the routing device stops receiving a reply after a specified interval. The BFD failure detection timers have shorter time limits than the OSPF failure detection mechanisms, so they provide faster detection.

The BFD failure detection timers are adaptive and can be adjusted to be faster or slower. The lower the BFD failure detection timer value, the faster the failure detection and vice versa. For example, the timers can adapt to a higher value if the adjacency fails (that is, the timer detects failures more slowly). Or a neighbor can negotiate a higher value for a timer than the configured value. The timers adapt to a higher value when a BFD session flap occurs more than three times in a span of 15 seconds. A back-off algorithm increases the receive (Rx) interval by two if the local BFD instance is the reason for the session flap. The transmission (Tx) interval is increased by two if the remote BFD instance is the reason for the session flap. You can use the **clear bfd adaptation** command to return BFD interval timers to their configured values. The **clear bfd adaptation** command is hitless, meaning that the command does not affect traffic flow on the routing device.

NOTE: QFX5000 Series switches and EX4600 switches do not support minimum interval values of less than 1 second.

NOTE: BFD is supported for OSPFv3 in Junos OS Release 9.3 and later.

NOTE: For branch SRX Series devices, we recommend 1000 ms as the minimum keepalive time interval for BFD packets.

You can configure the following BFD protocol settings:

- **detection-time threshold**—Threshold for the adaptation of the detection time. When the BFD session detection time adapts to a value equal to or greater than the configured threshold, a single trap and a single system log message are sent.
- **full-neighbors-only**—Ability to establish BFD sessions only for OSPF neighbors with full neighbor adjacency. The default behavior is to establish BFD sessions for all OSPF neighbors. This setting is available in Junos OS Release 9.5 and later.
- **minimum-interval**—Minimum transmit and receive interval for failure detection. This setting configures both the minimum interval after which the local routing device transmits hello packets and the minimum interval after which the routing device expects to receive a reply from the neighbor with which it has established a BFD session. Both intervals are in milliseconds. You can also specify the minimum transmit and receive intervals separately using the **transmit-interval minimum-interval** and **minimum-receive-interval** statements.

NOTE: BFD is an intensive protocol that consumes system resources. Specifying a minimum interval for BFD of less than 100 ms for Routing Engine-based sessions and 10 ms for distributed BFD sessions can cause undesired BFD flapping.

Depending on your network environment, these additional recommendations might apply:

- For large-scale network deployments with a large number of BFD sessions, specify a minimum interval of no less than 500 ms. An interval of 1000 ms is recommended to avoid any instability issues.
- For very large-scale network deployments with a large number of BFD sessions, contact Juniper Networks customer support for more information.
- For BFD sessions to remain up during a Routing Engine switchover event when nonstop active routing (NSR) is configured, specify a minimum interval of 2500 ms for Routing Engine-based sessions. Without NSR, Routing Engine-based sessions can have a minimum interval of 100 ms. In OSPFv3, BFD is always based in the Routing Engine, meaning that BFD is not distributed. For distributed BFD sessions with NSR configured, the minimum interval recommendations are unchanged and depend only on your network deployment.
- On a single QFX5100 switch, when you add a QFX-EM-4Q expansion module, specify a minimum interval higher than 1000 ms.

- **minimum-receive-interval**—Minimum receive interval for failure detection. This setting configures the minimum receive interval, in milliseconds, after which the routing device expects to receive a hello packet from a neighbor with which it has established a BFD session. You can also specify the minimum receive interval using the **minimum-interval** statement.
- **multiplier**—Multiplier for hello packets. This setting configures the number of hello packets that are not received by a neighbor, which causes the originating interface to be declared down. By default, three missed hello packets cause the originating interface to be declared down.
- **no-adaptation**—Disables BFD adaption. This setting disables BFD sessions from adapting to changing network conditions. This setting is available in Junos OS Release 9.0 and later.

NOTE: We recommend that you do not disable BFD adaptation unless it is preferable not to have BFD adaptation in your network.

- **transmit-interval minimum-interval**—Minimum transmit interval for failure detection. This setting configures the minimum transmit interval, in milliseconds, at which the local routing device transmits hello packets to the neighbor with which it has established a BFD session. You can also specify the minimum transmit interval using the **minimum-interval** statement.

- **transmit-interval threshold**—Threshold for the adaptation of the BFD session transmit interval. When the transmit interval adapts to a value greater than the threshold, a single trap and a single system log message are sent. The threshold value must be greater than the minimum transmit interval. If you attempt to commit a configuration with a threshold value less than the minimum transmit interval, the routing device displays an error and does not accept the configuration.
- **version**—BFD version. This setting configures the BFD version used for detection. You can explicitly configure BFD version 1, or the routing device can automatically detect the BFD version. By default, the routing device automatically detects the BFD version automatically, which is either 0 or 1.

You can also trace BFD operations for troubleshooting purposes.

Understanding BFD for IS-IS

The Bidirectional Forwarding Detection (BFD) protocol is a simple hello mechanism that detects failures in a network. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the routing device stops receiving a reply after a specified interval. BFD works with a wide variety of network environments and topologies. The failure detection timers for BFD have shorter time limits than the failure detection mechanisms of IS-IS, providing faster detection.

The BFD failure detection timers are adaptive and can be adjusted to be faster or slower. For example, the timers can adapt to a higher value if the adjacency fails, or a neighbor can negotiate a higher value for a timer than the configured value. The timers adapt to a higher value when a BFD session flap occurs more than three times in a span of 15 seconds. A back-off algorithm increases the receive (RX) interval by two if the local BFD instance is the reason for the session flap. The transmission (TX) interval is increased by two if the remote BFD instance is the reason for the session flap.

You can use the **clear bfd adaptation** command to return BFD interval timers to their configured values. The **clear bfd adaptation** command is hitless, meaning that the command does not affect traffic flow on the routing device.

NOTE: Starting with Junos OS Release 16.1R1, you can configure IS-IS BFD sessions for IPv6 by including the **bfd-liveness-detection** statement at the **[edit protocols isis interface *interface-name* family inet|inet6]** hierarchy level.

- For interfaces that support both IPv4 and IPv6 routing, the **bfd-liveness-detection** statement must be configured separately for each inet family.
- BFD over IPv6 link local address is currently not distributed because IS-IS uses link local addresses for forming adjacencies.
- BFD sessions over IPv6 must not have the same aggressive detection intervals as IPv4 sessions.
- BFD IPv6 sessions with detection intervals less than 2.5 seconds are currently not supported when nonstop active routing (NSR) is enabled.

NOTE: QFX5000 Series switches and EX4600 switches do not support minimum interval values of less than 1 second.

To detect failures in the network, the set of statements in Table 3 on page 21 are used in the configuration.

Table 3: Configuring BFD for IS-IS

Statement	Description
bfd-liveness-detection	Enable failure detection.

Table 3: Configuring BFD for IS-IS *(continued)*

Statement	Description
minimum-interval ***milliseconds***	Specify the minimum transmit and receive intervals for failure detection. This value represents the minimum interval at which the local router transmits hellos packets as well as the minimum interval at which the router expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number from 1 through 255,000 milliseconds. You can also specify the minimum transmit and receive intervals separately. **NOTE:** BFD is an intensive protocol that consumes system resources. Specifying a minimum interval for BFD less than 100 ms for Routing Engine-based sessions and 10 ms for distributed BFD sessions can cause undesired BFD flapping. Depending on your network environment, these additional recommendations might apply: • For large-scale network deployments with a large number of BFD sessions, specify a minimum interval of 300 ms for Routing Engine-based sessions and 100 ms for distributed BFD sessions. • For very large-scale network deployments with a large number of BFD sessions, please contact Juniper Networks customer support for more information. • For BFD sessions to remain up during a Routing Engine switchover event when nonstop active routing (NSR) is configured, specify a minimum interval of 2500 ms for Routing Engine-based sessions. For distributed BFD sessions with nonstop active routing configured, the minimum interval recommendations are unchanged and depend only on your network deployment.
minimum-receive-interval ***milliseconds***	Specify only the minimum receive interval for failure detection. This value represents the minimum interval at which the local router expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number from 1 through 255,000 milliseconds.
multiplier ***number***	Specify the number of hello packets not received by the neighbor that causes the originating interface to be declared down. The default is 3, and you can configure a value from 1 through 225.
no-adaptation	Disable BFD adaptation. In Junos OS Release 9.0 and later, you can specify that the BFD sessions not adapt to changing network conditions. **NOTE:** We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation enabled in your network.

Table 3: Configuring BFD for IS-IS *(continued)*

Statement	Description
threshold	Specify the threshold for the following: • Adaptation of the detection time When the BFD session detection time adapts to a value equal to or greater than the threshold, a single trap and a system log message are sent. • Transmit interval **NOTE:** The threshold value must be greater than the minimum transmit interval multiplied by the multiplier number.
transmit-interval minimum-interval	Specify the minimum transmit interval for failure detection. This value represents the minimum interval at which the local routing device transmits hello packets to the neighbor with which it has established a BFD session. You can configure a value from 1 through 255,000 milliseconds.
version	Specify the BFD version used for detection. The default is to have the version detected automatically.

NOTE: You can trace BFD operations by including the **traceoptions** statement at the **[edit protocols bfd]** hierarchy level.

For a list of hierarchy levels at which you can include these statements, see the statement summary sections for these statements.

RELATED DOCUMENTATION

Example: Configuring BFD for IS-IS | 59

Understanding BFD Authentication for IS-IS

Understanding BFD for RIP

The Bidirectional Forwarding Detection (BFD) Protocol is a simple hello mechanism that detects failures in a network. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the routing device stops receiving a reply after a specified interval. BFD works with a wide variety of network environments and topologies. BFD failure detection times are shorter than RIP detection times, providing faster reaction times to various kinds of failures in the network. Instead of waiting for the routing protocol neighbor timeout, BFD provides rapid detection of link failures. BFD timers are adaptive and can be adjusted to be more or less aggressive. For example, a timer can adapt to a higher value if the adjacency fails, or a neighbor can negotiate a higher value for a timer than the one configured. Note that the functionality of configuring BFD for RIP described in this topic is not supported in Junos OS Releases 15.1X49, 15.1X49-D30, or 15.1X49-D40.

NOTE: QFX5000 Series switches and EX4600 switches do not support minimum interval values of less than 1 second.

BFD enables quick failover between a primary and a secondary routed path. The protocol tests the operational status of the interface multiple times per second. BFD provides for configuration timers and thresholds for failure detection. For example, if the minimum interval is set for 50 milliseconds and the threshold uses the default value of three missed messages, a failure is detected on an interface within 200 milliseconds of the failure.

Intervening devices (for example, an Ethernet LAN switch) hide link-layer failures from routing protocol peers, such as when two routers are connected by way of a LAN switch, where the local interface status remains up even when a physical fault happens on the remote link. Link-layer failure detection times vary, depending on the physical media and the Layer 2 encapsulation. BFD can provide fast failure detection times for all media types, encapsulations, topologies, and routing protocols.

To enable BFD for RIP, both sides of the connection must receive an update message from the peer. By default, RIP does not export any routes. Therefore, you must enable update messages to be sent by configuring an export policy for routes before a BFD session is triggered.

Release History Table

Release	Description
15.1X49	Note that the functionality of configuring BFD for RIP described in this topic is not supported in Junos OS Releases 15.1X49, 15.1X49-D30, or 15.1X49-D40.

Understanding Independent Micro BFD Sessions for LAG

Starting with Junos OS Release 13.3, this feature is supported on the following PIC/FPC types:

- PC-1XGE-XENPAK (Type 3 FPC)
- PD-4XGE-XFP (Type 4 FPC)
- PD-5-10XGE-SFPP (Type 4 FPC)
- 24x10GE (LAN/WAN) SFPP, 12x10GE (LAN/WAN) SFPP, 1x100GE Type 5 PICs
- All MPCs on MX Series with Ethernet MICs
- FPC-PTX-P1-A on PTX5000 with 10-Gigabit Ethernet interfaces
- FPC2-PTX-P1A on PTX5000 with 10-Gigabit Ethernet interfaces in Junos OS Release 14.1 and later
- All FPCs on PTX Series with Ethernet interfaces in Junos OS Release 14.1R3 and later 14.1 releases, and Junos 14.2 and later

TIP: See *PTX Series PIC/FPC Compatibility* for a list of PICs that are supported on each PTX Series FPC.

NOTE: Micro-BFD configuration with interface addresses is not supported on PTX routers on FPC3 and QFX10000 line of switches.

The Bidirectional Forwarding Detection (BFD) protocol is a simple detection protocol that quickly detects failures in the forwarding paths. A link aggregation group (LAG) combines multiple links between devices that are in point-to-point connections, thereby increasing bandwidth, providing reliability, and allowing load balancing. To run a BFD session on LAG interfaces, configure an independent, asynchronous mode BFD session on every LAG member link in a LAG bundle. Instead of a single BFD session monitoring the status of the UDP port, independent micro BFD sessions monitor the status of individual member links.

The individual BFD sessions determine the Layer 2 and Layer 3 connectivity of each member link in the LAG. Once a BFD session is established on a particular link, the member links are attached to the LAG and the load balancer either by a static configuration or by the Link Aggregation Control Protocol (LACP). If the member links are attached to the LAG by a static configuration, the device control process acts as the client to the micro BFD session. When member links are attached to the LAG by the LACP, the LACP acts as the client to the micro BFD session.

When the micro BFD session is up, a LAG link is established and data is transmitted over that LAG link. If the micro BFD session on a member link is down, that particular member link is removed from the load

balancer, and the LAG managers stop directing traffic to that link. These micro BFD sessions are independent of each other despite having a single client that manages the LAG interface.

NOTE:

- Starting with Junos OS Release 13.3, IANA has allocated 01-00-5E-90-00-01 as the dedicated MAC address for micro BFD. Dedicated MAC mode is used by default for micro BFD sessions, in accordance with the latest draft for BFD over LAG.
- In Junos OS, MicroBFD control packets are always untagged by default. For L2 aggregated interfaces, the configuration must include vlan-tagging or flexible-vlan-tagging in the Aggregated Ethernet with BFD. Otherwise, the system will throw error while committing the configuration.
- When you enable MicroBFD on an aggregated Ethernet Interface, the aggregated Interface can receive MicroBFD packets. Starting with Junos OS Release 19.3 and later, for MPC10E and MPC11E MPCs, you cannot apply firewall filters on the MicroBFD packets received on the aggregated Ethernet Interface. For MPC1E through MPC9E, you can apply firewall filters on the MicroBFD packets received on the aggregated Ethernet Interface only if the aggregated Ethernet Interface is configured as an untagged Interface.

Micro BFD sessions run in the following modes:

- Distribution Mode—Micro BFD sessions are distributed by default at Layer 3.
- Non-Distribution Mode—You can configure the BFD session to run in this mode by including the **no-delegate-processing** statement under periodic packet management (PPM). In this mode, the packets are being sent or received by the Routing Engine at Layer 2.

A pair of routing devices in a LAG exchange BFD packets at a specified, regular interval. The routing device detects a neighbor failure when it stops receiving a reply after a specified interval. This allows the quick verification of member link connectivity with or without LACP. A UDP port distinguishes BFD over LAG packets from BFD over single-hop IP.

NOTE: IANA has allocated 6784 as the UDP destination port for micro BFD.

To enable failure detection for LAG networks for aggregated Ethernet interfaces:

- Include the *bfd-liveness-detection* statement in the configuration.
- Specify a hold-down interval value to set the minimum time that the BFD session must remain up before a state change notification is sent to the other members in the LAG network.
- Specify the minimum interval that indicates the time interval for transmitting and receiving data.
- Starting with Junos OS Release 14.1, specify the neighbor in a BFD session. In releases prior to Junos OS Release 16.1, you must configure the loopback address of the remote destination as the neighbor

address. Beginning with Junos OS Release 16.1, you can also configure this feature on MX series routers with aggregated Ethernet interface address of the remote destination as the neighbor address.

NOTE: On T1600 and T4000 routers, you cannot configure the local aggregated Ethernet Interface address of the remote destination as the neighbor address.

CAUTION: Deactivate *bfd-liveness-detection* at the **[edit interfaces aex aggregated-ether-options]** hierarchy level or deactivate the aggregated Ethernet interface before changing the neighbor address from loopback IP address to aggregated Ethernet interface IP address. Modifying the local and neighbor address without deactivating **bfd-liveness-detection** or the aggregated Ethernet interface first might cause micro BFD sessions failure.

NOTE: Beginning with Release 16.1R2, Junos OS checks and validates the configured micro BFD **local-address** against the interface or loopback IP address before the configuration commit. Junos OS performs this check on both IPv4 and IPv6 micro BFD address configurations, and if they do not match, the commit fails.

NOTE: This feature works only when both the devices support BFD. If BFD is configured at one end of the LAG, this feature does not work.

For the IPv6 address family, disable duplicate address detection before configuring this feature with AE interface addresses. To disable duplicate address detection, include the **dad-disable** statement at the **[edit interface *aex* unit *y* family inet6]** hierarchy level.

Release History Table

Release	Description
19.3	Starting with Junos OS Release 19.3 and later, for MPC10E and MPC11E MPCs, you cannot apply firewall filters on the MicroBFD packets received on the aggregated Ethernet Interface. For MPC1E through MPC9E, you can apply firewall filters on the MicroBFD packets received on the aggregated Ethernet Interface only if the aggregated Ethernet Interface is configured as an untagged Interface.
16.1	Beginning with Junos OS Release 16.1, you can also configure this feature on MX series routers with aggregated Ethernet interface address of the remote destination as the neighbor address.
16.1	Beginning with Release 16.1R2, Junos OS checks and validates the configured micro BFD **local-address** against the interface or loopback IP address before the configuration commit.
14.1	Starting with Junos OS Release 14.1, specify the neighbor in a BFD session. In releases prior to Junos OS Release 16.1, you must configure the loopback address of the remote destination as the neighbor address.
13.3	Starting with Junos OS Release 13.3, IANA has allocated 01-00-5E-90-00-01 as the dedicated MAC address for micro BFD.

RELATED DOCUMENTATION

authentication

bfd-liveness-detection

detection-time

transmit-interval

Understanding Distributed BFD

Bidirectional Forwarding Detection (BFD) is a protocol to verify the liveliness of data path.

The terms *nondistributed BFD* and *centralized BFD* refer to BFD that runs on the Routing Engine. The term *distributed BFD* refers to BFD that runs on the Packet Forwarding Engine.

NOTE: By default, SRX Series devices operate in centralized BFD mode.

- Single-hop BFD—Single-hop BFD in Junos OS runs in distributed mode by default. The exceptions are OSPFv3 BFD and PIMv6 BFD, for which only nondistributed BFD is supported. Single-hop BFD control packets use UDP port 3784.
- Multihop BFD—One desirable application of BFD is to detect connectivity to routing devices that span multiple network hops and follow unpredictable paths. This is known as a multihop session. Prior to Junos OS Release 12.3, multihop BFD is nondistributed and runs on the Routing Engine. Starting in Junos OS Release 12.3, multihop BFD runs in distributed mode by default. Multihop BFD control packets use UDP port 4784.

> **NOTE:** In a multichassis link aggregation group setup, Inter-Chassis Control Protocol (ICCP) uses BFD in multihop mode. Multihop BFD runs in centralized mode in this kind of setup prior to Junos OS Release 12.3 and continues to do so as of Junos OS Release 12.3 and later.

> **NOTE:** QFX5110, QFX5120, QFX5200, and QFX5210 switches support multihop Bidirectional Forwarding Detection (BFD) inline keep alive support which will enable sessions to be configured at less than 1 second. Performance may vary depending on the system load. 10 inline BFD sessions are supported and can be configured with a timer of 150 x 3 milliseconds.

For both single-hop BFD and multihop BFD, the BFD session can be made to run on the Routing Engine (in nondistributed mode) by configuring **set routing-options ppm no-delegate-processing** and then running the **clear bfd session** command.

The benefits of distributed BFD are mainly in the scaling and performance areas.

The benefits are as follows:

- Allows for the creation of a larger number of BFD sessions.
- Runs BFD sessions with a shorter transfer/receive timer interval, which can in turn be used to bring down the overall detection time.
- Separates the functionality of BFD from that of the Routing Engine. This means that a BFD session can stay up during graceful restart, even with an aggressive interval. The minimum interval for Routing Engine-based BFD sessions to survive graceful Routing Engine switchover is 2500 ms, This is improved to sub-second times with distribution.
- Offloads the processing to the FPC CPU. This frees up the Routing Engine CPU, resulting in improved scaling and performance for Routing Engine-based applications.
- Starting with Junos OS Release 15.1X49-D100, dedicated BFD is supported on SRX340, SRX345, and SRX1500 devices.

Starting with Junos OS Release 15.1X49-D100, real-time BFD is supported on SRX300 and SRX320 devices.

Starting with Junos OS Release 15.1X49-D110, dedicated BFD is supported on SRX550M devices.

Starting with Junos OS Release 12.3X48-D60, dedicated BFD is supported on SRX240, SRX550, and SRX650 devices.

Starting with Junos OS Release 12.3X48-D60, real-time BFD is supported on SRX100, SRX110, SRX210, and SRX220 devices.

- To enable dedicated BFD on SRX100, SRX110, SRX210, SRX220, SRX240, SRX300, SRX320, SRX340, SRX345, SRX550, SRX550M, SRX650, and SRX1500 devices, use the **set chassis dedicated-ukern-cpu** command.

  Enabling dedicated BFD impacts traffic throughput as one CPU core is removed from data plane processing.

- To enable real-time BFD on SRX100, SRX110, SRX210, SRX220, SRX240, SRX300, SRX320, SRX340, SRX345, SRX550, SRX550M, and SRX650 devices, use the **set chassis realtime-ukern-thread** command.

  Enabling real-time BFD does not impact data plane performance. Higher priority is given to the pfe process handling BFD in distributed mode. This is suitable for scenarios where the number of BFD sessions are less.

Table 4 on page 30 lists the BFD modes supported on SRX Series devices.

Table 4: BFD Modes Supported on SRX Series Devices

SRX Series Device	Default BFD Mode	Distributed BFD	Real-Time BFD	Dedicated Core
SRX100	Centralized	Configuration	Configuration (Optional)	Not supported
SRX110	Centralized	Configuration	Configuration (Optional)	Not supported
SRX210	Centralized	Configuration	Configuration (Optional)	Not supported
SRX220	Centralized	Configuration	Configuration (Optional)	Not supported
SRX240	Centralized	Configuration	Configuration	Configuration (Optional)
SRX300	Centralized	Configuration	Configuration (Optional)	Not supported
SRX320	Centralized	Configuration	Configuration (Optional)	Not supported
SRX340	Centralized	Configuration	Configuration	Configuration (Optional)
SRX345	Centralized	Configuration	Configuration	Configuration (Optional)

Table 4: BFD Modes Supported on SRX Series Devices *(continued)*

SRX Series Device	Default BFD Mode	Distributed BFD	Real-Time BFD	Dedicated Core
SRX550	Centralized	Configuration	Configuration	Configuration (Optional)
SRX550M	Centralized	Configuration	Configuration	Configuration (Optional)
SRX650	Centralized	Configuration	Configuration	Configuration (Optional)
SRX1500	Centralized	Configuration	Not supported	Configuration (Optional)
SRX4100	Centralized	Not supported	Not supported	Not supported
SRX4200	Centralized	Not supported	Not supported	Not supported
SRX5400	Centralized	Not supported	Not supported	Not supported
SRX5600	Centralized	Not supported	Not supported	Not supported
SRX5800	Centralized	Not supported	Not supported	Not supported

To determine if a BFD peer is running distributed BFD, run the **show bfd sessions extensive** command and look for **Remote is control-plane independent** in the command output.

For distributed BFD to work, you need to configure the lo0 interface with unit 0 and the appropriate family.

```
# set interfaces lo0 unit 0 family inet
# set interfaces lo0 unit 0 family inet6
# set interfaces lo0 unit 0 family mpls
```

This is true for the following types of BFD sessions:

- BFD over ae logical interfaces, both IPv4 and IPv6
- Multihop BFD, both IPv4 and IPv6
- BFD over VLAN interfaces in EX Series switches, both IPv4 and IPv6
- Virtual Circuit Connectivity Verification (VCCV) BFD (Layer 2 circuit, Layer 3 VPN, and VPLS) (MPLS)

NOTE: Starting in Junos OS Release 13.3R5, if you apply a firewall filter on a loopback interface for a multihop BFD session with a delegated anchor FPC, Junos OS does not execute this filter, because there is an implicit filter on all ingress FPCs to forward packets to the anchor FPC. Therefore, the firewall filter on the loopback interface is not applied on these packets. If you do not want these packets to be forwarded to the anchor FPC, you can configure the **no-delegate-processing** option.

For information about troubleshooting BFD, see Juniper Networks Knowledge Base article 26746.

NOTE: Starting in Junos OS Release 13.3, the distribution of adjacency entry (the IP addresses of adjacent routers) and transmit entry (the IP address of transmitting routers) for a BFD session is asymmetric. This is because an adjacency entry that requires rules might or might not be distributed based on the redirect rule, and the distribution of transmit entries is *not* dependent on the redirect rule.

The term *redirect rule* here denotes the capability of an interface to send protocol redirect messages. See *Disabling the Transmission of Redirect Messages on an Interface*.

Release History Table

Release	Description
15.1X49-D100	Starting with Junos OS Release 15.1X49-D100, dedicated BFD is supported on SRX340, SRX345, and SRX1500 devices.
15.1X49-D100	Starting with Junos OS Release 15.1X49-D100, real-time BFD is supported on SRX300 and SRX320 devices.
13.3R5	Starting in Junos OS Release 13.3R5, if you apply a firewall filter on a loopback interface for a multihop BFD session with a delegated anchor FPC, Junos OS does not execute this filter, because there is an implicit filter on all ingress FPCs to forward packets to the anchor FPC.
13.3	Starting in Junos OS Release 13.3, the distribution of adjacency entry (the IP addresses of adjacent routers) and transmit entry (the IP address of transmitting routers) for a BFD session is asymmetric.

RELATED DOCUMENTATION

show bfd session

Understanding BFD for RIP | 24

Understanding BFD for Static Routes for Faster Network Failure Detection | 10

Understanding BFD for BGP | 15

Understanding BFD for IS-IS | 20

Understanding BFD for OSPF | 17

Understanding EBGP Multihop

CHAPTER 3

Configuring BFD

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- Example: Configuring BFD on Internal BGP Peer Sessions | 42
- Example: Configuring BFD for OSPF | 55
- Example: Configuring BFD for IS-IS | 59
- Example: Configuring BFD for RIP | 68
- Configuring Micro BFD Sessions for LAG | 75
- Example: Configuring Independent Micro BFD Sessions for LAG | 81
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Example: Configuring BFD for Static Routes for Faster Network Failure Detection

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- Overview | 35
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- Verification | 40

This example shows how to configure Bidirectional Forwarding Detection (BFD) for static routes.

Requirements

In this example, no special configuration beyond device initialization is required.

Overview

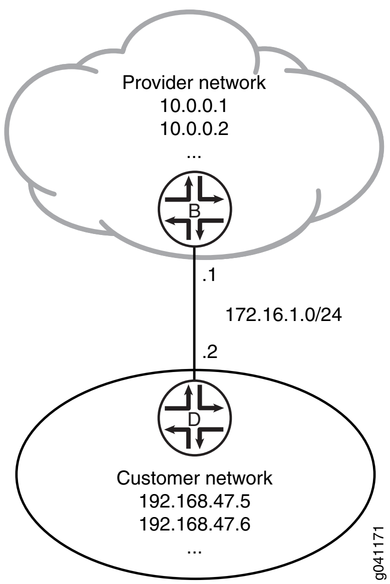
There are many practical applications for static routes. Static routing is often used at the network edge to support attachment to stub networks, which, given their single point of entry and egress, are well suited to the simplicity of a static route. In Junos OS, static routes have a global preference of 5. Static routes are activated if the specified next hop is reachable.

In this example, you configure the static route 192.168.47.0/24 from the provider network to the customer network, using the next-hop address of 172.16.1.2. You also configure a static default route of 0.0.0.0/0 from the customer network to the provider network, using a next-hop address of 172.16.1.1.

For demonstration purposes, some loopback interfaces are configured on Device B and Device D. These loopback interfaces provide addresses to ping and thus verify that the static routes are working.

Figure 1 on page 35 shows the sample network.

Figure 1: Customer Routes Connected to a Service Provider



Configuration

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

Device B

```
set interfaces ge-1/2/0 unit 0 description B->D
set interfaces ge-1/2/0 unit 0 family inet address 172.16.1.1/24
set interfaces lo0 unit 57 family inet address 10.0.0.1/32
set interfaces lo0 unit 57 family inet address 10.0.0.2/32
set routing-options static route 192.168.47.0/24 next-hop 172.16.1.2
set routing-options static route 192.168.47.0/24 bfd-liveness-detection minimum-interval 1000
set routing-options static route 192.168.47.0/24 bfd-liveness-detection description Site-xxx
set protocols bfd traceoptions file bfd-trace
set protocols bfd traceoptions flag all
```

Device D

```
set interfaces ge-1/2/0 unit 1 description D->B
set interfaces ge-1/2/0 unit 1 family inet address 172.16.1.2/24
set interfaces lo0 unit 2 family inet address 192.168.47.5/32
set interfaces lo0 unit 2 family inet address 192.168.47.6/32
set routing-options static route 0.0.0.0/0 next-hop 172.16.1.1
set routing-options static route 0.0.0.0/0 bfd-liveness-detection minimum-interval 1000
set protocols bfd traceoptions file bfd-trace
set protocols bfd traceoptions flag all
```

Step-by-Step Procedure

The following example requires that you navigate various levels in the configuration hierarchy. For information about navigating the CLI, see *Using the CLI Editor in Configuration Mode* in the *CLI User Guide*.

To configure BFD for static routes:

1. On Device B, configure the interfaces.

   ```
   [edit interfaces]
   user@B# set ge-1/2/0 unit 0 description B->D
   user@B# set ge-1/2/0 unit 0 family inet address 172.16.1.1/24
   user@B# set lo0 unit 57 family inet address 10.0.0.1/32
   user@B# set lo0 unit 57 family inet address 10.0.0.2/32
   ```

2. On Device B, create a static route and set the next-hop address.

   ```
   [edit routing-options]
   ```

```
user@B# set static route 192.168.47.0/24 next-hop 172.16.1.2
```

3. On Device B, configure BFD for the static route.

```
[edit routing-options]
user@B# set static route 192.168.47.0/24 bfd-liveness-detection minimum-interval 1000
set routing-options static route 192.168.47.0/24 bfd-liveness-detection description Site-xxx
```

4. On Device B, configure tracing operations for BFD.

```
[edit protocols]
user@B# set bfd traceoptions file bfd-trace
user@B# set bfd traceoptions flag all
```

5. If you are done configuring Device B, commit the configuration.

```
[edit]
user@B# commit
```

6. On Device D, configure the interfaces.

```
[edit interfaces]
user@D# set ge-1/2/0 unit 1 description D->B
user@D# set ge-1/2/0 unit 1 family inet address 172.16.1.2/24
user@D# set lo0 unit 2 family inet address 192.168.47.5/32
user@D# set lo0 unit 2 family inet address 192.168.47.6/32
```

7. On Device D, create a static route and set the next-hop address.

```
[edit routing-options]
user@D# set static route 0.0.0.0/0 next-hop 172.16.1.1
```

8. On Device D, configure BFD for the static route.

```
[edit routing-options]
user@D# set static route 0.0.0.0/0 bfd-liveness-detection minimum-interval 1000
```

9. On Device D, configure tracing operations for BFD.

```
[edit protocols]
user@D# set bfd traceoptions file bfd-trace
user@D# set bfd traceoptions flag all
```

10. If you are done configuring Device D, commit the configuration.

```
[edit]
user@D# commit
```

Results

Confirm your configuration by issuing the **show interfaces**, **show protocols**, and **show routing-options** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

Device B

```
user@B# show interfaces
ge-1/2/0 {
    unit 0 {
        description B->D;
        family inet {
            address 172.16.1.1/24;
        }
    }
}
lo0 {
    unit 57 {
        family inet {
            address 10.0.0.1/32;
            address 10.0.0.2/32;
        }
    }
}
```

```
user@D# show protocols
bfd {
```

```
    traceoptions {
        file bfd-trace;
        flag all;
    }
}
```

```
user@B# show routing-options
static {
    route 192.168.47.0/24 {
        next-hop 172.16.1.2;
        bfd-liveness-detection {
            description Site- xxx;
            minimum-interval 1000;
        }
    }
}
```

Device D

```
user@D# show interfaces
ge-1/2/0 {
    unit 1 {
        description D->B;
        family inet {
            address 172.16.1.2/24;
        }
    }
}
lo0 {
    unit 2 {
        family inet {
            address 192.168.47.5/32;
            address 192.168.47.6/32;
        }
    }
}
```

```
user@D# show routing-options
static {
    route 0.0.0.0/0 {
```

```
        next-hop 172.16.1.1;
        bfd-liveness-detection {
            description Site - xxx;
            minimum-interval 1000;
        }
    }
}
```

Verification

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- Verifying That BFD Sessions Are Up | 40
- Viewing Detailed BFD Events | 41

Confirm that the configuration is working properly.

Verifying That BFD Sessions Are Up

Purpose

Verify that the BFD sessions are up, and view details about the BFD sessions.

Action

From operational mode, enter the **show bfd session extensive** command.

`user@B>` **show bfd session extensive**

```
                                                   Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
172.16.1.2               Up        lt-1/2/0.0     3.000     1.000        3
 Client Static, description Site-xxx, TX interval 1.000, RX interval 1.000
 Session up time 00:14:30
 Local diagnostic None, remote diagnostic None
 Remote state Up, version 1
 Replicated, routing table index 172
 Min async interval 1.000, min slow interval 1.000
 Adaptive async TX interval 1.000, RX interval 1.000
 Local min TX interval 1.000, minimum RX interval 1.000, multiplier 3
 Remote min TX interval 1.000, min RX interval 1.000, multiplier 3
```

```
 Local discriminator 2, remote discriminator 1
 Echo mode disabled/inactive

1 sessions, 1 clients
Cumulative transmit rate 1.0 pps, cumulative receive rate 1.0 pps
```

NOTE: The **description Site- <*xxx*>** is supported only on the SRX Series devices.

If each client has more than one description field, then it displays "and more" along with the first description field.

`user@D>` **show bfd session extensive**

```
                                                  Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
172.16.1.1               Up        lt-1/2/0.1     3.000     1.000        3
 Client Static, TX interval 1.000, RX interval 1.000
 Session up time 00:14:35
 Local diagnostic None, remote diagnostic None
 Remote state Up, version 1
 Replicated, routing table index 170
 Min async interval 1.000, min slow interval 1.000
 Adaptive async TX interval 1.000, RX interval 1.000
 Local min TX interval 1.000, minimum RX interval 1.000, multiplier 3
 Remote min TX interval 1.000, min RX interval 1.000, multiplier 3
 Local discriminator 1, remote discriminator 2
 Echo mode disabled/inactive

1 sessions, 1 clients
Cumulative transmit rate 1.0 pps, cumulative receive rate 1.0 pps
```

Meaning

The **TX interval 1.000, RX interval 1.000** output represents the setting configured with the **minimum-interval** statement. All of the other output represents the default settings for BFD. To modify the default settings, include the optional statements under the **bfd-liveness-detection** statement.

Viewing Detailed BFD Events

Purpose

View the contents of the BFD trace file to assist in troubleshooting, if needed.

Action

From operational mode, enter the **file show /var/log/bfd-trace** command.

user@B> **file show /var/log/bfd-trace**

```
Nov 23 14:26:55    Data (9) len 35: (hex) 42 46 44 20 70 65 72 69 6f 64 69 63 20
78 6d 69 74 20 72
Nov 23 14:26:55 PPM Trace: BFD periodic xmit rt tbl index 172
Nov 23 14:26:55 Received Downstream TraceMsg (22) len 108:
Nov 23 14:26:55    IfIndex (3) len 4: 0
Nov 23 14:26:55    Protocol (1) len 1: BFD
Nov 23 14:26:55    Data (9) len 83: (hex) 70 70 6d 64 5f 62 66 64 5f 73 65 6e 64
6d 73 67 20 3a 20
Nov 23 14:26:55 PPM Trace: ppmd_bfd_sendmsg : socket 12 len 24, ifl 78 src
172.16.1.1 dst 172.16.1.2 errno 65
Nov 23 14:26:55 Received Downstream TraceMsg (22) len 93:
Nov 23 14:26:55    IfIndex (3) len 4: 0
Nov 23 14:26:55    Protocol (1) len 1: BFD
Nov 23 14:26:55    Data (9) len 68: (hex) 42 46 44 20 70 65 72 69 6f 64 69 63 20
78 6d 69 74 20 74
```

Meaning

BFD messages are being written to the trace file.

RELATED DOCUMENTATION

Understanding BFD for Static Routes for Faster Network Failure Detection | 10

Example: Configuring BFD on Internal BGP Peer Sessions

IN THIS SECTION

- Requirements | 43
- Overview | 43
- Configuration | 45
- Verification | 50

This example shows how to configure internal BGP (IBGP) peer sessions with the Bidirectional Forwarding Detection (BFD) protocol to detect failures in a network.

Requirements

No special configuration beyond device initialization is required before you configure this example.

Overview

The minimum configuration to enable BFD on IBGP sessions is to include the **bfd-liveness-detection minimum-interval** statement in the BGP configuration of all neighbors participating in the BFD session. The **minimum-interval** statement specifies the minimum transmit and receive intervals for failure detection. Specifically, this value represents the minimum interval after which the local routing device transmits hello packets as well as the minimum interval that the routing device expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a value from 1 through 255,000 milliseconds.

Optionally, you can specify the minimum transmit and receive intervals separately using the **transmit-interval minimum-interval** and **minimum-receive-interval** statements. For information about these and other optional BFD configuration statements, see **bfd-liveness-detection**.

NOTE: BFD is an intensive protocol that consumes system resources. Specifying a minimum interval for BFD less than 100 milliseconds for Routing Engine-based sessions and less than 10 milliseconds for distributed BFD sessions can cause undesired BFD flapping.

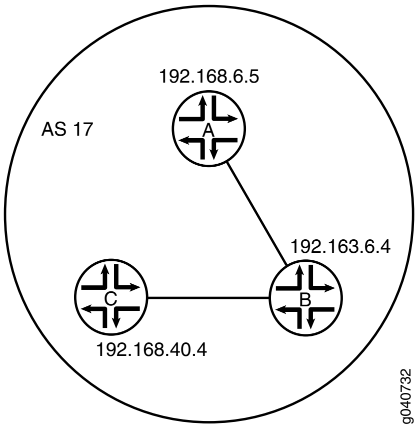
Depending on your network environment, these additional recommendations might apply:

- To prevent BFD flapping during the general Routing Engine switchover event, specify a minimum interval of 5000 milliseconds for Routing Engine-based sessions. This minimum value is required because, during the general Routing Engine switchover event, processes such as RPD, MIBD, and SNMPD utilize CPU resources for more than the specified threshold value. Hence, BFD processing and scheduling is affected because of this lack of CPU resources.
- For BFD sessions to remain up during the dual chassis cluster control link scenario, when the first control link fails, specify the minimum interval of 6000 milliseconds to prevent the LACP from flapping on the secondary node for Routing Engine-based sessions.
- For large-scale network deployments with a large number of BFD sessions, specify a minimum interval of 300 milliseconds for Routing Engine-based sessions and 100 milliseconds for distributed BFD sessions.
- For very large-scale network deployments with a large number of BFD sessions, contact Juniper Networks customer support for more information.
- For BFD sessions to remain up during a Routing Engine switchover event when nonstop active routing (NSR) is configured, specify a minimum interval of 2500 milliseconds for Routing Engine-based sessions. For distributed BFD sessions with NSR configured, the minimum interval recommendations are unchanged and depend only on your network deployment.

BFD is supported on the default routing instance (the main router), routing instances, and logical systems. This example shows BFD on logical systems.

Figure 2 on page 45 shows a typical network with internal peer sessions.

Figure 2: Typical Network with IBGP Sessions



Configuration

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

Device A

```
set logical-systems A interfaces lt-1/2/0 unit 1 description to-B
set logical-systems A interfaces lt-1/2/0 unit 1 encapsulation ethernet
set logical-systems A interfaces lt-1/2/0 unit 1 peer-unit 2
set logical-systems A interfaces lt-1/2/0 unit 1 family inet address 10.10.10.1/30
set logical-systems A interfaces lo0 unit 1 family inet address 192.168.6.5/32
set logical-systems A protocols bgp group internal-peers type internal
set logical-systems A protocols bgp group internal-peers traceoptions file bgp-bfd
set logical-systems A protocols bgp group internal-peers traceoptions flag bfd detail
set logical-systems A protocols bgp group internal-peers local-address 192.168.6.5
set logical-systems A protocols bgp group internal-peers export send-direct
set logical-systems A protocols bgp group internal-peers bfd-liveness-detection minimum-interval
  1000
set logical-systems A protocols bgp group internal-peers neighbor 192.163.6.4
set logical-systems A protocols bgp group internal-peers neighbor 192.168.40.4
set logical-systems A protocols ospf area 0.0.0.0 interface lo0.1 passive
set logical-systems A protocols ospf area 0.0.0.0 interface lt-1/2/0.1
set logical-systems A policy-options policy-statement send-direct term 2 from protocol direct
set logical-systems A policy-options policy-statement send-direct term 2 then accept
set logical-systems A routing-options router-id 192.168.6.5
```

```
set logical-systems A routing-options autonomous-system 17
```

Device B

```
set logical-systems B interfaces lt-1/2/0 unit 2 description to-A
set logical-systems B interfaces lt-1/2/0 unit 2 encapsulation ethernet
set logical-systems B interfaces lt-1/2/0 unit 2 peer-unit 1
set logical-systems B interfaces lt-1/2/0 unit 2 family inet address 10.10.10.2/30
set logical-systems B interfaces lt-1/2/0 unit 5 description to-C
set logical-systems B interfaces lt-1/2/0 unit 5 encapsulation ethernet
set logical-systems B interfaces lt-1/2/0 unit 5 peer-unit 6
set logical-systems B interfaces lt-1/2/0 unit 5 family inet address 10.10.10.5/30
set logical-systems B interfaces lo0 unit 2 family inet address 192.163.6.4/32
set logical-systems B protocols bgp group internal-peers type internal
set logical-systems B protocols bgp group internal-peers local-address 192.163.6.4
set logical-systems B protocols bgp group internal-peers export send-direct
set logical-systems B protocols bgp group internal-peers bfd-liveness-detection minimum-interval
  1000
set logical-systems B protocols bgp group internal-peers neighbor 192.168.40.4
set logical-systems B protocols bgp group internal-peers neighbor 192.168.6.5
set logical-systems B protocols ospf area 0.0.0.0 interface lo0.2 passive
set logical-systems B protocols ospf area 0.0.0.0 interface lt-1/2/0.2
set logical-systems B protocols ospf area 0.0.0.0 interface lt-1/2/0.5
set logical-systems B policy-options policy-statement send-direct term 2 from protocol direct
set logical-systems B policy-options policy-statement send-direct term 2 then accept
set logical-systems B routing-options router-id 192.163.6.4
set logical-systems B routing-options autonomous-system 17
```

Device C

```
set logical-systems C interfaces lt-1/2/0 unit 6 description to-B
set logical-systems C interfaces lt-1/2/0 unit 6 encapsulation ethernet
set logical-systems C interfaces lt-1/2/0 unit 6 peer-unit 5
set logical-systems C interfaces lt-1/2/0 unit 6 family inet address 10.10.10.6/30
set logical-systems C interfaces lo0 unit 3 family inet address 192.168.40.4/32
set logical-systems C protocols bgp group internal-peers type internal
set logical-systems C protocols bgp group internal-peers local-address 192.168.40.4
```

```
set logical-systems C protocols bgp group internal-peers export send-direct
set logical-systems C protocols bgp group internal-peers bfd-liveness-detection minimum-interval
  1000
set logical-systems C protocols bgp group internal-peers neighbor 192.163.6.4
set logical-systems C protocols bgp group internal-peers neighbor 192.168.6.5
set logical-systems C protocols ospf area 0.0.0.0 interface lo0.3 passive
set logical-systems C protocols ospf area 0.0.0.0 interface lt-1/2/0.6
set logical-systems C policy-options policy-statement send-direct term 2 from protocol direct
set logical-systems C policy-options policy-statement send-direct term 2 then accept
set logical-systems C routing-options router-id 192.168.40.4
set logical-systems C routing-options autonomous-system 17
```

Configuring Device A

Step-by-Step Procedure

The following example requires that you navigate various levels in the configuration hierarchy. For information about navigating the CLI, see *Using the CLI Editor in Configuration Mode* in the *CLI User Guide*.

To configure Device A:

1. Set the CLI to Logical System A.

```
user@host> set cli logical-system A
```

2. Configure the interfaces.

```
[edit interfaces lt-1/2/0 unit 1]
user@host:A# set description to-B
user@host:A# set encapsulation ethernet
user@host:A# set peer-unit 2
user@host:A# set family inet address 10.10.10.1/30
[edit interfaces lo0 unit 1]
user@host:A# set family inet address 192.168.6.5/32
```

3. Configure BGP.

   The **neighbor** statements are included for both Device B and Device C, even though Device A is not directly connected to Device C.

```
[edit protocols bgp group internal-peers]
```

```
user@host:A# set type internal
user@host:A# set local-address 192.168.6.5
user@host:A# set export send-direct
user@host:A# set neighbor 192.163.6.4
user@host:A# set neighbor 192.168.40.4
```

4. Configure BFD.

```
[edit protocols bgp group internal-peers]
user@host:A# set bfd-liveness-detection minimum-interval 1000
```

   You must configure the same minimum interval on the connecting peer.

5. (Optional) Configure BFD tracing.

```
[edit protocols bgp group internal-peers]
user@host:A# set traceoptions file bgp-bfd
user@host:A# set traceoptions flag bfd detail
```

6. Configure OSPF.

```
[edit protocols ospf area 0.0.0.0]
user@host:A# set interface lo0.1 passive
user@host:A# set interface lt-1/2/0.1
```

7. Configure a policy that accepts direct routes.

   Other useful options for this scenario might be to accept routes learned through OSPF or local routes.

```
[edit policy-options policy-statement send-direct term 2]
user@host:A# set from protocol direct
user@host:A# set then accept
```

8. Configure the router ID and the autonomous system (AS) number.

```
[edit routing-options]
user@host:A# set router-id 192.168.6.5
```

```
user@host:A# set autonomous-system 17
```

9. If you are done configuring the device, enter **commit** from configuration mode.
   Repeat these steps to configure Device B and Device C.

Results

From configuration mode, confirm your configuration by entering the **show interfaces**, **show policy-options**, **show protocols**, and **show routing-options** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@host:A# show interfaces
lt-1/2/0 {
    unit 1 {
        description to-B;
        encapsulation ethernet;
        peer-unit 2;
        family inet {
            address 10.10.10.1/30;
        }
    }
}
lo0 {
    unit 1 {
        family inet {
            address 192.168.6.5/32;
        }
    }
}
```

```
user@host:A# show policy-options
policy-statement send-direct {
    term 2 {
        from protocol direct;
        then accept;
    }
}
```

```
user@host:A# show protocols
bgp {
    group internal-peers {
        type internal;
```

```
        traceoptions {
            file bgp-bfd;
            flag bfd detail;
        }
        local-address 192.168.6.5;
        export send-direct;
        bfd-liveness-detection {
            minimum-interval 1000;
        }
        neighbor 192.163.6.4;
        neighbor 192.168.40.4;
    }
}
ospf {
    area 0.0.0.0 {
        interface lo0.1 {
            passive;
        }
        interface lt-1/2/0.1;
    }
}
```

```
user@host:A# show routing-options
router-id 192.168.6.5;
autonomous-system 17;
```

Verification

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- Verifying That BFD Sessions Are Up | 51
- Viewing Detailed BFD Events | 52
- Viewing Detailed BFD Events After Deactivating and Reactivating a Loopback Interface | 53

Confirm that the configuration is working properly.

Verifying That BFD Is Enabled

Purpose

Verify that BFD is enabled between the IBGP peers.

Action

From operational mode, enter the **show bgp neighbor** command. You can use the **| match bfd** filter to narrow the output.

`user@host:A>` **show bgp neighbor | match bfd**

```
Options: <BfdEnabled>
  BFD: enabled, up
  Trace file: /var/log/A/bgp-bfd size 131072 files 10
  Options: <BfdEnabled>
  BFD: enabled, up
  Trace file: /var/log/A/bgp-bfd size 131072 files 10
```

Meaning

The output shows that Logical System A has two neighbors with BFD enabled. When BFD is not enabled, the output displays **BFD: disabled, down**, and the **<BfdEnabled>** option is absent. If BFD is enabled and the session is down, the output displays **BFD: enabled, down**. The output also shows that BFD-related events are being written to a log file because trace operations are configured.

Verifying That BFD Sessions Are Up

Purpose

Verify that the BFD sessions are up, and view details about the BFD sessions.

Action

From operational mode, enter the **show bfd session extensive** command.

`user@host:A>` **show bfd session extensive**

```
                                                  Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
192.163.6.4              Up                       3.000     1.000       3
 Client BGP, TX interval 1.000, RX interval 1.000
 Session up time 00:54:40
 Local diagnostic None, remote diagnostic None
 Remote state Up, version 1
 Logical system 12, routing table index 25
 Min async interval 1.000, min slow interval 1.000
```

```
 Adaptive async TX interval 1.000, RX interval 1.000
 Local min TX interval 1.000, minimum RX interval 1.000, multiplier 3
 Remote min TX interval 1.000, min RX interval 1.000, multiplier 3
 Local discriminator 10, remote discriminator 9
 Echo mode disabled/inactive
 Multi-hop route table 25, local-address 192.168.6.5

                                                 Detect   Transmit
Address                  State     Interface     Time     Interval  Multiplier
192.168.40.4             Up                      3.000     1.000        3
 Client BGP, TX interval 1.000, RX interval 1.000
 Session up time 00:48:03
 Local diagnostic None, remote diagnostic None
 Remote state Up, version 1
 Logical system 12, routing table index 25
 Min async interval 1.000, min slow interval 1.000
 Adaptive async TX interval 1.000, RX interval 1.000
 Local min TX interval 1.000, minimum RX interval 1.000, multiplier 3
 Remote min TX interval 1.000, min RX interval 1.000, multiplier 3
 Local discriminator 14, remote discriminator 13
 Echo mode disabled/inactive
 Multi-hop route table 25, local-address 192.168.6.5

2 sessions, 2 clients
Cumulative transmit rate 2.0 pps, cumulative receive rate 2.0 pps
```

Meaning

The **TX interval 1.000, RX interval 1.000** output represents the setting configured with the **minimum-interval** statement. All of the other output represents the default settings for BFD. To modify the default settings, include the optional statements under the **bfd-liveness-detection** statement.

Viewing Detailed BFD Events

Purpose

View the contents of the BFD trace file to assist in troubleshooting, if needed.

Action

From operational mode, enter the **file show /var/log/A/bgp-bfd** command.

`user@host:A>` **file show /var/log/A/bgp-bfd**

```
Aug 15 17:07:25 trace_on: Tracing to "/var/log/A/bgp-bfd" started
Aug 15 17:07:26.492190 bgp_peer_init: BGP peer 192.163.6.4 (Internal AS 17) local
```

```
 address 192.168.6.5 not found.  Leaving peer idled
Aug 15 17:07:26.493176 bgp_peer_init: BGP peer 192.168.40.4 (Internal AS 17) local
 address 192.168.6.5 not found.  Leaving peer idled
Aug 15 17:07:32.597979 task_connect: task BGP_17.192.163.6.4+179 addr
192.163.6.4+179: No route to host
Aug 15 17:07:32.599623 bgp_connect_start: connect 192.163.6.4 (Internal AS 17):
No route to host
Aug 15 17:07:36.869394 task_connect: task BGP_17.192.168.40.4+179 addr
192.168.40.4+179: No route to host
Aug 15 17:07:36.870624 bgp_connect_start: connect 192.168.40.4 (Internal AS 17):
No route to host
Aug 15 17:08:04.599220 task_connect: task BGP_17.192.163.6.4+179 addr
192.163.6.4+179: No route to host
Aug 15 17:08:04.601135 bgp_connect_start: connect 192.163.6.4 (Internal AS 17):
No route to host
Aug 15 17:08:08.869717 task_connect: task BGP_17.192.168.40.4+179 addr
192.168.40.4+179: No route to host
Aug 15 17:08:08.869934 bgp_connect_start: connect 192.168.40.4 (Internal AS 17):
No route to host
Aug 15 17:08:36.603544 advertising receiving-speaker only capabilty to neighbor
192.163.6.4 (Internal AS 17)
Aug 15 17:08:36.606726 bgp_read_message: 192.163.6.4 (Internal AS 17): 0 bytes
buffered
Aug 15 17:08:36.609119 Initiated BFD session to peer 192.163.6.4 (Internal AS 17):
 address=192.163.6.4 ifindex=0 ifname=(none) txivl=1000 rxivl=1000 mult=3 ver=255
Aug 15 17:08:36.734033 advertising receiving-speaker only capabilty to neighbor
192.168.40.4 (Internal AS 17)
Aug 15 17:08:36.738436 Initiated BFD session to peer 192.168.40.4 (Internal AS
17): address=192.168.40.4 ifindex=0 ifname=(none) txivl=1000 rxivl=1000 mult=3
ver=255
Aug 15 17:08:40.537552 BFD session to peer 192.163.6.4 (Internal AS 17) up
Aug 15 17:08:40.694410 BFD session to peer 192.168.40.4 (Internal AS 17) up
```

Meaning

Before the routes are established, the **No route to host** message appears in the output. After the routes are established, the last two lines show that both BFD sessions come up.

Viewing Detailed BFD Events After Deactivating and Reactivating a Loopback Interface

Purpose

Check to see what happens after bringing down a router or switch and then bringing it back up. To simulate bringing down a router or switch, deactivate the loopback interface on Logical System B.

Action

1. From configuration mode, enter the **deactivate logical-systems B interfaces lo0 unit 2 family inet** command.

   user@host:A# **deactivate logical-systems B interfaces lo0 unit 2 family inet**

   user@host:A# **commit**

2. From operational mode, enter the **file show /var/log/A/bgp-bfd** command.

   user@host:A> **file show /var/log/A/bgp-bfd**

```
...
Aug 15 17:20:55.995648 bgp_read_v4_message:9747: NOTIFICATION received from
192.163.6.4 (Internal AS 17): code 6 (Cease) subcode 6 (Other Configuration
Change)
Aug 15 17:20:56.004508 Terminated BFD session to peer 192.163.6.4 (Internal AS
 17)
Aug 15 17:21:28.007755 task_connect: task BGP_17.192.163.6.4+179 addr
192.163.6.4+179: No route to host
Aug 15 17:21:28.008597 bgp_connect_start: connect 192.163.6.4 (Internal AS 17):
 No route to host
```

3. From configuration mode, enter the **activate logical-systems B interfaces lo0 unit 2 family inet** command.

   user@host:A# **activate logical-systems B interfaces lo0 unit 2 family inet**

   user@host:A# **commit**

4. From operational mode, enter the **file show /var/log/A/bgp-bfd** command.

   user@host:A> **file show /var/log/A/bgp-bfd**

```
...
Aug 15 17:25:53.623743 advertising receiving-speaker only capabilty to neighbor
 192.163.6.4 (Internal AS 17)
Aug 15 17:25:53.631314 Initiated BFD session to peer 192.163.6.4 (Internal AS
17): address=192.163.6.4 ifindex=0 ifname=(none) txivl=1000 rxivl=1000 mult=3
ver=255
Aug 15 17:25:57.570932 BFD session to peer 192.163.6.4 (Internal AS 17) up
```

RELATED DOCUMENTATION

Example: Configuring BFD Authentication for BGP

Example: Configuring BFD for OSPF

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This example shows how to configure the Bidirectional Forwarding Detection (BFD) protocol for OSPF.

Requirements

Before you begin:

- Configure the device interfaces. See the *Junos OS Network Interfaces Library for Routing Devices*.
- Configure the router identifiers for the devices in your OSPF network. See *Example: Configuring an OSPF Router Identifier*.
- Control OSPF designated router election. See *Example: Controlling OSPF Designated Router Election*.
- Configure a single-area OSPF network. See *Example: Configuring a Single-Area OSPF Network*.
- Configure a multiarea OSPF network. See *Example: Configuring a Multiarea OSPF Network*.
- Configure a multiarea OSPF network. See *Example: Configuring a Multiarea OSPF Network*.

Overview

An alternative to adjusting the OSPF hello interval and dead interval settings to increase route convergence is to configure BFD. The BFD protocol is a simple hello mechanism that detects failures in a network. The BFD failure detection timers have shorter timer limits than the OSPF failure detection mechanisms, thereby providing faster detection.

BFD is useful on interfaces that are unable to detect failure quickly, such as Ethernet interfaces. Other interfaces, such as SONET interfaces, already have built-in failure detection. Configuring BFD on those interfaces is unnecessary.

You configure BFD on a pair of neighboring OSPF interfaces. Unlike the OSPF hello interval and dead interval settings, you do not have to enable BFD on all interfaces in an OSPF area.

In this example, you enable failure detection by including the **bfd-liveness-detection** statement on the neighbor OSPF interface **fe-0/1/0** in area 0.0.0.0 and configure the BFD packet exchange interval to 300 milliseconds, configure 4 as the number of missed hello packets that causes the originating interface to be declared down, and configure BFD sessions only for OSPF neighbors with full neighbor adjacency by including the following settings:

- **full-neighbors-only**—In Junos OS Release 9.5 and later, configures the BFD protocol to establish BFD sessions only for OSPF neighbors with full neighbor adjacency. The default behavior is to establish BFD sessions for all OSPF neighbors.
- **minimum-interval**—Configures the minimum interval, in milliseconds, after which the local routing device transmits hello packets as well as the minimum interval after which the routing device expects to receive a reply from the neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds. You can also specify the minimum transmit and receive intervals separately using the **transmit-interval minimum-interval** and **minimum-receive-interval** statements.

> **NOTE:** BFD is an intensive protocol that consumes system resources. Specifying a minimum interval for BFD of less than 100 ms for Routing Engine-based sessions and 10 ms for distributed BFD sessions can cause undesired BFD flapping.
>
> Depending on your network environment, these additional recommendations might apply:
>
> - For large-scale network deployments with a large number of BFD sessions, specify a minimum interval of no less than 500 ms. An interval of 1000 ms is recommended to avoid any instability issues.
>
>   > **NOTE:**
>   > - For the bfdd process, the detection time interval set is lower than 300 ms. If there is a high priority process such as ppmd running on the system, the CPU might spend time on the ppmd process rather than the bfdd process.
>   > - For branch SRX Series devices, we recommend 1000 ms as the minimum keepalive time interval for BFD packets.
>
> - For very large-scale network deployments with a large number of BFD sessions, contact Juniper Networks customer support for more information.
> - For BFD sessions to remain up during a Routing Engine switchover event when nonstop active routing (NSR) is configured, specify a minimum interval of 2500 ms for Routing Engine-based sessions. For distributed BFD sessions with NSR configured, the minimum interval recommendations are unchanged and depend only on your network deployment.

- **multiplier**—Configures the number of hello packets not received by a neighbor that causes the originating interface to be declared down. By default, three missed hello packets cause the originating interface to be declared down. You can configure a value in the range from 1 through 255.

Configuration

CLI Quick Configuration

To quickly configure the BFD protocol for OSPF, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, copy and paste the commands into the CLI at the [edit] hierarchy level, and then enter **commit** from configuration mode.

```
[edit]
set protocols ospf area 0.0.0.0 interface fe-0/0/1 bfd-liveness-detection minimum-interval 300
set protocols ospf area 0.0.0.0 interface fe-0/0/1 bfd-liveness-detection multiplier 4
set protocols ospf area 0.0.0.0 interface fe-0/0/1 bfd-liveness-detection full-neighbors-only
```

Step-by-Step Procedure

To configure the BFD protocol for OSPF on one neighboring interface:

1. Create an OSPF area.

   NOTE: To specify OSPFv3, include the **ospf3** statement at the **[edit protocols]** hierarchy level.

   ```
   [edit]
   user@host# edit protocols ospf area 0.0.0.0
   ```

2. Specify the interface.

   ```
   [edit protocols ospf area 0.0.0.0]
   user@host# set interface fe-0/0/1
   ```

3. Specify the minimum transmit and receive intervals.

   ```
   [edit protocols ospf area 0.0.0.0 ]
   user@host# set interface fe-0/0/1 bfd-liveness-detection minimum-interval 300
   ```

4. Configure the number of missed hello packets that cause the originating interface to be declared down.

```
[edit protocols ospf area 0.0.0.0 ]
user@host# set interface fe-0/0/1 bfd-liveness-detection multiplier 4
```

5. Configure BFD sessions only for OSPF neighbors with full neighbor adjacency.

```
[edit protocols ospf area 0.0.0.0 ]
user@host# set interface fe-0/0/1 bfd-liveness-detection full-neighbors-only
```

6. If you are done configuring the device, commit the configuration.

```
[edit protocols ospf area 0.0.0.0 ]
user@host# commit
```

NOTE: Repeat this entire configuration on the other neighboring interface.

Results

Confirm your configuration by entering the **show protocols ospf** command. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@host# show protocols ospf
area 0.0.0.0 {
    interface fe-0/0/1.0 {
        bfd-liveness-detection {
            minimum-interval 300;
            multiplier 4;
            full-neighbors-only;
        }
    }
}
```

To confirm your OSPFv3 configuration, enter the **show protocols ospf3** command.

Verification

Confirm that the configuration is working properly.

Verifying the BFD Sessions

Purpose

Verify that the OSPF interfaces have active BFD sessions, and that session components have been configured correctly.

Action

From operational mode, enter the **show bfd session detail** command.

Meaning

The output displays information about the BFD sessions.

- The Address field displays the IP address of the neighbor.
- The Interface field displays the interface you configured for BFD.
- The State field displays the state of the neighbor and should show Full to reflect the full neighbor adjacency that you configured.
- The Transmit Interval field displays the time interval you configured to send BFD packets.
- The Multiplier field displays the multiplier you configured.

Example: Configuring BFD for IS-IS

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This example describes how to configure the Bidirectional Forwarding Detection (BFD) protocol to detect failures in an IS-IS network.

> **NOTE:** BFD is not supported with ISIS for IPV6 on QFX10000 series switches.

Requirements

Before you begin, configure IS-IS on both routers. See *Example: Configuring IS-IS* for information about the required IS-IS configuration.

This example uses the following hardware and software components:

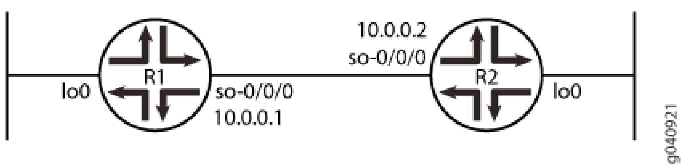
- Junos OS Release 7.3 or later
- M Series, MX Series, and T Series routers

Overview

This example shows two routers connected to each other. A loopback interface is configured on each router. IS-IS and BFD protocols are configured on both routers.

Figure 3 on page 60 shows the sample network.

Figure 3: Configuring BFD for IS-IS



Configuration

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

Router R1

```
set protocols isis interface so-0/0/0 bfd-liveness-detection detection-time threshold 5
set protocols isis interface so-0/0/0 bfd-liveness-detection minimum-interval 2
set protocols isis interface so-0/0/0 bfd-liveness-detection minimum-receive-interval 1
set protocols isis interface so-0/0/0 bfd-liveness-detection no-adaptation
set protocols isis interface so-0/0/0 bfd-liveness-detection transmit-interval threshold 3
set protocols isis interface so-0/0/0 bfd-liveness-detection transmit-interval minimum-interval 1
set protocols isis interface so-0/0/0 bfd-liveness-detection multiplier 2
set protocols isis interface so-0/0/0 bfd-liveness-detection version automatic
```

Router R2

```
set protocols isis interface so-0/0/0 bfd-liveness-detection detection-time threshold 6
set protocols isis interface so-0/0/0 bfd-liveness-detection minimum-interval 3
set protocols isis interface so-0/0/0 bfd-liveness-detection minimum-receive-interval 1
set protocols isis interface so-0/0/0 bfd-liveness-detection no-adaptation
set protocols isis interface so-0/0/0 bfd-liveness-detection transmit-interval threshold 4
set protocols isis interface so-0/0/0 bfd-liveness-detection transmit-interval minimum-interval 1
set protocols isis interface so-0/0/0 bfd-liveness-detection multiplier 2
set protocols isis interface so-0/0/0 bfd-liveness-detection version automatic
```

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see *Using the CLI Editor in Configuration Mode*.

> **NOTE:** To simply configure BFD for IS-IS, only the **minimum-interval** statement is required. The BFD protocol selects default parameters for all the other configuration statements when you use the **bfd-liveness-detection** statement without specifying any parameters.

> **NOTE:** You can change parameters at any time without stopping or restarting the existing session. BFD automatically adjusts to the new parameter value. However, no changes to BFD parameters take place until the values resynchronize with each BFD peer.

To configure BFD for IS-IS on Routers R1 and R2:

1. Enable BFD failure detection for IS-IS.

   ```
   [edit protocols isis]
   user@R1# set interface so-0/0/0 bfd-liveness-detection
   ```

   ```
   [edit protocols isis]
   user@R2# set interface so-0/0/0 bfd-liveness-detection
   ```

2. Configure the threshold for the adaptation of the detection time, which must be greater than the multiplier number multiplied by the minimum interval.

   ```
   [edit protocols isis interface so-0/0/0 bfd-liveness-detection]
   user@R1# set detection-time threshold 5
   ```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set detection-time threshold 6
```

3. Configure the minimum transmit and receive intervals for failure detection.

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R1# set minimum-interval 2
```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set minimum-interval 3
```

4. Configure only the minimum receive interval for failure detection.

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R1# set minimum-receive-interval 1
```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set minimum-receive-interval 1
```

5. Disable BFD adaptation.

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R1# set no-adaptation
```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set no-adaptation
```

6. Configure the threshold for the transmit interval, which must be greater than the minimum transmit interval.

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R1# set transmit-interval threshold 3
```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set transmit-interval threshold 4
```

7. Configure the minimum transmit interval for failure detection.

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R1# set transmit-interval minimum-interval 1
```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set transmit-interval minimum-interval 1
```

8. Configure the multiplier number, which is the number of hello packets not received by the neighbor that causes the originating interface to be declared down.

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R1# set multiplier 2
```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set multiplier 2
```

9. Configure the BFD version used for detection.

   The default is to have the version detected automatically.

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R1# set version automatic
```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set version automatic
```

Results

From configuration mode, confirm your configuration by issuing the **show protocols isis interface** command. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

`user@R1#` **show protocols isis interface so-0/0/0**

```
bfd-liveness-detection {
    version automatic;
    minimum-interval 2;
```

```
        minimum-receive-interval 1;
        multiplier 2;
        no-adaptation;
        transmit-interval {
            minimum-interval 1;
            threshold 3;
        }
        detection-time {
            threshold 5;
        }
}
...
```

user@R2# **show protocols isis interface so-0/0/0**

```
    bfd-liveness-detection {
        version automatic;
        minimum-interval 3;
        minimum-receive-interval 1;
        multiplier 2;
        no-adaptation;
        transmit-interval {
            minimum-interval 1;
            threshold 4;
        }
        detection-time {
            threshold 6;
        }
}
...
```

Verification

IN THIS SECTION

- Verifying the Connection Between Routers R1 and R2 | **65**
- Verifying That IS-IS Is Configured | **65**
- Verifying That BFD Is configured | **66**

Confirm that the configuration is working properly.

Verifying the Connection Between Routers R1 and R2

Purpose

Make sure that Routers R1 and R2 are connected to each other.

Action

Ping the other router to check the connectivity between the two routers as per the network topology.

`user@R1>` **ping 10.0.0.2**

```
PING 10.0.0.2 (10.0.0.2): 56 data bytes
64 bytes from 10.0.0.2: icmp_seq=0 ttl=64 time=1.367 ms
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=1.662 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=1.291 ms
^C
--- 10.0.0.2 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max/stddev = 1.291/1.440/1.662/0.160 ms
```

`user@R2>` **ping 10.0.0.1**

```
PING 10.0.0.1 (10.0.0.1): 56 data bytes
64 bytes from 10.0.0.1: icmp_seq=0 ttl=64 time=1.287 ms
64 bytes from 10.0.0.1: icmp_seq=1 ttl=64 time=1.310 ms
64 bytes from 10.0.0.1: icmp_seq=2 ttl=64 time=1.289 ms
^C
--- 10.0.0.1 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max/stddev = 1.287/1.295/1.310/0.010 ms
```

Meaning

Routers R1 and R2 are connected to each other.

Verifying That IS-IS Is Configured

Purpose

Make sure that the IS-IS instance is running on both routers.

Action

Use the **show isis database** statement to check if the IS-IS instance is running on both routers, R1 and R2.

`user@R1>` **show isis database**

```
IS-IS level 1 link-state database:
LSP ID         Sequence Checksum Lifetime Attributes
R1.00-00       0x4a571   0x30c5     1195 L1 L2
R2.00-00       0x4a586   0x4b7e     1195 L1 L2
R2.02-00       0x330ca1  0x3492     1196 L1 L2
  3 LSPs

IS-IS level 2 link-state database:
LSP ID         Sequence Checksum Lifetime Attributes
R1.00-00       0x4a856   0x5db0     1194 L1 L2
R2.00-00       0x4a89d   0x149b     1194 L1 L2
R2.02-00       0x1fb2ff  0xd302     1194 L1 L2
  3 LSPs
```

`user@R2>` **show isis database**

```
IS-IS level 1 link-state database:
LSP ID            Sequence Checksum Lifetime Attributes
R1.00-00          0x4b707   0xcc80     1195 L1 L2
R2.00-00          0x4b71b   0xeb37     1198 L1 L2
R2.02-00          0x33c2ce  0xb52d     1198 L1 L2
  3 LSPs

IS-IS level 2 link-state database:
LSP ID             Sequence Checksum Lifetime Attributes
R1.00-00           0x4b9f2   0xee70     1192 L1 L2
R2.00-00           0x4ba41   0x9862     1197 L1 L2
R2.02-00               0x3   0x6242     1198 L1 L2
  3 LSPs
```

Meaning

IS-IS is configured on both routers, R1 and R2.

Verifying That BFD Is configured

Purpose

Make sure that the BFD instance is running on both routers, R1 and R2.

Action

Use the **show bfd session detail** statement to check if BFD instance is running on the routers.

user@R1> **show bfd session detail**

```
                                                  Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
10.0.0.2                 Up        so-0/0/0      2.000     1.000        2
 Client ISIS R2, TX interval 0.001, RX interval 0.001
 Client ISIS R1, TX interval 0.001, RX interval 0.001
 Session down time 00:00:00, previous up time 00:00:15
 Local diagnostic NbrSignal, remote diagnostic NbrSignal
 Remote state AdminDown, version 1
 Router 3, routing table index 17

1 sessions, 2 clients
Cumulative transmit rate 1.0 pps, cumulative receive rate 1.0 pps
```

user@R2> **show bfd session detail**

```
                                                  Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
10.0.0.1                 Up        so-0/0/0      2.000     1.000        2
 Client ISIS R2, TX interval 0.001, RX interval 0.001
 Session down time 00:00:00, previous up time 00:00:05
 Local diagnostic NbrSignal, remote diagnostic NbrSignal
 Remote state AdminDown, version 1
 Router 2, routing table index 15

1 sessions, 1 clients
Cumulative transmit rate 1.0 pps, cumulative receive rate 1.0 pps
```

Meaning

BFD is configured on Routers R1 and R2 for detecting failures in the IS-IS network.

RELATED DOCUMENTATION

Understanding BFD for IS-IS | 20

Example: Configuring BFD for RIP

IN THIS SECTION

- Requirements | 68
- Overview | 68
- Configuration | 70
- Verification | 73

This example shows how to configure Bidirectional Forwarding Detection (BFD) for a RIP network.

Requirements

No special configuration beyond device initialization is required before configuring this example.

Overview

To enable failure detection, include the **bfd-liveness-detection** statement:

```
bfd-liveness-detection {
    detection-time {
        threshold milliseconds;
    }
    minimum-interval milliseconds;
    minimum-receive-interval milliseconds;
    multiplier number;
    no-adaptation;
    transmit-interval {
        threshold milliseconds;
        minimum-interval milliseconds;
    }
    version (1 | automatic);
}
```

Optionally, you can specify the threshold for the adaptation of the detection time by including the **threshold** statement. When the BFD session detection time adapts to a value equal to or greater than the threshold, a single trap and a system log message are sent.

To specify the minimum transmit and receive interval for failure detection, include the **minimum-interval** statement. This value represents the minimum interval at which the local routing device transmits hello packets as well as the minimum interval at which the routing device expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds. This examples sets a minimum interval of 600 milliseconds.

NOTE: BFD is an intensive protocol that consumes system resources. Specifying a minimum interval for BFD of less than 100 ms for Routing Engine-based sessions and 10 ms for distributed BFD sessions can cause undesired BFD flapping.

Depending on your network environment, these additional recommendations might apply:

- For large-scale network deployments with a large number of BFD sessions, specify a minimum interval of 300 ms for Routing Engine-based sessions and 100 ms for distributed BFD sessions.
- For very large-scale network deployments with a large number of BFD sessions, contact Juniper Networks customer support for more information.
- For BFD sessions to remain up during a Routing Engine switchover event when nonstop active routing (NSR) is configured, specify a minimum interval of 2500 ms for Routing Engine-based sessions. For distributed BFD sessions with nonstop active routing configured, the minimum interval recommendations are unchanged and depend only on your network deployment.

You can optionally specify the minimum transmit and receive intervals separately.

To specify only the minimum receive interval for failure detection, include the **minimum-receive-interval** statement. This value represents the minimum interval at which the local routing device expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,00 milliseconds.

To specify only the minimum transmit interval for failure detection, include the **transmit-interval minimum-interval** statement. This value represents the minimum interval at which the local routing device transmits hello packets to the neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds.

To specify the number of hello packets not received by a neighbor that causes the originating interface to be declared down, include the **multiplier** statement. The default is 3, and you can configure a value in the range from 1 through 255.

To specify the threshold for detecting the adaptation of the transmit interval, include the **transmit-interval threshold** statement. The threshold value must be greater than the transmit interval.

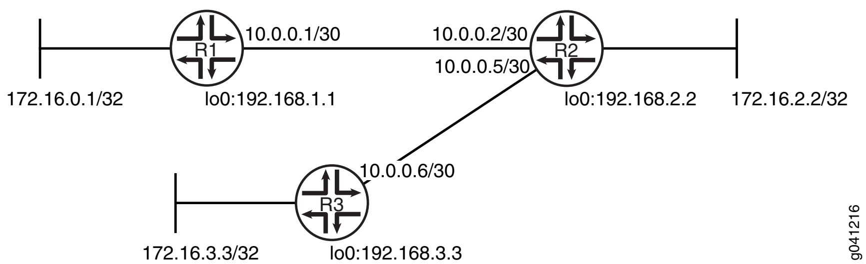
To specify the BFD version used for detection, include the **version** statement. The default is to have the version detected automatically.

You can trace BFD operations by including the **traceoptions** statement at the **[edit protocols bfd]** hierarchy level.

In Junos OS Release 9.0 and later, you can configure BFD sessions not to adapt to changing network conditions. To disable BFD adaptation, include the **no-adaptation** statement. We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation enabled in your network.

Figure 4 on page 70 shows the topology used in this example.

Figure 4: RIP BFD Network Topology



"CLI Quick Configuration" on page 70 shows the configuration for all of the devices in Figure 4 on page 70. The section "Step-by-Step Procedure" on page 71 describes the steps on Device R1.

Configuration

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

Device R1

```
set interfaces fe-1/2/0 unit 1 family inet address 10.0.0.1/30
set protocols bfd traceoptions file bfd-trace
set protocols bfd traceoptions flag all
set protocols rip group rip-group export advertise-routes-through-rip
set protocols rip group rip-group neighbor fe-1/2/0.1
set protocols rip group rip-group bfd-liveness-detection minimum-interval 600
set policy-options policy-statement advertise-routes-through-rip term 1 from protocol direct
set policy-options policy-statement advertise-routes-through-rip term 1 from protocol rip
set policy-options policy-statement advertise-routes-through-rip term 1 then accept
```

Device R2

```
set interfaces fe-1/2/0 unit 2 family inet address 10.0.0.2/30
set interfaces fe-1/2/1 unit 5 family inet address 10.0.0.5/30
set protocols rip group rip-group export advertise-routes-through-rip
set protocols rip group rip-group neighbor fe-1/2/0.2
set protocols rip group rip-group neighbor fe-1/2/1.5
set protocols rip group rip-group bfd-liveness-detection minimum-interval 600
set policy-options policy-statement advertise-routes-through-rip term 1 from protocol direct
set policy-options policy-statement advertise-routes-through-rip term 1 from protocol rip
set policy-options policy-statement advertise-routes-through-rip term 1 then accept
```

Device R3

```
set interfaces fe-1/2/0 unit 6 family inet address 10.0.0.6/30
set protocols rip group rip-group export advertise-routes-through-rip
set protocols rip group rip-group neighbor fe-1/2/0.6
set protocols rip group rip-group bfd-liveness-detection minimum-interval 600
set policy-options policy-statement advertise-routes-through-rip term 1 from protocol direct
set policy-options policy-statement advertise-routes-through-rip term 1 from protocol rip
set policy-options policy-statement advertise-routes-through-rip term 1 then accept
```

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see *Using the CLI Editor in Configuration Mode* in the *CLI User Guide*.

To configure a BFD for a RIP network:

1. Configure the network interfaces.

   ```
   [edit interfaces]
   user@R1# set fe-1/2/0 unit 1 family inet address 10.0.0.1/30
   ```

2. Create the RIP group and add the interface.

   To configure RIP in Junos OS, you must configure a group that contains the interfaces on which RIP is enabled. You do not need to enable RIP on the loopback interface.

   ```
   [edit protocols rip group rip-group]
   user@R1# set neighbor fe-1/2/0.1
   ```

3. Create the routing policy to advertise both direct and RIP-learned routes.

```
[edit policy-options policy-statement advertise-routes-through-rip term 1]
user@R1# set from protocol direct
user@R1# set from protocol rip
user@R1# set then accept
```

4. Apply the routing policy.

   In Junos OS, you can only apply RIP export policies at the group level.

```
[edit protocols rip group rip-group]
user@R1# set export advertise-routes-through-rip
```

5. Enable BFD.

```
[edit protocols rip group rip-group]
user@R1# set bfd-liveness-detection minimum-interval 600
```

6. Configure tracing operations to track BFD messages.

```
[edit protocols bfd traceoptions]
user@R1# set file bfd-trace
user@R1# set flag all
```

Results

From configuration mode, confirm your configuration by entering the **show interfaces**, **show protocols**, and **show policy-options** commands. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
user@R1# show interfaces
fe-1/2/0 {
    unit 1 {
        family inet {
            address 10.0.0.1/30;
        }
    }
}
```

```
user@R1# show protocols
bfd {
    traceoptions {
        file bfd-trace;
        flag all;
    }
}
rip {
    group rip-group {
        export advertise-routes-through-rip;
        bfd-liveness-detection {
            minimum-interval 600;
        }
        neighbor fe-1/2/0.1;
    }
}
```

```
user@R1# show policy-options
policy-statement advertise-routes-through-rip {
    term 1 {
        from protocol [ direct rip ];
        then accept;
    }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Verification

IN THIS SECTION

- Verifying That the BFD Sessions Are Up | 73
- Checking the BFD Trace File | 74

Confirm that the configuration is working properly.

Verifying That the BFD Sessions Are Up

Purpose

Make sure that the BFD sessions are operating.

Action

From operational mode, enter the **show bfd session** command.

`user@R1>` **show bfd session**

```
                                                  Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
10.0.0.2                 Up        fe-1/2/0.1     1.800     0.600        3

1 sessions, 1 clients
Cumulative transmit rate 1.7 pps, cumulative receive rate 1.7 pps
```

Meaning

The output shows that there are no authentication failures.

Checking the BFD Trace File

Purpose

Use tracing operations to verify that BFD packets are being exchanged.

Action

From operational mode, enter the **show log** command.

`user@R1>` **show log bfd-trace**

```
Feb 16 10:26:32 PPM Trace: BFD periodic xmit to 10.0.0.2 (IFL 124, rtbl 53,
single-hop port)
Feb 16 10:26:32 Received Downstream TraceMsg (24) len 86:
Feb 16 10:26:32    IfIndex (3) len 4: 0
Feb 16 10:26:32    Protocol (1) len 1: BFD
Feb 16 10:26:32    Data (9) len 61: (hex) 42 46 44 20 70 61 63 6b 65 74 20 66 72
6f 6d 20 31 30 2e
Feb 16 10:26:32 PPM Trace: BFD packet from 10.0.0.1 (IFL 73, rtbl 56, ttl 255)
absorbed
Feb 16 10:26:32 Received Downstream TraceMsg (24) len 60:
Feb 16 10:26:32    IfIndex (3) len 4: 0
Feb 16 10:26:32    Protocol (1) len 1: BFD
Feb 16 10:26:32    Data (9) len 35: (hex) 42 46 44 20 70 65 72 69 6f 64 69 63 20
78 6d 69 74 20 6f
...
```

Meaning

The output shows the normal functioning of BFD.

Configuring Micro BFD Sessions for LAG

The Bidirectional Forwarding Detection (BFD) protocol is a simple detection protocol that quickly detects failures in the forwarding paths. A link aggregation group (LAG) combines multiple links between devices that are in point-to-point connections, thereby increasing bandwidth, providing reliability, and allowing load balancing. To run a BFD session on LAG interfaces, configure an independent, asynchronous mode BFD session on every LAG member link in a LAG bundle. Instead of a single BFD session monitoring the status of the UDP port, independent micro BFD sessions monitor the status of individual member links.

> **NOTE:** Starting in Junos OS Evolved Release 20.1R1, independent micro Bidirectional Forwarding Detection (BFD) sessions are enabled on a per member link basis of a Link Aggregation Group (LAG) bundle.

To enable failure detection for aggregated Ethernet interfaces:

1. Include the following statement in the configuration at the **[edit interfaces *aex* aggregated-ether-options]** hierarchy level:

```
bfd-liveness-detection
```

2. Configure the authentication criteria of the BFD session for LAG.

   To specify the authentication criteria, include the **authentication** statement:

```
bfd-liveness-detection {
   authentication {
      algorithm algorithm-name;
      key-chain key-chain-name;
      loose-check;
   }
}
```

   - Specify the algorithm to be used to authenticate the BFD session. You can use one of the following algorithms for authentication:
     - keyed-md5
     - keyed-sha-1
     - meticulous-keyed-md5
     - meticulous-keyed-sha-1
     - simple-password

- To configure the key chain, specify the name that is associated with the security key for the BFD session. The name you specify must match one of the key chains configured in the **authentication-key-chains *key-chain*** statement at the **[edit security]** hierarchy level.
- Configure loose authentication checking on the BFD session. Use only for transitional periods when authentication might not be configured at both ends of the BFD session.

3. Configure BFD timers for aggregated Ethernet interfaces.

   To specify the BFD timers, include the **detection-time** statement:

```
bfd-liveness-detection {
   detection-time {
      threshold  milliseconds;
   }
}
```

   Specify the threshold value. This is the maximum time interval for detecting a BFD neighbor. If the transmit interval is greater than this value, the device triggers a trap.

4. Configure a hold-down interval value to set the minimum time that the BFD session must remain up before a state change notification is sent to the other members in the LAG network.

   To specify the hold-down interval, include the **holddown-interval** statement:

```
bfd-liveness-detection {
   holddown-interval milliseconds;
}
```

   You can configure a number in the range from 0 through 255,000 milliseconds, and the default is 0. If the BFD session goes down and then comes back up during the hold-down interval, the timer is restarted.

   This value represents the minimum interval at which the local routing device transmits BFD packets, as well as the minimum interval in which the routing device expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds. You can also specify the minimum transmit and receive intervals separately.

5. Configure the source address for the BFD session.

   To specify a local address, include the **local-address** statement:

```
bfd-liveness-detection {
   local-address bfd-local-address;
}
```

   The BFD local address is the loopback address of the source of the BFD session.

NOTE: Beginning with Junos OS Release 16.1, you can also configure this feature with the AE interface address as the local address in a micro BFD session. For the IPv6 address family, disable duplicate address detection before configuring this feature with the AE interface address. To disable duplicate address detection, include the **dad-disable** statement at the **[edit interface *aex* unit *y* family inet6]** hierarchy level.

Beginning with Release 16.1R2, Junos OS checks and validates the configured micro BFD **local-address** against the interface or loopback IP address before the configuration commit. Junos OS performs this check on both IPv4 and IPv6 micro BFD address configurations, and if they do not match, the commit fails.

6. Specify the minimum interval that indicates the time interval for transmitting and receiving data.

   This value represents the minimum interval at which the local routing device transmits BFD packets, as well as the minimum interval in which the routing device expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds. You can also specify the minimum transmit and receive intervals separately.

   To specify the minimum transmit and receive intervals for failure detection, include the **minimum-interval** statement:

   ```
   bfd-liveness-detection {
       minimum-interval milliseconds;
   }
   ```

NOTE: BFD is an intensive protocol that consumes system resources. Specifying a minimum interval for BFD less than 100 ms for Routing Engine-based sessions and 10 ms for distributed BFD sessions can cause undesired BFD flapping.

Depending on your network environment, these additional recommendations might apply:

- For large-scale network deployments with a large number of BFD sessions, specify a minimum interval of 300 ms for Routing Engine-based sessions and 100 ms for distributed BFD sessions.
- For very large-scale network deployments with a large number of BFD sessions, contact Juniper Networks customer support for more information.
- For BFD sessions to remain up during a Routing Engine switchover event when nonstop active routing is configured, specify a minimum interval of 2500 ms for Routing Engine-based sessions. For distributed BFD sessions with nonstop active routing configured, the minimum interval recommendations are unchanged and depend only on your network deployment.

7. Specify only the minimum receive interval for failure detection by including the **minimum-receive-interval** statement:

   ```
   bfd-liveness-detection {
     minimum-receive-interval milliseconds;
   }
   ```

   This value represents the minimum interval in which the local routing device expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds.

8. Specify the number of BFD packets that were not received by the neighbor that causes the originating interface to be declared down by including the **multiplier** statement:

   ```
   bfd-liveness-detection {
     multiplier number;
   }
   ```

   The default value is 3. You can configure a number in the range from 1 through 255.

9. Configure the neighbor in a BFD session.

   The neighbor address can be either an IPv4 or an IPv6 address.

   To specify the next hop of the BFD session, include the **neighbor** statement:

```
bfd-liveness-detection {
    neighbor bfd-neighbor-address;
}
```

The BFD neighbor address is the loopback address of the remote destination of the BFD session.

NOTE: Beginning with Junos OS Release 16.1, you can also configure the AE interface address of the remote destination as the BFD neighbor address in a micro BFD session.

10. (Optional) Configure BFD sessions not to adapt to changing network conditions.

    To disable BFD adaptation, include the **no-adaptation** statement:

```
bfd-liveness-detection {
    no-adaptation;
}
```

NOTE: We recommend that you do not disable BFD adaptation unless it is preferable not to have BFD adaptation in your network.

11. Specify a threshold for detecting the adaptation of the detection time by including the **threshold** statement:

```
bfd-liveness-detection {
    detection-time {
        threshold milliseconds;
    }
}
```

When the BFD session detection time adapts to a value equal to or greater than the threshold, a single trap and a system log message are sent. The detection time is based on the multiplier of the minimum-interval or the minimum-receive-interval value. The threshold must be a higher value than the multiplier for either of these configured values. For example, if the minimum-receive-interval is 300 ms and the multiplier is 3, the total detection time is 900 ms. Therefore, the detection time threshold must have a value greater than 900.

12. Specify only the minimum transmit interval for failure detection by including the **transmit-interval minimum-interval** statement:

```
bfd-liveness-detection {
    transmit-interval {
        minimum-interval milliseconds;
    }
}
```

This value represents the minimum interval at which the local routing device transmits BFD packets to the neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds.

13. Specify the transmit threshold for detecting the adaptation of the transmit interval by including the **transmit-interval threshold** statement:

```
bfd-liveness-detection {
    transmit-interval {
        threshold milliseconds;
    }
}
```

The threshold value must be greater than the transmit interval. When the BFD session detection time adapts to a value greater than the threshold, a single trap and a system log message are sent. The detection time is based on the multiplier of the minimum-interval or the minimum-receive-interval value. The threshold must be a higher value than the multiplier for either of these configured values.

14. Specify the BFD version by including the **version** statement:

```
bfd-liveness-detection {
    version (1 | automatic);
}
```

The default is to have the version detected automatically.

NOTE:

- The **version** option is not supported on the QFX Series. Starting in Junos OS Release 17.2R1, a warning will appear if you attempt to use this command.
- This feature works when both the devices support BFD. If BFD is configured at only one end of the LAG, this feature does not work.

RELATED DOCUMENTATION

authentication

bfd-liveness-detection

detection-time

Example: Configuring Independent Micro BFD Sessions for LAG

Example: Configuring Independent Micro BFD Sessions for LAG

IN THIS SECTION

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- Overview | 82
- Configuration | 82
- Verification | 89

This example shows how to configure an independent micro BFD session for aggregated Ethernet interfaces.

Requirements

This example uses the following hardware and software components:

- MX Series routers with Junos Trio chipset
- T Series routers with Type 4 FPC or Type 5 FPC

  BFD for LAG is supported on the following PIC types on T-Series:

  - PC-1XGE-XENPAK (Type 3 FPC),
  - PD-4XGE-XFP (Type 4 FPC),
  - PD-5-10XGE-SFPP (Type 4 FPC),
  - 24x10GE (LAN/WAN) SFPP, 12x10GE (LAN/WAN) SFPP, 1X100GE Type 5 PICs
- PTX Series routers with 24X10GE (LAN/WAN) SFPP
- Junos OS Release 13.3 or later running on all devices

Overview

The example includes two routers that are directly connected. Configure two aggregated Ethernet interfaces, AE0 for IPv4 connectivity and AE1 for IPv6 connectivity. Configure micro BFD session on the AE0 bundle using IPv4 addresses as local and neighbor endpoints on both routers. Configure micro BFD session on the AE1 bundle using IPv6 addresses as local and neighbor endpoints on both routers. This example verifies that independent micro BFD sessions are active in the output.

Topology

Figure 5 on page 82 shows the sample topology.

Figure 5: Configuring an Independent Micro BFD Session for LAG

Configuration

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

Router R0

```
set interfaces ge-1/0/1 unit 0 family inet address 20.20.20.1/30
set interfaces ge-1/0/1 unit 0 family inet6 address 3ffe::1:1/126
set interfaces xe-4/0/0 gigether-options 802.3ad ae0
set interfaces xe-4/0/1 gigether-options 802.3ad ae0
set interfaces xe-4/1/0 gigether-options 802.3ad ae1
set interfaces xe-4/1/1 gigether-options 802.3ad ae1
set interfaces lo0 unit 0 family inet address 10.255.106.107/32
set interfaces lo0 unit 0 family inet6 address 201:DB8:251::aa:aa:1/126
set interfaces ae0 aggregated-ether-options bfd-liveness-detection minimum-interval 100
set interfaces ae0 aggregated-ether-options bfd-liveness-detection neighbor 10.255.106.102
set interfaces ae0 aggregated-ether-options bfd-liveness-detection local-address 10.255.106.107
set interfaces ae0 aggregated-ether-options minimum-links 1
set interfaces ae0 aggregated-ether-options link-speed 10g
set interfaces ae0 aggregated-ether-options lacp active
set interfaces ae0 unit 0 family inet address 10.0.0.1/30
```

```
set interfaces ae1 aggregated-ether-options bfd-liveness-detection minimum-interval 100
set interfaces ae1 aggregated-ether-options bfd-liveness-detection multiplier 3
set interfaces ae1 aggregated-ether-options bfd-liveness-detection neighbor 201:DB8:251::bb:bb:1
set interfaces ae1 aggregated-ether-options bfd-liveness-detection local-address 201:DB8:251::aa:aa:1
set interfaces ae1 aggregated-ether-options minimum-links 1
set interfaces ae1 aggregated-ether-options link-speed 10g
set interfaces ae1 aggregated-ether-options lacp active
set interfaces ae1 unit 0 family inet6 address 5555::1/126
set interface ae1 unit 0 family inet6 dad-disable
set routing-options nonstop-routing
set routing-options static route 30.30.30.0/30 next-hop 10.0.0.2
set routing-options rib inet6.0 static route 3ffe::1:2/126 next-hop 5555::2
set protocols bfd traceoptions file bfd
set protocols bfd traceoptions file size 100m
set protocols bfd traceoptions file files 10
set protocols bfd traceoptions flag all
```

Router R1

```
set interfaces ge-1/1/8 unit 0 family inet address 30.30.30.1/30
set interfaces ge-1/1/8 unit 0 family inet6 address 3ffe::1:2/126
set interfaces xe-0/0/0 gigether-options 802.3ad ae0
set interfaces xe-0/0/1 gigether-options 802.3ad ae0
set interfaces xe-0/0/2 gigether-options 802.3ad ae1
set interfaces xe-0/0/3 gigether-options 802.3ad ae1
set interfaces lo0 unit 0 family inet address 10.255.106.102/32
set interfaces lo0 unit 0 family inet6 address 201:DB8:251::bb:bb:1/126
set interfaces ae0 aggregated-ether-options bfd-liveness-detection minimum-interval 150
set interfaces ae0 aggregated-ether-options bfd-liveness-detection multiplier 3
set interfaces ae0 aggregated-ether-options bfd-liveness-detection neighbor 10.255.106.107
set interfaces ae0 aggregated-ether-options bfd-liveness-detection local-address 10.255.106.102
set interfaces ae0 aggregated-ether-options minimum-links 1
set interfaces ae0 aggregated-ether-options link-speed 10g
set interfaces ae0 aggregated-ether-options lacp passive
set interfaces ae0 unit 0 family inet address 10.0.0.2/30
set interfaces ae1 aggregated-ether-options bfd-liveness-detection minimum-interval 200
set interfaces ae1 aggregated-ether-options bfd-liveness-detection multiplier 3
set interfaces ae1 aggregated-ether-options bfd-liveness-detection neighbor 201:DB8:251::aa:aa:1
set interfaces ae1 aggregated-ether-options bfd-liveness-detection local-address 201:DB8:251::bb:bb:1
set interfaces ae1 aggregated-ether-options minimum-links 1
```

```
set interfaces ae1 aggregated-ether-options link-speed 10g
set interfaces ae1 aggregated-ether-options lacp passive
set interfaces ae1 unit 0 family inet6 address 5555::2/126
set routing-options static route 20.20.20.0/30 next-hop 10.0.0.1
set routing-options rib inet6.0 static route 3ffe::1:1/126 next-hop 5555::1
```

Configuring a Micro BFD Session for Aggregated Ethernet Interfaces

Step-by-Step Procedure

The following example requires that you navigate various levels in the configuration hierarchy. For information about navigating the CLI, see "*Using the CLI Editor in Configuration Mode*" in the *CLI User Guide*.

> **NOTE:** Repeat this procedure for Router R1, modifying the appropriate interface names, addresses, and any other parameters for each router.

To configure a micro BFD session for aggregated Ethernet interfaces on Router R0:

1. Configure the physical interfaces.

```
[edit interfaces]
user@R0# set ge-1/0/1 unit 0 family inet address 20.20.20.1/30
user@R0# set ge-1/0/1 unit 0 family inet6 address 3ffe::1:1/126
user@R0# set xe-4/0/0 gigether-options 802.3ad ae0
user@R0# set xe-4/0/1 gigether-options 802.3ad ae0
user@R0# set xe-4/1/0 gigether-options 802.3ad ae1
user@R0# set xe-4/1/1 gigether-options 802.3ad ae1
```

2. Configure the loopback interface.

```
[edit interfaces]
user@R0# set lo0 unit 0 family inet address 10.255.106.107/32
user@R0# set lo0 unit 0 family inet6 address 201:DB8:251::aa:aa:1/128
```

3. Configure an IP address on the aggregated Ethernet interface ae0 with either IPv4 or IPv6 addresses, as per your network requirements.

```
[edit interfaces]
```

```
user@R0# set ae0 unit 0 family inet address 10.0.0.1/30
```

4. Set the routing option, create a static route, and set the next-hop address.

   NOTE: You can configure either an IPv4 or IPv6 static route, depending on your network requirements.

```
[edit routing-options]
user@R0# set nonstop-routing
user@R0# set static route 30.30.30.0/30 next-hop 10.0.0.2
user@R0# set rib inet6.0 static route 3ffe::1:2/126 next-hop 5555::2
```

5. Configure the Link Aggregation Control Protocol (LACP).

```
[edit interfaces]
user@R0# set ae0 aggregated-ether-options lacp active
```

6. Configure BFD for the aggregated Ethernet interface ae0, and specify the minimum interval, local IP address, and the neighbor IP address.

```
[edit interfaces]
user@R0# set ae0 aggregated-ether-options bfd-liveness-detection minimum-interval 100
user@R0# set ae0 aggregated-ether-options bfd-liveness-detection multiplier 3
user@R0# set ae0 aggregated-ether-options bfd-liveness-detection neighbor 10.255.106.102
user@R0# set ae0 aggregated-ether-options bfd-liveness-detection local-address 10.255.106.107
user@R0# set ae0 aggregated-ether-options minimum-links 1
user@R0# set ae0 aggregated-ether-options link-speed 10g
```

7. Configure an IP addresse on the aggregated Ethernet interface ae1.

   You can assign either IPv4 or IPv6 addresses as per your network requirements.

```
[edit interfaces]
user@R0# set ae1 unit 0 family inet6 address 5555::1/126
```

8. Configure BFD for the aggregated Ethernet interface ae1.

```
[edit interfaces]
user@R0# set ae1 aggregated-ether-options bfd-liveness-detection minimum-interval 100
user@R0# set ae1 aggregated-ether-options bfd-liveness-detection multiplier 3
user@R0# set ae1 aggregated-ether-options bfd-liveness-detection neighbor 201:DB8:251::bb:bb:1
user@R0# set ae1 aggregated-ether-options bfd-liveness-detection local-address 201:DB8:251::aa:aa:1
user@R0# set ae1 aggregated-ether-options minimum-links 1
user@R0# set ae1 aggregated-ether-options link-speed 10g
```

NOTE: Beginning with Junos OS Release 16.1, you can also configure this feature with the AE interface address as the local address in a micro BFD session.

Beginning with Release 16.1R2, Junos OS checks and validates the configured micro BFD **local-address** against the interface or loopback IP address before the configuration commit. Junos OS performs this check on both IPv4 and IPv6 micro BFD address configurations, and if they do not match, the commit fails.

9. Configure tracing options for BFD for troubleshooting.

```
[edit protocols]
user@R0# set bfd traceoptions file bfd
user@R0# set bfd traceoptions file size 100m
user@R0# set bfd traceoptions file files 10
user@R0# set bfd traceoptions flag all
```

Results

From configuration mode, enter the **show interfaces**, **show protocols**, and **show routing-options** commands and confirm your configuration. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@R0> show interfaces
traceoptions {
  flag bfd-events;
}
ge-1/0/1 {
  unit 0 {
    family inet {
      address 20.20.20.1/30;
    }
```

```
        family inet6 {
            address 3ffe::1:1/126;
        }
    }
}
xe-4/0/0 {
    enable;
    gigether-options {
        802.3ad ae0;
    }
}
xe-4/0/1 {
    gigether-options {
        802.3ad ae0;
    }
}
xe-4/1/0 {
    enable;
    gigether-options {
        802.3ad ae1;
    }
}
xe-4/1/1 {
    gigether-options {
        802.3ad ae1;
    }
}
lo0 {
    unit 0 {
        family inet {
            address 10.255.106.107/32;
        }
        family inet6 {
            address 201:DB8:251::aa:aa:1/128;
        }
    }
}
ae0 {
    aggregated-ether-options {
        bfd-liveness-detection {
            minimum-interval 100;
            neighbor 10.255.106.102;
            local-address 10.255.106.107;
        }
```

```
        minimum-links 1;
        link-speed 10g;
        lacp {
            active;
        }
    }
    unit 0 {
        family inet {
            address 10.0.0.1/30;
        }
    }
}
ae1 {
    aggregated-ether-options {
        bfd-liveness-detection {
            minimum-interval 100;
            multiplier 3;
            neighbor 201:DB8:251::bb:bb:1;
            local-address 201:DB8:251::aa:aa:1;
        }
        minimum-links 1
        link-speed 10g;
    }
    unit 0 {
        family inet6 {
            address 5555::1/126;
        }
    }
}
```

```
user@R0> show protocols
bfd {
    traceoptions {
        file bfd size 100m files 10;
        flag all;
    }
}
```

```
user@R0> show routing-options
nonstop-routing ;
    rib inet6.0 {
    static {
        route 3ffe:1:2/126 {
```

```
            next-hop 5555::2;
        }
    }
}
static {
    route 30.30.30.0/30 {
        next-hop 10.0.0.2;
    }
}
```

If you are done configuring the device, commit the configuration.

```
user@R0# commit
```

Verification

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- Viewing Detailed BFD Events | 91

Confirm that the configuration is working properly.

Verifying That the Independent BFD Sessions Are Up

Purpose

Verify that the micro BFD sessions are up, and view details about the BFD sessions.

Action

From operational mode, enter the **show bfd session extensive** command.

`user@R0>` **show bfd session extensive**

```
                                                   Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
10.255.106.102                 Up        xe-4/0/0       9.000     3.000        3

 Client LACPD, TX interval 0.100, RX interval 0.100
```

```
 Session up time 4d 23:13, previous down time 00:00:06
 Local diagnostic None, remote diagnostic None
 Remote heard, hears us, version 1
 Replicated
 Session type: Micro BFD
 Min async interval 0.100, min slow interval 1.000
 Adaptive async TX interval 0.100, RX interval 0.100
 Local min TX interval 0.100, minimum RX interval 0.100, multiplier 3
 Remote min TX interval 3.000, min RX interval 3.000, multiplier 3
 Local discriminator 21, remote discriminator 75
 Echo mode disabled/inactive
 Remote is control-plane independent
  Session ID: 0x0

                                                  Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
10.255.106.102                 Up        xe-4/0/1       9.000     3.000        3

 Client LACPD, TX interval 0.100, RX interval 0.100
 Session up time 4d 23:13, previous down time 00:00:07
 Local diagnostic None, remote diagnostic None
 Remote heard, hears us, version 1
 Replicated
 Session type: Micro BFD
 Min async interval 0.100, min slow interval 1.000
 Adaptive async TX interval 0.100, RX interval 0.100
 Local min TX interval 0.100, minimum RX interval 0.100, multiplier 3
 Remote min TX interval 3.000, min RX interval 3.000, multiplier 3
 Local discriminator 19, remote discriminator 74
 Echo mode disabled/inactive
 Remote is control-plane independent
  Session ID: 0x0

                                                  Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
201:DB8:251::bb:bb:1                  Up        xe-4/1/1       9.000     3.000
     3
 Client LACPD, TX interval 0.100, RX interval 0.100
 Session up time 4d 23:13
 Local diagnostic None, remote diagnostic None
 Remote not heard, hears us, version 1
 Replicated
 Session type: Micro BFD
 Min async interval 0.100, min slow interval 1.000
```

```
 Adaptive async TX interval 0.100, RX interval 0.100
 Local min TX interval 1.000, minimum RX interval 0.100, multiplier 3
 Remote min TX interval 3.000, min RX interval 3.000, multiplier 3
 Local discriminator 17, remote discriminator 67
 Echo mode disabled/inactive, no-absorb, no-refresh
 Remote is control-plane independent
  Session ID: 0x0

                                                Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
201:DB8:251::bb:bb:1                 UP        xe-4/1/0       9.000     3.000
     3
 Client LACPD, TX interval 0.100, RX interval 0.100
 Session up time 4d 23:13
 Local diagnostic None, remote diagnostic None
 Remote not heard, hears us, version 1
 Replicated
 Session type: Micro BFD
 Min async interval 0.100, min slow interval 1.000
 Adaptive async TX interval 0.100, RX interval 0.100
 Local min TX interval 1.000, minimum RX interval 0.100, multiplier 3
 Remote min TX interval 3.000, min RX interval 3.000, multiplier 3
 Local discriminator 16, remote discriminator 66
 Echo mode disabled/inactive, no-absorb, no-refresh
 Remote is control-plane independent
  Session ID: 0x0

4 sessions, 4 clients
Cumulative transmit rate 2.0 pps, cumulative receive rate 1.7 pps
```

Meaning

The Micro BFD field represents the independent micro BFD sessions running on the links in a LAG. The TX interval *item*, RX interval *item* output represents the setting configured with the **minimum-interval** statement. All of the other output represents the default settings for BFD. To modify the default settings, include the optional statements under **bfd-liveness-detection** statement.

Viewing Detailed BFD Events

Purpose

View the contents of the BFD trace file to assist in troubleshooting, if required.

Action

From operational mode, enter the **file show /var/log/bfd** command.

`user@R0>` **file show /var/log/bfd**

```
Jun  5 00:48:59    Protocol (1) len 1: BFD
Jun  5 00:48:59    Data (9) len 41: (hex) 42 46 44 20 6e 65 69 67 68 62 6f 72 20
31 30 2e 30 2e 30
Jun  5 00:48:59 PPM Trace: BFD neighbor 10.255.106.102 (IFL 349) set, 9 0
Jun  5 00:48:59 Received Downstream RcvPkt (19) len 108:
Jun  5 00:48:59    IfIndex (3) len 4: 329
Jun  5 00:48:59    Protocol (1) len 1: BFD
Jun  5 00:48:59    SrcAddr (5) len 8: 10.255.106.102
Jun  5 00:48:59    Data (9) len 24: (hex) 00 88 03 18 00 00 00 4b 00 00 00 15 00
2d c6 c0 00 2d c6
Jun  5 00:48:59    PktError (26) len 4: 0
Jun  5 00:48:59    RtblIdx (24) len 4: 0
Jun  5 00:48:59    MultiHop (64) len 1: (hex) 00
Jun  5 00:48:59    Unknown (168) len 1: (hex) 01
Jun  5 00:48:59    Unknown (171) len 2: (hex) 02 3d
Jun  5 00:48:59    Unknown (172) len 6: (hex) 80 71 1f c7 81 c0
Jun  5 00:48:59    Authenticated (121) len 1: (hex) 01
Jun  5 00:48:59 BFD packet from 10.0.0.2 (IFL 329), len 24
Jun  5 00:48:59    Ver 0, diag 0, mult 3, len 24
Jun  5 00:48:59    Flags: IHU Fate
Jun  5 00:48:59    My discr 0x0000004b, your discr 0x00000015
Jun  5 00:48:59    Tx ivl 3000000, rx ivl 3000000, echo rx ivl 0
Jun  5 00:48:59 [THROTTLE]bfdd_rate_limit_can_accept_pkt: session 10.255.106.102
is up or already in program thread
Jun  5 00:48:59 Replicate: marked session (discr 21) for update
```

Meaning

BFD messages are being written to the specified trace file.

RELATED DOCUMENTATION

authentication

bfd-liveness-detection

detection-time

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Configuring BFD for PIM

The Bidirectional Forwarding Detection (BFD) Protocol is a simple hello mechanism that detects failures in a network. BFD works with a wide variety of network environments and topologies. A pair of routing devices exchanges BFD packets. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the routing device stops receiving a reply after a specified interval. The BFD failure detection timers have shorter time limits than the Protocol Independent Multicast (PIM) hello hold time, so they provide faster detection.

The BFD failure detection timers are adaptive and can be adjusted to be faster or slower. The lower the BFD failure detection timer value, the faster the failure detection and vice versa. For example, the timers can adapt to a higher value if the adjacency fails (that is, the timer detects failures more slowly). Or a neighbor can negotiate a higher value for a timer than the configured value. The timers adapt to a higher value when a BFD session flap occurs more than three times in a span of 15 seconds. A back-off algorithm increases the receive (Rx) interval by two if the local BFD instance is the reason for the session flap. The transmission (Tx) interval is increased by two if the remote BFD instance is the reason for the session flap. You can use the **clear bfd adaptation** command to return BFD interval timers to their configured values. The **clear bfd adaptation** command is hitless, meaning that the command does not affect traffic flow on the routing device.

You must specify the minimum transmit and minimum receive intervals to enable BFD on PIM.

To enable failure detection:

1. Configure the interface globally or in a routing instance.

   This example shows the global configuration.

   ```
   [edit protocols pim]
   user@host# edit interface fe-1/0/0.0 family inet bfd-liveness-detection
   ```

2. Configure the minimum transmit interval.

   This is the minimum interval after which the routing device transmits hello packets to a neighbor with which it has established a BFD session. Specifying an interval smaller than 300 ms can cause undesired BFD flapping.

   ```
   [edit protocols pim interface fe-1/0/0.0 family inet bfd-liveness-detection]
   user@host# set transmit-interval 350
   ```

3. Configure the minimum interval after which the routing device expects to receive a reply from a neighbor with which it has established a BFD session.

   Specifying an interval smaller than 300 ms can cause undesired BFD flapping.

```
[edit protocols pim interface fe-1/0/0.0 family inet bfd-liveness-detection]
user@host# set minimum-receive-interval 350
```

4. (Optional) Configure other BFD settings.

   As an alternative to setting the receive and transmit intervals separately, configure one interval for both.

```
[edit protocols pim interface fe-1/0/0.0 family inet bfd-liveness-detection]
user@host# set minimum-interval 350
```

5. Configure the threshold for the adaptation of the BFD session detection time.

   When the detection time adapts to a value equal to or greater than the threshold, a single trap and a single system log message are sent.

```
[edit protocols pim interface fe-1/0/0.0 family inet bfd-liveness-detection]
user@host# set detection-time threshold 800
```

6. Configure the number of hello packets not received by a neighbor that causes the originating interface to be declared down.

```
[edit protocols pim interface fe-1/0/0.0 family inet bfd-liveness-detection]
user@host# set multiplier 50
```

7. Configure the BFD version.

```
[edit protocols pim interface fe-1/0/0.0 family inet bfd-liveness-detection]
user@host# set version 1
```

8. Specify that BFD sessions should not adapt to changing network conditions.

   We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation enabled in your network.

```
[edit protocols pim interface fe-1/0/0.0 family inet bfd-liveness-detection]
```

```
user@host# set no-adaptation
```

9. Verify the configuration by checking the output of the **show bfd session** command.

RELATED DOCUMENTATION

show bfd session

4

CHAPTER

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High Availability Overview Test

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Understanding High Availability Features on Juniper Networks Routers

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For Juniper Networks routing platforms running the Junos operating system (Junos OS), *high availability* refers to the hardware and software components that provide redundancy and reliability for packet-based communications. This topic provides brief overviews of the following high availability features:

Routing Engine Redundancy

Redundant Routing Engines are two Routing Engines that are installed in the same routing platform. One functions as the master, while the other stands by as a backup should the master Routing Engine fail. On routing platforms with dual Routing Engines, network reconvergence takes place more quickly than on routing platforms with a single Routing Engine.

Graceful Routing Engine Switchover

Graceful Routing Engine switchover (GRES) enables a routing platform with redundant Routing Engines to continue forwarding packets, even if one Routing Engine fails. Graceful Routing Engine switchover preserves interface and kernel information. Traffic is not interrupted. However, graceful Routing Engine switchover does not preserve the control plane. Neighboring routers detect that the router has experienced a restart and react to the event in a manner prescribed by individual routing protocol specifications.

> **NOTE:** To preserve routing during a switchover, graceful Routing Engine switchover must be combined with either graceful restart protocol extensions or nonstop active routing. For more information, see *Understanding Graceful Routing Engine Switchover* and *Nonstop Active Routing Concepts*.

> **NOTE:** In T Series routers, TX Matrix routers, and TX Matrix Plus routers, the control plane is preserved in case of GRES with NSR, and 75% of line rate worth of traffic per Packet Forwarding Engine remains uninterrupted during GRES.

Nonstop Bridging

Nonstop bridging enables an MX Series 5G Universal Routing Platform with redundant Routing Engines to switch from a primary Routing Engine to a backup Routing Engine without losing Layer 2 Control Protocol (L2CP) information. Nonstop bridging uses the same infrastructure as graceful Routing Engine switchover to preserve interface and kernel information. However, nonstop bridging also saves L2CP information by running the Layer 2 Control Protocol process (l2cpd) on the backup Routing Engine.

> **NOTE:** To use nonstop bridging, you must first enable graceful Routing Engine switchover.

Nonstop bridging is supported for the following Layer 2 control protocols:

- Spanning Tree Protocol (STP)
- Rapid Spanning Tree Protocol (RSTP)
- Multiple Spanning Tree Protocol (MSTP)
- VLAN Spanning Tree Protocol (VSTP)

For more information, see *Nonstop Bridging Concepts*.

Nonstop Active Routing

Nonstop active routing (NSR) enables a routing platform with redundant Routing Engines to switch from a primary Routing Engine to a backup Routing Engine without alerting peer nodes that a change has occurred. Nonstop active routing uses the same infrastructure as graceful Routing Engine switchover to preserve interface and kernel information. However, nonstop active routing also preserves routing information and protocol sessions by running the routing protocol process (rpd) on both Routing Engines. In addition, nonstop active routing preserves TCP connections maintained in the kernel.

> **NOTE:** To use nonstop active routing, you must also configure graceful Routing Engine switchover.

For a list of protocols and features supported by nonstop active routing, see *Nonstop Active Routing Protocol and Feature Support*.

For more information about nonstop active routing, see *Nonstop Active Routing Concepts*.

Graceful Restart

With routing protocols, any service interruption requires an affected router to recalculate adjacencies with neighboring routers, restore routing table entries, and update other protocol-specific information. An unprotected restart of a router can result in forwarding delays, route flapping, wait times stemming from protocol reconvergence, and even dropped packets. To alleviate this situation, graceful restart provides extensions to routing protocols. These protocol extensions define two roles for a router—*restarting* and *helper*. The extensions signal neighboring routers about a router undergoing a restart and prevent the neighbors from propagating the change in state to the network during a graceful restart wait interval. The main benefits of graceful restart are uninterrupted packet forwarding and temporary suppression of all routing protocol updates. Graceful restart enables a router to pass through intermediate convergence states that are hidden from the rest of the network.

When a router is running graceful restart and the router stops sending and replying to protocol liveness messages (hellos), the adjacencies assume a graceful restart and begin running a timer to monitor the restarting router. During this interval, helper routers do not process an adjacency change for the router that they assume is restarting, but continue active routing with the rest of the network. The helper routers assume that the router can continue stateful forwarding based on the last preserved routing state during the restart.

If the router was actually restarting and is back up before the graceful timer period expires in all of the helper routers, the helper routers provide the router with the routing table, topology table, or label table (depending on the protocol), exit the graceful period, and return to normal network routing.

If the router does not complete its negotiation with helper routers before the graceful timer period expires in all of the helper routers, the helper routers process the router's change in state and send routing updates, so that convergence occurs across the network. If a helper router detects a link failure from the router, the topology change causes the helper router to exit the graceful wait period and to send routing updates, so that network convergence occurs.

To enable a router to undergo a graceful restart, you must include the **graceful-restart** statement at the global **[edit routing-options]** or **[edit routing-instances *instance-name* routing-options]** hierarchy level. You can, optionally, modify the global settings at the individual protocol level. When a routing session is started, a router that is configured with graceful restart must negotiate with its neighbors to support it when it undergoes a graceful restart. A neighboring router will accept the negotiation and support helper mode without requiring graceful restart to be configured on the neighboring router.

> **NOTE:** A Routing Engine switchover event on a helper router that is in graceful wait state causes the router to drop the wait state and to propagate the adjacency's state change to the network.

Graceful restart is supported for the following protocols and applications:

- BGP
- ES-IS
- IS-IS
- OSPF/OSPFv3
- PIM sparse mode
- RIP/RIPng
- MPLS-related protocols, including:
  - Label Distribution Protocol (LDP)
  - Resource Reservation Protocol (RSVP)
  - Circuit cross-connect (CCC)
  - Translational cross-connect (TCC)
- Layer 2 and Layer 3 virtual private networks (VPNs)

For more information, see *Graceful Restart Concepts*.

Nonstop Active Routing Versus Graceful Restart

Nonstop active routing and graceful restart are two different methods of maintaining high availability. Graceful restart requires a router restart. A router undergoing a graceful restart relies on its neighbors (or helpers) to restore its routing protocol information. The restart is the mechanism by which helpers are signaled to exit the wait interval and start providing routing information to the restarting router For more information, see *Graceful Restart Concepts*.

In contrast, nonstop active routing does not involve a router restart. Both the master and backup Routing Engines are running the routing protocol process (rpd) and exchanging updates with neighbors. When one Routing Engine fails, the router simply switches to the active Routing Engine to exchange routing information with neighbors. Because of these feature differences, nonstop routing and graceful restart are mutually exclusive. Nonstop active routing cannot be enabled when the router is configured as a graceful restarting router. If you include the **graceful-restart** statement at any hierarchy level and the **nonstop-routing** statement at the **[edit routing-options]** hierarchy level and try to commit the configuration, the commit request fails. For more information, see *Nonstop Active Routing Concepts*.

Effects of a Routing Engine Switchover

Effects of a Routing Engine Switchover describes the effects of a Routing Engine switchover when no high availability features are enabled and when graceful Routing Engine switchover, graceful restart, and nonstop active routing features are enabled.

VRRP

The Virtual Router Redundancy Protocol (VRRP) enables hosts on a LAN to make use of redundant routing platforms (master and backup pairs) on the LAN, requiring only the static configuration of a single default route on the hosts.

The VRRP routing platform pairs share the IP address corresponding to the default route configured on the hosts. At any time, one of the VRRP routing platforms is the master (active) and the others are backups. If the master fails, one of the backup routers or switches becomes the new master router.

VRRP has advantages in ease of administration and network throughput and reliability:

- It provides a virtual default routing platform.
- It enables traffic on the LAN to be routed without a single point of failure.
- A virtual backup router can take over a failed default router:
  - Within a few seconds.
  - With a minimum of VRRP traffic.
  - Without any interaction with the hosts.

Devices running VRRP dynamically elect master and backup routers. You can also force assignment of master and backup routers using priorities from 1 through 255, with 255 being the highest priority.

In VRRP operation, the default master router sends advertisements to backup routers at regular intervals (default 1 second). If a backup router does not receive an advertisement for a set period, the backup router with the next highest priority takes over as master and begins forwarding packets.

As of Junos OS Release 13.2, VRRP nonstop active routing (NSR) is enabled only when you configure the **nonstop-routing** statement at the **[edit routing-options]** or **[edit logical system *logical-system-name* routing-options]** hierarchy level.

For more information, see *Understanding VRRP*.

Unified ISSU

A unified in-service software upgrade (unified ISSU) enables you to upgrade between two different Junos OS Releases with no disruption on the control plane and with minimal disruption of traffic. Unified ISSU is only supported by dual Routing Engine platforms. In addition, graceful Routing Engine switchover (GRES) and nonstop active routing (NSR) must be enabled.

With a unified ISSU, you can eliminate network downtime, reduce operating costs, and deliver higher services levels. For more information, see *Getting Started with Unified In-Service Software Upgrade*.

Interchassis Redundancy for MX Series Routers Using Virtual Chassis

Interchassis redundancy is a high availability feature that can span equipment located across multiple geographies to prevent network outages and protect routers against access link failures, uplink failures, and wholesale chassis failures without visibly disrupting the attached subscribers or increasing the network management burden for service providers. As more high-priority voice and video traffic is carried on the network, interchassis redundancy has become a requirement for providing stateful redundancy on broadband subscriber management equipment such as broadband services routers, broadband network gateways, and broadband remote access servers. Interchassis redundancy support enables service providers to fulfill strict service-level agreements (SLAs) and avoid unplanned network outages to better meet the needs of their customers.

To provide a stateful interchassis redundancy solution for MX Series 5G Universal Routing Platforms, you can configure a Virtual Chassis. A *Virtual Chassis* configuration interconnects two MX Series routers into a logical system that you can manage as a single network element. The member routers in a Virtual Chassis are designated as the *master router* (also known as the *protocol master*) and the *backup router* (also known as the *protocol backup*). The member routers are interconnected by means of dedicated *Virtual Chassis ports* that you configure on Trio Modular Port Concentrator/Modular Interface Card (MPC/MIC) interfaces.

An MX Series Virtual Chassis is managed by the *Virtual Chassis Control Protocol* (*VCCP*), which is a dedicated control protocol based on IS-IS. VCCP runs on the Virtual Chassis port interfaces and is responsible for building the Virtual Chassis topology, electing the Virtual Chassis master router, and establishing the interchassis routing table to route traffic within the Virtual Chassis.

Starting with Junos OS Release 11.2, Virtual Chassis configurations are supported on MX240, MX480, and MX960 Universal Routing Platforms with Trio MPC/MIC interfaces and dual Routing Engines. In addition, graceful Routing Engine switchover (GRES) and nonstop active routing (NSR) must be enabled on both member routers in the Virtual Chassis.

SEE ALSO

High Availability-Related Features in Junos OS | 8

High Availability-Related Features in Junos OS

Related redundancy and reliability features include:

- Redundant power supplies, host modules, host subsystems, and forwarding boards. For more information, see the *Junos OS Administration Library* and the *Junos OS Hardware Network Operations Guide*.
- Additional link-layer redundancy, including Automatic Protection Switching (APS) for SONET interfaces, Multiplex Section Protection (MSP) for SDH interfaces, and DLSw redundancy for Ethernet interfaces. For more information, see the *Junos OS Network Interfaces Library for Routing Devices*.
- Bidirectional Forwarding Detection (BFD) works with other routing protocols to detect failures rapidly. For more information, see the *Junos OS Routing Protocols Library*.
- Redirection of Multiprotocol Label Switching (MPLS) label-switched path (LSP) traffic—Mechanisms such as link protection, node-link protection, and fast reroute recognize link and node failures, allowing MPLS LSPs to select a bypass LSP to circumvent failed links or devices. For more information, see the *MPLS Applications User Guide*.

SEE ALSO

Understanding High Availability Features on Juniper Networks Routers | 2

5

CHAPTER

Configuring Bidirectional Forwarding Detection (BFD)- Test

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BFD Overview - Test

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Understanding BFD for Static Routes for Faster Network Failure Detection

The Bidirectional Forwarding Detection (BFD) protocol is a simple hello mechanism that detects failures in a network. BFD works with a wide variety of network environments and topologies. A pair of routing devices exchanges BFD packets. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the routing device stops receiving a reply after a specified interval. The BFD failure detection timers have shorter time limits than the static route failure detection mechanisms, so they provide faster detection.

The BFD failure detection timers can be adjusted to be faster or slower. The lower the BFD failure detection timer value, the faster the failure detection and vice versa. For example, the timers can adapt to a higher value if the adjacency fails (that is, the timer detects failures more slowly). Or a neighbor can negotiate a higher value for a timer than the configured value. The timers adapt to a higher value when a BFD session flap occurs more than three times in a span of 15 seconds. A back-off algorithm increases the receive (Rx) interval by two if the local BFD instance is the reason for the session flap. The transmission (Tx) interval is increased by two if the remote BFD instance is the reason for the session flap. You can use the **clear bfd adaptation** command to return BFD interval timers to their configured values. The **clear bfd adaptation** command is hitless, meaning that the command does not affect traffic flow on the routing device.

By default, BFD is supported on single-hop static routes.

NOTE: On MX Series devices, multihop BFD is not supported on a static route if the static route is configured with more than one next hop. It is recommended that you avoid using multiple next hops when a multihop BFD is required for a static route.

To enable failure detection, include the **bfd-liveness-detection** statement in the static route configuration.

NOTE: Starting with Junos OS Release 15.1X49-D70 and Junos OS Release 17.3R1, the **bfd-liveness-detection** command includes the description field. The description is an attribute under the **bfd-liveness-detection** object and it is supported only on SRX Series devices. This field is applicable only for the static routes.

In Junos OS Release 9.1 and later, the BFD protocol is supported for IPv6 static routes. Global unicast and link-local IPv6 addresses are supported for static routes. The BFD protocol is not supported on multicast or anycast IPv6 addresses. For IPv6, the BFD protocol supports only static routes and only in Junos OS Release 9.3 and later. IPv6 for BFD is also supported for the eBGP protocol.

NOTE: Inline BFD is supported on PTX5000 routers with third-generation FPCs starting in Junos OS Release 15.1F3 and 16.1R2. Inline BFD is supported on PTX3000 routers with third-generation FPCs starting in Junos OS Release 15.1F6 and 16.1R2.

There are three types of BFD sessions based on the source from which BFD packets are sent to the neighbors. Different types of BFD sessions and their descriptions are:

Type of BFD session	Description
Non-distributed BFD	BFD sessions running completely on the Routing Engine.
Distributed BFD	BFD sessions running completely on the Packet Forwarding Engine.
Inline BFD **NOTE:** Starting in Junos OS Release 13.3, inline BFD is supported only on static MX Series routers with MPCs/MICs that have configured **enhanced-ip**. **NOTE:** Starting in Junos OS Release 16.1R1, the inline BFD sessions are supported on integrated routing and bridging (IRB) interfaces.	BFD sessions running on the FPC hardware.

To configure the BFD protocol for IPv6 static routes, include the **bfd-liveness-detection** statement at the **[edit routing-options rib inet6.0 static route *destination-prefix*]** hierarchy level.

In Junos OS Release 8.5 and later, you can configure a hold-down interval to specify how long the BFD session must remain up before a state change notification is sent.

To specify the hold-down interval, include the **holddown-interval** statement in the BFD configuration.

You can configure a number in the range from 0 through 255,000 milliseconds. The default is 0. If the BFD session goes down and then comes back up during the hold-down interval, the timer is restarted.

> **NOTE:** If a single BFD session includes multiple static routes, the hold-down interval with the highest value is used.

To specify the minimum transmit and receive intervals for failure detection, include the **minimum-interval** statement in the BFD configuration.

This value represents both the minimum interval after which the local routing device transmits hello packets and the minimum interval after which the routing device expects to receive a reply from the neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds. Optionally, instead of using this statement, you can configure the minimum transmit and receive intervals separately using the **transmit-interval minimum-interval** and **minimum-receive-interval** statements.

> **NOTE:** QFX5000 Series switches and EX4600 switches do not support minimum interval values of less than 1 second.

NOTE: BFD is an intensive protocol that consumes system resources. Specifying a minimum interval for BFD of less than 100 ms for Routing Engine-based sessions and 10 ms for distributed BFD sessions can cause undesired BFD flapping.

Depending on your network environment, these additional recommendations might apply:

- For large-scale network deployments with a large number of BFD sessions, specify a minimum interval of 300 ms for Routing Engine-based sessions and 100 ms for distributed BFD sessions.
- For very large-scale network deployments with a large number of BFD sessions, contact Juniper Networks customer support for more information.
- For BFD sessions to remain up during a Routing Engine switchover event when nonstop active routing (NSR) is configured, specify a minimum interval of 2500 ms for Routing Engine-based sessions. For distributed BFD sessions with NSR configured, the minimum interval recommendations are unchanged and depend only on your network deployment.

To specify the minimum receive interval for failure detection, include the **minimum-receive-interval** statement in the BFD configuration. This value represents the minimum interval after which the routing device expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds. Optionally, instead of using this statement, you can configure the minimum receive interval using the **minimum-interval** statement at the **[edit routing-options static route *destination-prefix* bfd-liveness-detection]** hierarchy level.

To specify the number of hello packets not received by the neighbor that causes the originating interface to be declared down, include the **multiplier** statement in the BFD configuration.

The default value is 3. You can configure a number in the range from 1 through 255.

To specify a threshold for detecting the adaptation of the detection time, include the **threshold** statement in the BFD configuration.

When the BFD session detection time adapts to a value equal to or higher than the threshold, a single trap and a system log message are sent. The detection time is based on the multiplier of the **minimum-interval** or the **minimum-receive-interval** value. The threshold must be a higher value than the multiplier for either of these configured values. For example if the **minimum-receive-interval** is 300 ms and the **multiplier** is 3, the total detection time is 900 ms. Therefore, the detection time threshold must have a value higher than 900.

To specify the minimum transmit interval for failure detection, include the **transmit-interval minimum-interval** statement in the BFD configuration.

This value represents the minimum interval after which the local routing device transmits hello packets to the neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds. Optionally, instead of using this statement, you can configure the minimum transmit interval using the **minimum-interval** statement at the **[edit routing-options static route *destination-prefix* bfd-liveness-detection]** hierarchy level.

To specify the threshold for the adaptation of the transmit interval, include the **transmit-interval threshold** statement in the BFD configuration.

The threshold value must be greater than the transmit interval. When the BFD session transmit time adapts to a value greater than the threshold, a single trap and a system log message are sent. The detection time is based on the multiplier of the value for the **minimum-interval** or the **minimum-receive-interval** statement at the **[edit routing-options static route *destination-prefix* bfd-liveness-detection]** hierarchy level. The threshold must be a higher value than the multiplier for either of these configured values.

To specify the BFD version, include the **version** statement in the BFD configuration. The default is to have the version detected automatically.

To include an IP address for the next hop of the BFD session, include the **neighbor** statement in the BFD configuration.

> **NOTE:** You must configure the **neighbor** statement if the next hop specified is an interface name. If you specify an IP address as the next hop, that address is used as the neighbor address for the BFD session.

In Junos OS Release 9.0 and later, you can configure BFD sessions not to adapt to changing network conditions.

To disable BFD adaptation, include the **no-adaptation** statement in the BFD configuration.

> **NOTE:** We recommend that you not disable BFD adaptation unless it is preferable *not* to have BFD adaptation in your network.

> **NOTE:** If BFD is configured only on one end of a static route, the route is removed from the routing table. BFD establishes a session when BFD is configured on both ends of the static route.
>
> BFD is not supported on ISO address families in static routes. BFD does support IS-IS.
>
> If you configure graceful Routing Engine switchover (GRES) at the same time as BFD, GRES does not preserve the BFD state information during a failover.

SEE ALSO

Enabling Dedicated and Real-Time BFD
Example: Configuring BFD for Static Routes for Faster Network Failure Detection | 34
Example: Enabling BFD on Qualified Next Hops in Static Routes for Route Selection

Understanding BFD for BGP

The Bidirectional Forwarding Detection (BFD) protocol is a simple hello mechanism that detects failures in a network. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the routing device stops receiving a reply after a specified interval. BFD works with a wide variety of network environments and topologies. The failure detection timers for BFD have shorter time limits than default failure detection mechanisms for BGP, so they provide faster detection.

NOTE: Configuring both BFD and graceful restart for BGP on the same device is counterproductive. When an interface goes down, BFD detects this instantly, stops traffic forwarding and the BGP session goes down whereas graceful restart forwards traffic despite the interface failure, this behavior might cause network issues. Hence we do not recommend configuring both BFD and graceful restart on the same device.

NOTE: QFX5000 Series switches and EX4600 switches do not support minimum interval values of less than 1 second.

NOTE: QFX5110, QFX5120, QFX5200, and QFX5210 switches support multihop Bidirectional Forwarding Detection (BFD) inline keep alive support which will enable sessions to be configured at less than 1 second. Performance may vary depending on the system load. 10 inline BFD sessions are supported and can be configured with a timer of 150 x 3 milliseconds.

The BFD failure detection timers can be adjusted to be faster or slower. The lower the BFD failure detection timer value, the faster the failure detection and vice versa. For example, the timers can adapt to a higher value if the adjacency fails (that is, the timer detects failures more slowly). Or a neighbor can negotiate a higher value for a timer than the configured value. The timers adapt to a higher value when a BFD session flap occurs more than three times in a span of 15 seconds (15000 milliseconds). A back-off algorithm increases the receive (Rx) interval by two if the local BFD instance is the reason for the session flap. The transmission (Tx) interval is increased by two if the remote BFD instance is the reason for the session flap.

You can use the **clear bfd adaptation** command to return BFD interval timers to their configured values. The **clear bfd adaptation** command is hitless, meaning that the command does not affect traffic flow on the routing device.

> **NOTE:** On all SRX Series devices, high CPU utilization triggered for reasons such as CPU intensive commands and SNMP walks causes the BFD protocol to flap while processing large BGP updates. (Platform support depends on the Junos OS release in your installation.)
>
> Starting with Junos OS Release 15.1X49-D100, SRX340, SRX345, and SRX1500 devices support dedicated BFD.
>
> Starting with Junos OS Release 15.1X49-D100, SRX300 and SRX320 devices support real-time BFD.
>
> Starting with Junos OS Release 15.1X49-D110, SRX550M devices support dedicated BFD.

In Junos OS Release 8.3 and later, BFD is supported on internal BGP (IBGP) and multihop external BGP (EBGP) sessions as well as on single-hop EBGP sessions. In Junos OS Release 9.1 through Junos OS Release 11.1, BFD supports IPv6 interfaces in static routes only. In Junos OS Release 11.2 and later, BFD supports IPv6 interfaces with BGP.

SEE ALSO

Enabling Dedicated and Real-Time BFD

Understanding BFD for OSPF

The Bidirectional Forwarding Detection (BFD) protocol is a simple hello mechanism that detects failures in a network. BFD works with a wide variety of network environments and topologies. A pair of routing devices exchange BFD packets. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the routing device stops receiving a reply after a specified interval. The BFD failure detection timers have shorter time limits than the OSPF failure detection mechanisms, so they provide faster detection.

The BFD failure detection timers are adaptive and can be adjusted to be faster or slower. The lower the BFD failure detection timer value, the faster the failure detection and vice versa. For example, the timers can adapt to a higher value if the adjacency fails (that is, the timer detects failures more slowly). Or a neighbor can negotiate a higher value for a timer than the configured value. The timers adapt to a higher value when a BFD session flap occurs more than three times in a span of 15 seconds. A back-off algorithm increases the receive (Rx) interval by two if the local BFD instance is the reason for the session flap. The transmission (Tx) interval is increased by two if the remote BFD instance is the reason for the session flap. You can use the **clear bfd adaptation** command to return BFD interval timers to their configured values. The **clear bfd adaptation** command is hitless, meaning that the command does not affect traffic flow on the routing device.

NOTE: QFX5000 Series switches and EX4600 switches do not support minimum interval values of less than 1 second.

NOTE: BFD is supported for OSPFv3 in Junos OS Release 9.3 and later.

NOTE: For branch SRX Series devices, we recommend 1000 ms as the minimum keepalive time interval for BFD packets.

You can configure the following BFD protocol settings:

- **detection-time threshold**—Threshold for the adaptation of the detection time. When the BFD session detection time adapts to a value equal to or greater than the configured threshold, a single trap and a single system log message are sent.
- **full-neighbors-only**—Ability to establish BFD sessions only for OSPF neighbors with full neighbor adjacency. The default behavior is to establish BFD sessions for all OSPF neighbors. This setting is available in Junos OS Release 9.5 and later.
- **minimum-interval**—Minimum transmit and receive interval for failure detection. This setting configures both the minimum interval after which the local routing device transmits hello packets and the minimum interval after which the routing device expects to receive a reply from the neighbor with which it has established a BFD session. Both intervals are in milliseconds. You can also specify the minimum transmit and receive intervals separately using the **transmit-interval minimum-interval** and **minimum-receive-interval** statements.

NOTE: BFD is an intensive protocol that consumes system resources. Specifying a minimum interval for BFD of less than 100 ms for Routing Engine-based sessions and 10 ms for distributed BFD sessions can cause undesired BFD flapping.

Depending on your network environment, these additional recommendations might apply:

- For large-scale network deployments with a large number of BFD sessions, specify a minimum interval of no less than 500 ms. An interval of 1000 ms is recommended to avoid any instability issues.
- For very large-scale network deployments with a large number of BFD sessions, contact Juniper Networks customer support for more information.
- For BFD sessions to remain up during a Routing Engine switchover event when nonstop active routing (NSR) is configured, specify a minimum interval of 2500 ms for Routing Engine-based sessions. Without NSR, Routing Engine-based sessions can have a minimum interval of 100 ms. In OSPFv3, BFD is always based in the Routing Engine, meaning that BFD is not distributed. For distributed BFD sessions with NSR configured, the minimum interval recommendations are unchanged and depend only on your network deployment.
- On a single QFX5100 switch, when you add a QFX-EM-4Q expansion module, specify a minimum interval higher than 1000 ms.

- **minimum-receive-interval**—Minimum receive interval for failure detection. This setting configures the minimum receive interval, in milliseconds, after which the routing device expects to receive a hello packet from a neighbor with which it has established a BFD session. You can also specify the minimum receive interval using the **minimum-interval** statement.
- **multiplier**—Multiplier for hello packets. This setting configures the number of hello packets that are not received by a neighbor, which causes the originating interface to be declared down. By default, three missed hello packets cause the originating interface to be declared down.
- **no-adaptation**—Disables BFD adaption. This setting disables BFD sessions from adapting to changing network conditions. This setting is available in Junos OS Release 9.0 and later.

NOTE: We recommend that you do not disable BFD adaptation unless it is preferable not to have BFD adaptation in your network.

- **transmit-interval minimum-interval**—Minimum transmit interval for failure detection. This setting configures the minimum transmit interval, in milliseconds, at which the local routing device transmits hello packets to the neighbor with which it has established a BFD session. You can also specify the minimum transmit interval using the **minimum-interval** statement.

- **transmit-interval threshold**—Threshold for the adaptation of the BFD session transmit interval. When the transmit interval adapts to a value greater than the threshold, a single trap and a single system log message are sent. The threshold value must be greater than the minimum transmit interval. If you attempt to commit a configuration with a threshold value less than the minimum transmit interval, the routing device displays an error and does not accept the configuration.
- **version**—BFD version. This setting configures the BFD version used for detection. You can explicitly configure BFD version 1, or the routing device can automatically detect the BFD version. By default, the routing device automatically detects the BFD version automatically, which is either 0 or 1.

You can also trace BFD operations for troubleshooting purposes.

Understanding BFD for IS-IS

The Bidirectional Forwarding Detection (BFD) protocol is a simple hello mechanism that detects failures in a network. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the routing device stops receiving a reply after a specified interval. BFD works with a wide variety of network environments and topologies. The failure detection timers for BFD have shorter time limits than the failure detection mechanisms of IS-IS, providing faster detection.

The BFD failure detection timers are adaptive and can be adjusted to be faster or slower. For example, the timers can adapt to a higher value if the adjacency fails, or a neighbor can negotiate a higher value for a timer than the configured value. The timers adapt to a higher value when a BFD session flap occurs more than three times in a span of 15 seconds. A back-off algorithm increases the receive (RX) interval by two if the local BFD instance is the reason for the session flap. The transmission (TX) interval is increased by two if the remote BFD instance is the reason for the session flap.

You can use the **clear bfd adaptation** command to return BFD interval timers to their configured values. The **clear bfd adaptation** command is hitless, meaning that the command does not affect traffic flow on the routing device.

NOTE: Starting with Junos OS Release 16.1R1, you can configure IS-IS BFD sessions for IPv6 by including the **bfd-liveness-detection** statement at the **[edit protocols isis interface *interface-name* family inet|inet6]** hierarchy level.

- For interfaces that support both IPv4 and IPv6 routing, the **bfd-liveness-detection** statement must be configured separately for each inet family.
- BFD over IPv6 link local address is currently not distributed because IS-IS uses link local addresses for forming adjacencies.
- BFD sessions over IPv6 must not have the same aggressive detection intervals as IPv4 sessions.
- BFD IPv6 sessions with detection intervals less than 2.5 seconds are currently not supported when nonstop active routing (NSR) is enabled.

NOTE: QFX5000 Series switches and EX4600 switches do not support minimum interval values of less than 1 second.

To detect failures in the network, the set of statements in Table 3 on page 21 are used in the configuration.

Table 5: Configuring BFD for IS-IS

Statement	Description
bfd-liveness-detection	Enable failure detection.

Table 5: Configuring BFD for IS-IS *(continued)*

Statement	Description
minimum-interval ***milliseconds***	Specify the minimum transmit and receive intervals for failure detection. This value represents the minimum interval at which the local router transmits hellos packets as well as the minimum interval at which the router expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number from 1 through 255,000 milliseconds. You can also specify the minimum transmit and receive intervals separately. **NOTE:** BFD is an intensive protocol that consumes system resources. Specifying a minimum interval for BFD less than 100 ms for Routing Engine-based sessions and 10 ms for distributed BFD sessions can cause undesired BFD flapping. Depending on your network environment, these additional recommendations might apply: • For large-scale network deployments with a large number of BFD sessions, specify a minimum interval of 300 ms for Routing Engine-based sessions and 100 ms for distributed BFD sessions. • For very large-scale network deployments with a large number of BFD sessions, please contact Juniper Networks customer support for more information. • For BFD sessions to remain up during a Routing Engine switchover event when nonstop active routing (NSR) is configured, specify a minimum interval of 2500 ms for Routing Engine-based sessions. For distributed BFD sessions with nonstop active routing configured, the minimum interval recommendations are unchanged and depend only on your network deployment.
minimum-receive-interval ***milliseconds***	Specify only the minimum receive interval for failure detection. This value represents the minimum interval at which the local router expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number from 1 through 255,000 milliseconds.
multiplier ***number***	Specify the number of hello packets not received by the neighbor that causes the originating interface to be declared down. The default is 3, and you can configure a value from 1 through 225.
no-adaptation	Disable BFD adaptation. In Junos OS Release 9.0 and later, you can specify that the BFD sessions not adapt to changing network conditions. **NOTE:** We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation enabled in your network.

Table 5: Configuring BFD for IS-IS *(continued)*

Statement	Description
threshold	Specify the threshold for the following: • Adaptation of the detection time When the BFD session detection time adapts to a value equal to or greater than the threshold, a single trap and a system log message are sent. • Transmit interval **NOTE:** The threshold value must be greater than the minimum transmit interval multiplied by the multiplier number.
transmit-interval minimum-interval	Specify the minimum transmit interval for failure detection. This value represents the minimum interval at which the local routing device transmits hello packets to the neighbor with which it has established a BFD session. You can configure a value from 1 through 255,000 milliseconds.
version	Specify the BFD version used for detection. The default is to have the version detected automatically.

NOTE: You can trace BFD operations by including the **traceoptions** statement at the **[edit protocols bfd]** hierarchy level.

For a list of hierarchy levels at which you can include these statements, see the statement summary sections for these statements.

SEE ALSO

Example: Configuring BFD for IS-IS | 59
Understanding BFD Authentication for IS-IS

Understanding BFD for RIP

The Bidirectional Forwarding Detection (BFD) Protocol is a simple hello mechanism that detects failures in a network. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the routing device stops receiving a reply after a specified interval. BFD works with a wide variety of network environments and topologies. BFD failure detection times are shorter than RIP detection times, providing faster reaction times to various kinds of failures in the network. Instead of waiting for the routing protocol neighbor timeout, BFD provides rapid detection of link failures. BFD timers are adaptive and can be adjusted to be more or less aggressive. For example, a timer can adapt to a higher value if the adjacency fails, or a neighbor can negotiate a higher value for a timer than the one configured. Note that the functionality of configuring BFD for RIP described in this topic is not supported in Junos OS Releases 15.1X49, 15.1X49-D30, or 15.1X49-D40.

NOTE: QFX5000 Series switches and EX4600 switches do not support minimum interval values of less than 1 second.

BFD enables quick failover between a primary and a secondary routed path. The protocol tests the operational status of the interface multiple times per second. BFD provides for configuration timers and thresholds for failure detection. For example, if the minimum interval is set for 50 milliseconds and the threshold uses the default value of three missed messages, a failure is detected on an interface within 200 milliseconds of the failure.

Intervening devices (for example, an Ethernet LAN switch) hide link-layer failures from routing protocol peers, such as when two routers are connected by way of a LAN switch, where the local interface status remains up even when a physical fault happens on the remote link. Link-layer failure detection times vary, depending on the physical media and the Layer 2 encapsulation. BFD can provide fast failure detection times for all media types, encapsulations, topologies, and routing protocols.

To enable BFD for RIP, both sides of the connection must receive an update message from the peer. By default, RIP does not export any routes. Therefore, you must enable update messages to be sent by configuring an export policy for routes before a BFD session is triggered.

Understanding Independent Micro BFD Sessions for LAG

Starting with Junos OS Release 13.3, this feature is supported on the following PIC/FPC types:

- PC-1XGE-XENPAK (Type 3 FPC)
- PD-4XGE-XFP (Type 4 FPC)
- PD-5-10XGE-SFPP (Type 4 FPC)
- 24x10GE (LAN/WAN) SFPP, 12x10GE (LAN/WAN) SFPP, 1x100GE Type 5 PICs
- All MPCs on MX Series with Ethernet MICs
- FPC-PTX-P1-A on PTX5000 with 10-Gigabit Ethernet interfaces
- FPC2-PTX-P1A on PTX5000 with 10-Gigabit Ethernet interfaces in Junos OS Release 14.1 and later
- All FPCs on PTX Series with Ethernet interfaces in Junos OS Release 14.1R3 and later 14.1 releases, and Junos 14.2 and later

TIP: See *PTX Series PIC/FPC Compatibility* for a list of PICs that are supported on each PTX Series FPC.

NOTE: Micro-BFD configuration with interface addresses is not supported on PTX routers on FPC3 and QFX10000 line of switches.

The Bidirectional Forwarding Detection (BFD) protocol is a simple detection protocol that quickly detects failures in the forwarding paths. A link aggregation group (LAG) combines multiple links between devices that are in point-to-point connections, thereby increasing bandwidth, providing reliability, and allowing load balancing. To run a BFD session on LAG interfaces, configure an independent, asynchronous mode BFD session on every LAG member link in a LAG bundle. Instead of a single BFD session monitoring the status of the UDP port, independent micro BFD sessions monitor the status of individual member links.

The individual BFD sessions determine the Layer 2 and Layer 3 connectivity of each member link in the LAG. Once a BFD session is established on a particular link, the member links are attached to the LAG and the load balancer either by a static configuration or by the Link Aggregation Control Protocol (LACP). If the member links are attached to the LAG by a static configuration, the device control process acts as the client to the micro BFD session. When member links are attached to the LAG by the LACP, the LACP acts as the client to the micro BFD session.

When the micro BFD session is up, a LAG link is established and data is transmitted over that LAG link. If the micro BFD session on a member link is down, that particular member link is removed from the load

balancer, and the LAG managers stop directing traffic to that link. These micro BFD sessions are independent of each other despite having a single client that manages the LAG interface.

NOTE:

- Starting with Junos OS Release 13.3, IANA has allocated 01-00-5E-90-00-01 as the dedicated MAC address for micro BFD. Dedicated MAC mode is used by default for micro BFD sessions, in accordance with the latest draft for BFD over LAG.
- In Junos OS, MicroBFD control packets are always untagged by default. For L2 aggregated interfaces, the configuration must include vlan-tagging or flexible-vlan-tagging in the Aggregated Ethernet with BFD. Otherwise, the system will throw error while committing the configuration.
- When you enable MicroBFD on an aggregated Ethernet Interface, the aggregated Interface can receive MicroBFD packets. Starting with Junos OS Release 19.3 and later, for MPC10E and MPC11E MPCs, you cannot apply firewall filters on the MicroBFD packets received on the aggregated Ethernet Interface. For MPC1E through MPC9E, you can apply firewall filters on the MicroBFD packets received on the aggregated Ethernet Interface only if the aggregated Ethernet Interface is configured as an untagged Interface.

Micro BFD sessions run in the following modes:

- Distribution Mode—Micro BFD sessions are distributed by default at Layer 3.
- Non-Distribution Mode—You can configure the BFD session to run in this mode by including the **no-delegate-processing** statement under periodic packet management (PPM). In this mode, the packets are being sent or received by the Routing Engine at Layer 2.

A pair of routing devices in a LAG exchange BFD packets at a specified, regular interval. The routing device detects a neighbor failure when it stops receiving a reply after a specified interval. This allows the quick verification of member link connectivity with or without LACP. A UDP port distinguishes BFD over LAG packets from BFD over single-hop IP.

NOTE: IANA has allocated 6784 as the UDP destination port for micro BFD.

To enable failure detection for LAG networks for aggregated Ethernet interfaces:

- Include the *bfd-liveness-detection* statement in the configuration.
- Specify a hold-down interval value to set the minimum time that the BFD session must remain up before a state change notification is sent to the other members in the LAG network.
- Specify the minimum interval that indicates the time interval for transmitting and receiving data.
- Starting with Junos OS Release 14.1, specify the neighbor in a BFD session. In releases prior to Junos OS Release 16.1, you must configure the loopback address of the remote destination as the neighbor

address. Beginning with Junos OS Release 16.1, you can also configure this feature on MX series routers with aggregated Ethernet interface address of the remote destination as the neighbor address.

NOTE: On T1600 and T4000 routers, you cannot configure the local aggregated Ethernet Interface address of the remote destination as the neighbor address.

CAUTION: Deactivate *bfd-liveness-detection* at the **[edit interfaces aex aggregated-ether-options]** hierarchy level or deactivate the aggregated Ethernet interface before changing the neighbor address from loopback IP address to aggregated Ethernet interface IP address. Modifying the local and neighbor address without deactivating **bfd-liveness-detection** or the aggregated Ethernet interface first might cause micro BFD sessions failure.

NOTE: Beginning with Release 16.1R2, Junos OS checks and validates the configured micro BFD **local-address** against the interface or loopback IP address before the configuration commit. Junos OS performs this check on both IPv4 and IPv6 micro BFD address configurations, and if they do not match, the commit fails.

NOTE: This feature works only when both the devices support BFD. If BFD is configured at one end of the LAG, this feature does not work.

For the IPv6 address family, disable duplicate address detection before configuring this feature with AE interface addresses. To disable duplicate address detection, include the **dad-disable** statement at the **[edit interface *aex* unit *y* family inet6]** hierarchy level.

SEE ALSO

authentication

bfd-liveness-detection

detection-time

transmit-interval

Understanding Independent Micro BFD Sessions for LAG

Starting with Junos OS Release 13.3, this feature is supported on the following PIC/FPC types:

- PC-1XGE-XENPAK (Type 3 FPC)
- PD-4XGE-XFP (Type 4 FPC)
- PD-5-10XGE-SFPP (Type 4 FPC)
- 24x10GE (LAN/WAN) SFPP, 12x10GE (LAN/WAN) SFPP, 1x100GE Type 5 PICs
- All MPCs on MX Series with Ethernet MICs
- FPC-PTX-P1-A on PTX5000 with 10-Gigabit Ethernet interfaces
- FPC2-PTX-P1A on PTX5000 with 10-Gigabit Ethernet interfaces in Junos OS Release 14.1 and later
- All FPCs on PTX Series with Ethernet interfaces in Junos OS Release 14.1R3 and later 14.1 releases, and Junos 14.2 and later

TIP: See *PTX Series PIC/FPC Compatibility* for a list of PICs that are supported on each PTX Series FPC.

NOTE: Micro-BFD configuration with interface addresses is not supported on PTX routers on FPC3 and QFX10000 line of switches.

The Bidirectional Forwarding Detection (BFD) protocol is a simple detection protocol that quickly detects failures in the forwarding paths. A link aggregation group (LAG) combines multiple links between devices that are in point-to-point connections, thereby increasing bandwidth, providing reliability, and allowing load balancing. To run a BFD session on LAG interfaces, configure an independent, asynchronous mode BFD session on every LAG member link in a LAG bundle. Instead of a single BFD session monitoring the status of the UDP port, independent micro BFD sessions monitor the status of individual member links.

The individual BFD sessions determine the Layer 2 and Layer 3 connectivity of each member link in the LAG. Once a BFD session is established on a particular link, the member links are attached to the LAG and the load balancer either by a static configuration or by the Link Aggregation Control Protocol (LACP). If the member links are attached to the LAG by a static configuration, the device control process acts as the client to the micro BFD session. When member links are attached to the LAG by the LACP, the LACP acts as the client to the micro BFD session.

When the micro BFD session is up, a LAG link is established and data is transmitted over that LAG link. If the micro BFD session on a member link is down, that particular member link is removed from the load

balancer, and the LAG managers stop directing traffic to that link. These micro BFD sessions are independent of each other despite having a single client that manages the LAG interface.

NOTE:

- Starting with Junos OS Release 13.3, IANA has allocated 01-00-5E-90-00-01 as the dedicated MAC address for micro BFD. Dedicated MAC mode is used by default for micro BFD sessions, in accordance with the latest draft for BFD over LAG.
- In Junos OS, MicroBFD control packets are always untagged by default. For L2 aggregated interfaces, the configuration must include vlan-tagging or flexible-vlan-tagging in the Aggregated Ethernet with BFD. Otherwise, the system will throw error while committing the configuration.
- When you enable MicroBFD on an aggregated Ethernet Interface, the aggregated Interface can receive MicroBFD packets. Starting with Junos OS Release 19.3 and later, for MPC10E and MPC11E MPCs, you cannot apply firewall filters on the MicroBFD packets received on the aggregated Ethernet Interface. For MPC1E through MPC9E, you can apply firewall filters on the MicroBFD packets received on the aggregated Ethernet Interface only if the aggregated Ethernet Interface is configured as an untagged Interface.

Micro BFD sessions run in the following modes:

- Distribution Mode—Micro BFD sessions are distributed by default at Layer 3.
- Non-Distribution Mode—You can configure the BFD session to run in this mode by including the **no-delegate-processing** statement under periodic packet management (PPM). In this mode, the packets are being sent or received by the Routing Engine at Layer 2.

A pair of routing devices in a LAG exchange BFD packets at a specified, regular interval. The routing device detects a neighbor failure when it stops receiving a reply after a specified interval. This allows the quick verification of member link connectivity with or without LACP. A UDP port distinguishes BFD over LAG packets from BFD over single-hop IP.

NOTE: IANA has allocated 6784 as the UDP destination port for micro BFD.

To enable failure detection for LAG networks for aggregated Ethernet interfaces:

- Include the *bfd-liveness-detection* statement in the configuration.
- Specify a hold-down interval value to set the minimum time that the BFD session must remain up before a state change notification is sent to the other members in the LAG network.
- Specify the minimum interval that indicates the time interval for transmitting and receiving data.
- Starting with Junos OS Release 14.1, specify the neighbor in a BFD session. In releases prior to Junos OS Release 16.1, you must configure the loopback address of the remote destination as the neighbor

address. Beginning with Junos OS Release 16.1, you can also configure this feature on MX series routers with aggregated Ethernet interface address of the remote destination as the neighbor address.

NOTE: On T1600 and T4000 routers, you cannot configure the local aggregated Ethernet Interface address of the remote destination as the neighbor address.

CAUTION: Deactivate *bfd-liveness-detection* at the **[edit interfaces aex aggregated-ether-options]** hierarchy level or deactivate the aggregated Ethernet interface before changing the neighbor address from loopback IP address to aggregated Ethernet interface IP address. Modifying the local and neighbor address without deactivating **bfd-liveness-detection** or the aggregated Ethernet interface first might cause micro BFD sessions failure.

NOTE: Beginning with Release 16.1R2, Junos OS checks and validates the configured micro BFD **local-address** against the interface or loopback IP address before the configuration commit. Junos OS performs this check on both IPv4 and IPv6 micro BFD address configurations, and if they do not match, the commit fails.

NOTE: This feature works only when both the devices support BFD. If BFD is configured at one end of the LAG, this feature does not work.

For the IPv6 address family, disable duplicate address detection before configuring this feature with AE interface addresses. To disable duplicate address detection, include the **dad-disable** statement at the **[edit interface *aex* unit *y* family inet6]** hierarchy level.

SEE ALSO

authentication

bfd-liveness-detection

detection-time

transmit-interval

Understanding Distributed BFD

Bidirectional Forwarding Detection (BFD) is a protocol to verify the liveliness of data path.

The terms *nondistributed BFD* and *centralized BFD* refer to BFD that runs on the Routing Engine. The term *distributed BFD* refers to BFD that runs on the Packet Forwarding Engine.

> **NOTE:** By default, SRX Series devices operate in centralized BFD mode.

- Single-hop BFD—Single-hop BFD in Junos OS runs in distributed mode by default. The exceptions are OSPFv3 BFD and PIMv6 BFD, for which only nondistributed BFD is supported. Single-hop BFD control packets use UDP port 3784.
- Multihop BFD—One desirable application of BFD is to detect connectivity to routing devices that span multiple network hops and follow unpredictable paths. This is known as a multihop session. Prior to Junos OS Release 12.3, multihop BFD is nondistributed and runs on the Routing Engine. Starting in Junos OS Release 12.3, multihop BFD runs in distributed mode by default. Multihop BFD control packets use UDP port 4784.

  > **NOTE:** In a multichassis link aggregation group setup, Inter-Chassis Control Protocol (ICCP) uses BFD in multihop mode. Multihop BFD runs in centralized mode in this kind of setup prior to Junos OS Release 12.3 and continues to do so as of Junos OS Release 12.3 and later.

  > **NOTE:** QFX5110, QFX5120, QFX5200, and QFX5210 switches support multihop Bidirectional Forwarding Detection (BFD) inline keep alive support which will enable sessions to be configured at less than 1 second. Performance may vary depending on the system load. 10 inline BFD sessions are supported and can be configured with a timer of 150 x 3 milliseconds.

For both single-hop BFD and multihop BFD, the BFD session can be made to run on the Routing Engine (in nondistributed mode) by configuring **set routing-options ppm no-delegate-processing** and then running the **clear bfd session** command.

The benefits of distributed BFD are mainly in the scaling and performance areas.

The benefits are as follows:

- Allows for the creation of a larger number of BFD sessions.
- Runs BFD sessions with a shorter transfer/receive timer interval, which can in turn be used to bring down the overall detection time.

- Separates the functionality of BFD from that of the Routing Engine. This means that a BFD session can stay up during graceful restart, even with an aggressive interval. The minimum interval for Routing Engine-based BFD sessions to survive graceful Routing Engine switchover is 2500 ms, This is improved to sub-second times with distribution.
- Offloads the processing to the FPC CPU. This frees up the Routing Engine CPU, resulting in improved scaling and performance for Routing Engine-based applications.
- Starting with Junos OS Release 15.1X49-D100, dedicated BFD is supported on SRX340, SRX345, and SRX1500 devices.

  Starting with Junos OS Release 15.1X49-D100, real-time BFD is supported on SRX300 and SRX320 devices.

  Starting with Junos OS Release 15.1X49-D110, dedicated BFD is supported on SRX550M devices.

  Starting with Junos OS Release 12.3X48-D60, dedicated BFD is supported on SRX240, SRX550, and SRX650 devices.

  Starting with Junos OS Release 12.3X48-D60, real-time BFD is supported on SRX100, SRX110, SRX210, and SRX220 devices.

  - To enable dedicated BFD on SRX100, SRX110, SRX210, SRX220, SRX240, SRX300, SRX320, SRX340, SRX345, SRX550, SRX550M, SRX650, and SRX1500 devices, use the **set chassis dedicated-ukern-cpu** command.

    Enabling dedicated BFD impacts traffic throughput as one CPU core is removed from data plane processing.
  - To enable real-time BFD on SRX100, SRX110, SRX210, SRX220, SRX240, SRX300, SRX320, SRX340, SRX345, SRX550, SRX550M, and SRX650 devices, use the **set chassis realtime-ukern-thread** command.

    Enabling real-time BFD does not impact data plane performance. Higher priority is given to the pfe process handling BFD in distributed mode. This is suitable for scenarios where the number of BFD sessions are less.

Table 4 on page 30 lists the BFD modes supported on SRX Series devices.

Table 6: BFD Modes Supported on SRX Series Devices

SRX Series Device	Default BFD Mode	Distributed BFD	Real-Time BFD	Dedicated Core
SRX100	Centralized	Configuration	Configuration (Optional)	Not supported
SRX110	Centralized	Configuration	Configuration (Optional)	Not supported
SRX210	Centralized	Configuration	Configuration (Optional)	Not supported
SRX220	Centralized	Configuration	Configuration (Optional)	Not supported

Table 6: BFD Modes Supported on SRX Series Devices *(continued)*

SRX Series Device	Default BFD Mode	Distributed BFD	Real-Time BFD	Dedicated Core
SRX240	Centralized	Configuration	Configuration	Configuration (Optional)
SRX300	Centralized	Configuration	Configuration (Optional)	Not supported
SRX320	Centralized	Configuration	Configuration (Optional)	Not supported
SRX340	Centralized	Configuration	Configuration	Configuration (Optional)
SRX345	Centralized	Configuration	Configuration	Configuration (Optional)
SRX550	Centralized	Configuration	Configuration	Configuration (Optional)
SRX550M	Centralized	Configuration	Configuration	Configuration (Optional)
SRX650	Centralized	Configuration	Configuration	Configuration (Optional)
SRX1500	Centralized	Configuration	Not supported	Configuration (Optional)
SRX4100	Centralized	Not supported	Not supported	Not supported
SRX4200	Centralized	Not supported	Not supported	Not supported
SRX5400	Centralized	Not supported	Not supported	Not supported
SRX5600	Centralized	Not supported	Not supported	Not supported
SRX5800	Centralized	Not supported	Not supported	Not supported

To determine if a BFD peer is running distributed BFD, run the **show bfd sessions extensive** command and look for **Remote is control-plane independent** in the command output.

For distributed BFD to work, you need to configure the lo0 interface with unit 0 and the appropriate family.

```
# set interfaces lo0 unit 0 family inet
# set interfaces lo0 unit 0 family inet6
# set interfaces lo0 unit 0 family mpls
```

This is true for the following types of BFD sessions:

- BFD over ae logical interfaces, both IPv4 and IPv6
- Multihop BFD, both IPv4 and IPv6
- BFD over VLAN interfaces in EX Series switches, both IPv4 and IPv6
- Virtual Circuit Connectivity Verification (VCCV) BFD (Layer 2 circuit, Layer 3 VPN, and VPLS) (MPLS)

> **NOTE:** Starting in Junos OS Release 13.3R5, if you apply a firewall filter on a loopback interface for a multihop BFD session with a delegated anchor FPC, Junos OS does not execute this filter, because there is an implicit filter on all ingress FPCs to forward packets to the anchor FPC. Therefore, the firewall filter on the loopback interface is not applied on these packets. If you do not want these packets to be forwarded to the anchor FPC, you can configure the **no-delegate-processing** option.

For information about troubleshooting BFD, see Juniper Networks Knowledge Base article 26746.

> **NOTE:** Starting in Junos OS Release 13.3, the distribution of adjacency entry (the IP addresses of adjacent routers) and transmit entry (the IP address of transmitting routers) for a BFD session is asymmetric. This is because an adjacency entry that requires rules might or might not be distributed based on the redirect rule, and the distribution of transmit entries is *not* dependent on the redirect rule.
>
> The term *redirect rule* here denotes the capability of an interface to send protocol redirect messages. See *Disabling the Transmission of Redirect Messages on an Interface*.

SEE ALSO

show bfd session

Understanding BFD for RIP | 24

Understanding BFD for Static Routes for Faster Network Failure Detection | 10

Understanding BFD for BGP | 15

Understanding BFD for IS-IS | 20

Understanding BFD for OSPF | 17

Understanding EBGP Multihop

Configuring BFD for PIM

The Bidirectional Forwarding Detection (BFD) Protocol is a simple hello mechanism that detects failures in a network. BFD works with a wide variety of network environments and topologies. A pair of routing devices exchanges BFD packets. Hello packets are sent at a specified, regular interval. A neighbor failure is detected when the routing device stops receiving a reply after a specified interval. The BFD failure detection timers have shorter time limits than the Protocol Independent Multicast (PIM) hello hold time, so they provide faster detection.

The BFD failure detection timers are adaptive and can be adjusted to be faster or slower. The lower the BFD failure detection timer value, the faster the failure detection and vice versa. For example, the timers can adapt to a higher value if the adjacency fails (that is, the timer detects failures more slowly). Or a neighbor can negotiate a higher value for a timer than the configured value. The timers adapt to a higher value when a BFD session flap occurs more than three times in a span of 15 seconds. A back-off algorithm increases the receive (Rx) interval by two if the local BFD instance is the reason for the session flap. The transmission (Tx) interval is increased by two if the remote BFD instance is the reason for the session flap. You can use the **clear bfd adaptation** command to return BFD interval timers to their configured values. The **clear bfd adaptation** command is hitless, meaning that the command does not affect traffic flow on the routing device.

You must specify the minimum transmit and minimum receive intervals to enable BFD on PIM.

To enable failure detection:

1. Configure the interface globally or in a routing instance.

   This example shows the global configuration.

   ```
   [edit protocols pim]
   user@host# edit interface fe-1/0/0.0 family inet bfd-liveness-detection
   ```

2. Configure the minimum transmit interval.

   This is the minimum interval after which the routing device transmits hello packets to a neighbor with which it has established a BFD session. Specifying an interval smaller than 300 ms can cause undesired BFD flapping.

   ```
   [edit protocols pim interface fe-1/0/0.0 family inet bfd-liveness-detection]
   user@host# set transmit-interval 350
   ```

3. Configure the minimum interval after which the routing device expects to receive a reply from a neighbor with which it has established a BFD session.

Specifying an interval smaller than 300 ms can cause undesired BFD flapping.

```
[edit protocols pim interface fe-1/0/0.0 family inet bfd-liveness-detection]
user@host# set minimum-receive-interval 350
```

4. (Optional) Configure other BFD settings.

   As an alternative to setting the receive and transmit intervals separately, configure one interval for both.

```
[edit protocols pim interface fe-1/0/0.0 family inet bfd-liveness-detection]
user@host# set minimum-interval 350
```

5. Configure the threshold for the adaptation of the BFD session detection time.

   When the detection time adapts to a value equal to or greater than the threshold, a single trap and a single system log message are sent.

```
[edit protocols pim interface fe-1/0/0.0 family inet bfd-liveness-detection]
user@host# set detection-time threshold 800
```

6. Configure the number of hello packets not received by a neighbor that causes the originating interface to be declared down.

```
[edit protocols pim interface fe-1/0/0.0 family inet bfd-liveness-detection]
user@host# set multiplier 50
```

7. Configure the BFD version.

```
[edit protocols pim interface fe-1/0/0.0 family inet bfd-liveness-detection]
user@host# set version 1
```

8. Specify that BFD sessions should not adapt to changing network conditions.

   We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation enabled in your network.

```
[edit protocols pim interface fe-1/0/0.0 family inet bfd-liveness-detection]
```

```
user@host# set no-adaptation
```

9. Verify the configuration by checking the output of the **show bfd session** command.

RELATED DOCUMENTATION

show bfd session

Example: Configuring BFD for Static Routes for Faster Network Failure Detection

IN THIS SECTION

- Requirements | 131
- Overview | 131
- Configuration | 132
- Verification | 137

This example shows how to configure Bidirectional Forwarding Detection (BFD) for static routes.

Requirements

In this example, no special configuration beyond device initialization is required.

Overview

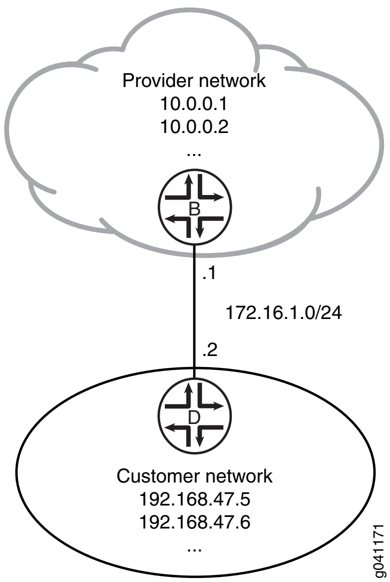
There are many practical applications for static routes. Static routing is often used at the network edge to support attachment to stub networks, which, given their single point of entry and egress, are well suited to the simplicity of a static route. In Junos OS, static routes have a global preference of 5. Static routes are activated if the specified next hop is reachable.

In this example, you configure the static route 192.168.47.0/24 from the provider network to the customer network, using the next-hop address of 172.16.1.2. You also configure a static default route of 0.0.0.0/0 from the customer network to the provider network, using a next-hop address of 172.16.1.1.

For demonstration purposes, some loopback interfaces are configured on Device B and Device D. These loopback interfaces provide addresses to ping and thus verify that the static routes are working.

Figure 1 on page 35 shows the sample network.

Figure 6: Customer Routes Connected to a Service Provider



Configuration

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

Device B

```
set interfaces ge-1/2/0 unit 0 description B->D
```

```
set interfaces ge-1/2/0 unit 0 family inet address 172.16.1.1/24
set interfaces lo0 unit 57 family inet address 10.0.0.1/32
set interfaces lo0 unit 57 family inet address 10.0.0.2/32
set routing-options static route 192.168.47.0/24 next-hop 172.16.1.2
set routing-options static route 192.168.47.0/24 bfd-liveness-detection minimum-interval 1000
set routing-options static route 192.168.47.0/24 bfd-liveness-detection description Site-xxx
set protocols bfd traceoptions file bfd-trace
set protocols bfd traceoptions flag all
```

Device D

```
set interfaces ge-1/2/0 unit 1 description D->B
set interfaces ge-1/2/0 unit 1 family inet address 172.16.1.2/24
set interfaces lo0 unit 2 family inet address 192.168.47.5/32
set interfaces lo0 unit 2 family inet address 192.168.47.6/32
set routing-options static route 0.0.0.0/0 next-hop 172.16.1.1
set routing-options static route 0.0.0.0/0 bfd-liveness-detection minimum-interval 1000
set protocols bfd traceoptions file bfd-trace
set protocols bfd traceoptions flag all
```

Step-by-Step Procedure

The following example requires that you navigate various levels in the configuration hierarchy. For information about navigating the CLI, see *Using the CLI Editor in Configuration Mode* in the *CLI User Guide*.

To configure BFD for static routes:

1. On Device B, configure the interfaces.

```
[edit interfaces]
user@B# set ge-1/2/0 unit 0 description B->D
user@B# set ge-1/2/0 unit 0 family inet address 172.16.1.1/24
user@B# set lo0 unit 57 family inet address 10.0.0.1/32
user@B# set lo0 unit 57 family inet address 10.0.0.2/32
```

2. On Device B, create a static route and set the next-hop address.

```
[edit routing-options]
user@B# set static route 192.168.47.0/24 next-hop 172.16.1.2
```

3. On Device B, configure BFD for the static route.

```
[edit routing-options]
user@B# set static route 192.168.47.0/24 bfd-liveness-detection minimum-interval 1000
set routing-options static route 192.168.47.0/24 bfd-liveness-detection description Site-xxx
```

4. On Device B, configure tracing operations for BFD.

```
[edit protocols]
user@B# set bfd traceoptions file bfd-trace
user@B# set bfd traceoptions flag all
```

5. If you are done configuring Device B, commit the configuration.

```
[edit]
user@B# commit
```

6. On Device D, configure the interfaces.

```
[edit interfaces]
user@D# set ge-1/2/0 unit 1 description D->B
user@D# set ge-1/2/0 unit 1 family inet address 172.16.1.2/24
user@D# set lo0 unit 2 family inet address 192.168.47.5/32
user@D# set lo0 unit 2 family inet address 192.168.47.6/32
```

7. On Device D, create a static route and set the next-hop address.

```
[edit routing-options]
user@D# set static route 0.0.0.0/0 next-hop 172.16.1.1
```

8. On Device D, configure BFD for the static route.

```
[edit routing-options]
user@D# set static route 0.0.0.0/0 bfd-liveness-detection minimum-interval 1000
```

9. On Device D, configure tracing operations for BFD.

```
[edit protocols]
```

```
user@D# set bfd traceoptions file bfd-trace
user@D# set bfd traceoptions flag all
```

10. If you are done configuring Device D, commit the configuration.

```
[edit]
user@D# commit
```

Results

Confirm your configuration by issuing the **show interfaces**, **show protocols**, and **show routing-options** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

Device B

```
user@B# show interfaces
ge-1/2/0 {
    unit 0 {
        description B->D;
        family inet {
            address 172.16.1.1/24;
        }
    }
}
lo0 {
    unit 57 {
        family inet {
            address 10.0.0.1/32;
            address 10.0.0.2/32;
        }
    }
}
```

```
user@D# show protocols
bfd {
    traceoptions {
        file bfd-trace;
```

```
        flag all;
    }
}
```

```
user@B# show routing-options
static {
    route 192.168.47.0/24 {
        next-hop 172.16.1.2;
        bfd-liveness-detection {
            description Site- xxx;
            minimum-interval 1000;
        }
    }
}
```

Device D

```
user@D# show interfaces
ge-1/2/0 {
    unit 1 {
        description D->B;
        family inet {
            address 172.16.1.2/24;
        }
    }
}
lo0 {
    unit 2 {
        family inet {
            address 192.168.47.5/32;
            address 192.168.47.6/32;
        }
    }
}
```

```
user@D# show routing-options
static {
    route 0.0.0.0/0 {
        next-hop 172.16.1.1;
        bfd-liveness-detection {
```

```
            description Site - xxx;
            minimum-interval 1000;
        }
    }
}
```

Verification

IN THIS SECTION

- Verifying That BFD Sessions Are Up | 137
- Viewing Detailed BFD Events | 139

Confirm that the configuration is working properly.

Verifying That BFD Sessions Are Up

Purpose

Verify that the BFD sessions are up, and view details about the BFD sessions.

Action

From operational mode, enter the **show bfd session extensive** command.

`user@B>` **show bfd session extensive**

```
                                                    Detect   Transmit
Address                  State     Interface        Time     Interval  Multiplier
172.16.1.2               Up        lt-1/2/0.0       3.000     1.000        3
 Client Static, description Site-xxx, TX interval 1.000, RX interval 1.000
 Session up time 00:14:30
 Local diagnostic None, remote diagnostic None
 Remote state Up, version 1
 Replicated, routing table index 172
 Min async interval 1.000, min slow interval 1.000
 Adaptive async TX interval 1.000, RX interval 1.000
 Local min TX interval 1.000, minimum RX interval 1.000, multiplier 3
```

```
 Remote min TX interval 1.000, min RX interval 1.000, multiplier 3
 Local discriminator 2, remote discriminator 1
 Echo mode disabled/inactive

1 sessions, 1 clients
Cumulative transmit rate 1.0 pps, cumulative receive rate 1.0 pps
```

NOTE: The **description Site- <*xxx*>** is supported only on the SRX Series devices.

If each client has more than one description field, then it displays "and more" along with the first description field.

`user@D>` **show bfd session extensive**

```
                                                  Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
172.16.1.1               Up        lt-1/2/0.1     3.000     1.000        3
 Client Static, TX interval 1.000, RX interval 1.000
 Session up time 00:14:35
 Local diagnostic None, remote diagnostic None
 Remote state Up, version 1
 Replicated, routing table index 170
 Min async interval 1.000, min slow interval 1.000
 Adaptive async TX interval 1.000, RX interval 1.000
 Local min TX interval 1.000, minimum RX interval 1.000, multiplier 3
 Remote min TX interval 1.000, min RX interval 1.000, multiplier 3
 Local discriminator 1, remote discriminator 2
 Echo mode disabled/inactive

1 sessions, 1 clients
Cumulative transmit rate 1.0 pps, cumulative receive rate 1.0 pps
```

Meaning

The **TX interval 1.000, RX interval 1.000** output represents the setting configured with the **minimum-interval** statement. All of the other output represents the default settings for BFD. To modify the default settings, include the optional statements under the **bfd-liveness-detection** statement.

Viewing Detailed BFD Events

Purpose

View the contents of the BFD trace file to assist in troubleshooting, if needed.

Action

From operational mode, enter the **file show /var/log/bfd-trace** command.

user@B> **file show /var/log/bfd-trace**

```
Nov 23 14:26:55    Data (9) len 35: (hex) 42 46 44 20 70 65 72 69 6f 64 69 63 20
78 6d 69 74 20 72
Nov 23 14:26:55 PPM Trace: BFD periodic xmit rt tbl index 172
Nov 23 14:26:55 Received Downstream TraceMsg (22) len 108:
Nov 23 14:26:55    IfIndex (3) len 4: 0
Nov 23 14:26:55    Protocol (1) len 1: BFD
Nov 23 14:26:55    Data (9) len 83: (hex) 70 70 6d 64 5f 62 66 64 5f 73 65 6e 64
6d 73 67 20 3a 20
Nov 23 14:26:55 PPM Trace: ppmd_bfd_sendmsg : socket 12 len 24, ifl 78 src
172.16.1.1 dst 172.16.1.2 errno 65
Nov 23 14:26:55 Received Downstream TraceMsg (22) len 93:
Nov 23 14:26:55    IfIndex (3) len 4: 0
Nov 23 14:26:55    Protocol (1) len 1: BFD
Nov 23 14:26:55    Data (9) len 68: (hex) 42 46 44 20 70 65 72 69 6f 64 69 63 20
78 6d 69 74 20 74
```

Meaning

BFD messages are being written to the trace file.

RELATED DOCUMENTATION

Understanding BFD for Static Routes for Faster Network Failure Detection | 10

Example: Configuring BFD on Internal BGP Peer Sessions

IN THIS SECTION

- Requirements | 140
- Overview | 140
- Configuration | 142
- Verification | 147

This example shows how to configure internal BGP (IBGP) peer sessions with the Bidirectional Forwarding Detection (BFD) protocol to detect failures in a network.

Requirements

No special configuration beyond device initialization is required before you configure this example.

Overview

The minimum configuration to enable BFD on IBGP sessions is to include the **bfd-liveness-detection minimum-interval** statement in the BGP configuration of all neighbors participating in the BFD session. The **minimum-interval** statement specifies the minimum transmit and receive intervals for failure detection. Specifically, this value represents the minimum interval after which the local routing device transmits hello packets as well as the minimum interval that the routing device expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a value from 1 through 255,000 milliseconds.

Optionally, you can specify the minimum transmit and receive intervals separately using the **transmit-interval minimum-interval** and **minimum-receive-interval** statements. For information about these and other optional BFD configuration statements, see **bfd-liveness-detection**.

NOTE: BFD is an intensive protocol that consumes system resources. Specifying a minimum interval for BFD less than 100 milliseconds for Routing Engine-based sessions and less than 10 milliseconds for distributed BFD sessions can cause undesired BFD flapping.

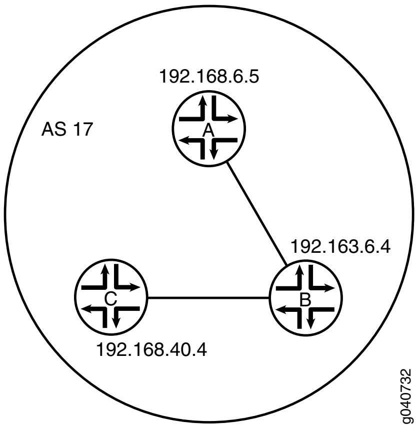
Depending on your network environment, these additional recommendations might apply:

- To prevent BFD flapping during the general Routing Engine switchover event, specify a minimum interval of 5000 milliseconds for Routing Engine-based sessions. This minimum value is required because, during the general Routing Engine switchover event, processes such as RPD, MIBD, and SNMPD utilize CPU resources for more than the specified threshold value. Hence, BFD processing and scheduling is affected because of this lack of CPU resources.
- For BFD sessions to remain up during the dual chassis cluster control link scenario, when the first control link fails, specify the minimum interval of 6000 milliseconds to prevent the LACP from flapping on the secondary node for Routing Engine-based sessions.
- For large-scale network deployments with a large number of BFD sessions, specify a minimum interval of 300 milliseconds for Routing Engine-based sessions and 100 milliseconds for distributed BFD sessions.
- For very large-scale network deployments with a large number of BFD sessions, contact Juniper Networks customer support for more information.
- For BFD sessions to remain up during a Routing Engine switchover event when nonstop active routing (NSR) is configured, specify a minimum interval of 2500 milliseconds for Routing Engine-based sessions. For distributed BFD sessions with NSR configured, the minimum interval recommendations are unchanged and depend only on your network deployment.

BFD is supported on the default routing instance (the main router), routing instances, and logical systems. This example shows BFD on logical systems.

Figure 2 on page 45 shows a typical network with internal peer sessions.

Figure 7: Typical Network with IBGP Sessions



Configuration

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

Device A

```
set logical-systems A interfaces lt-1/2/0 unit 1 description to-B
set logical-systems A interfaces lt-1/2/0 unit 1 encapsulation ethernet
set logical-systems A interfaces lt-1/2/0 unit 1 peer-unit 2
set logical-systems A interfaces lt-1/2/0 unit 1 family inet address 10.10.10.1/30
set logical-systems A interfaces lo0 unit 1 family inet address 192.168.6.5/32
set logical-systems A protocols bgp group internal-peers type internal
set logical-systems A protocols bgp group internal-peers traceoptions file bgp-bfd
set logical-systems A protocols bgp group internal-peers traceoptions flag bfd detail
set logical-systems A protocols bgp group internal-peers local-address 192.168.6.5
set logical-systems A protocols bgp group internal-peers export send-direct
set logical-systems A protocols bgp group internal-peers bfd-liveness-detection minimum-interval
  1000
set logical-systems A protocols bgp group internal-peers neighbor 192.163.6.4
set logical-systems A protocols bgp group internal-peers neighbor 192.168.40.4
set logical-systems A protocols ospf area 0.0.0.0 interface lo0.1 passive
set logical-systems A protocols ospf area 0.0.0.0 interface lt-1/2/0.1
set logical-systems A policy-options policy-statement send-direct term 2 from protocol direct
```

```
set logical-systems A policy-options policy-statement send-direct term 2 then accept
set logical-systems A routing-options router-id 192.168.6.5
set logical-systems A routing-options autonomous-system 17
```

Device B

```
set logical-systems B interfaces lt-1/2/0 unit 2 description to-A
set logical-systems B interfaces lt-1/2/0 unit 2 encapsulation ethernet
set logical-systems B interfaces lt-1/2/0 unit 2 peer-unit 1
set logical-systems B interfaces lt-1/2/0 unit 2 family inet address 10.10.10.2/30
set logical-systems B interfaces lt-1/2/0 unit 5 description to-C
set logical-systems B interfaces lt-1/2/0 unit 5 encapsulation ethernet
set logical-systems B interfaces lt-1/2/0 unit 5 peer-unit 6
set logical-systems B interfaces lt-1/2/0 unit 5 family inet address 10.10.10.5/30
set logical-systems B interfaces lo0 unit 2 family inet address 192.163.6.4/32
set logical-systems B protocols bgp group internal-peers type internal
set logical-systems B protocols bgp group internal-peers local-address 192.163.6.4
set logical-systems B protocols bgp group internal-peers export send-direct
set logical-systems B protocols bgp group internal-peers bfd-liveness-detection minimum-interval
  1000
set logical-systems B protocols bgp group internal-peers neighbor 192.168.40.4
set logical-systems B protocols bgp group internal-peers neighbor 192.168.6.5
set logical-systems B protocols ospf area 0.0.0.0 interface lo0.2 passive
set logical-systems B protocols ospf area 0.0.0.0 interface lt-1/2/0.2
set logical-systems B protocols ospf area 0.0.0.0 interface lt-1/2/0.5
set logical-systems B policy-options policy-statement send-direct term 2 from protocol direct
set logical-systems B policy-options policy-statement send-direct term 2 then accept
set logical-systems B routing-options router-id 192.163.6.4
set logical-systems B routing-options autonomous-system 17
```

Device C

```
set logical-systems C interfaces lt-1/2/0 unit 6 description to-B
set logical-systems C interfaces lt-1/2/0 unit 6 encapsulation ethernet
set logical-systems C interfaces lt-1/2/0 unit 6 peer-unit 5
set logical-systems C interfaces lt-1/2/0 unit 6 family inet address 10.10.10.6/30
set logical-systems C interfaces lo0 unit 3 family inet address 192.168.40.4/32
```

```
set logical-systems C protocols bgp group internal-peers type internal
set logical-systems C protocols bgp group internal-peers local-address 192.168.40.4
set logical-systems C protocols bgp group internal-peers export send-direct
set logical-systems C protocols bgp group internal-peers bfd-liveness-detection minimum-interval
  1000
set logical-systems C protocols bgp group internal-peers neighbor 192.163.6.4
set logical-systems C protocols bgp group internal-peers neighbor 192.168.6.5
set logical-systems C protocols ospf area 0.0.0.0 interface lo0.3 passive
set logical-systems C protocols ospf area 0.0.0.0 interface lt-1/2/0.6
set logical-systems C policy-options policy-statement send-direct term 2 from protocol direct
set logical-systems C policy-options policy-statement send-direct term 2 then accept
set logical-systems C routing-options router-id 192.168.40.4
set logical-systems C routing-options autonomous-system 17
```

Configuring Device A

Step-by-Step Procedure

The following example requires that you navigate various levels in the configuration hierarchy. For information about navigating the CLI, see *Using the CLI Editor in Configuration Mode* in the *CLI User Guide*.

To configure Device A:

1. Set the CLI to Logical System A.

```
user@host> set cli logical-system A
```

2. Configure the interfaces.

```
[edit interfaces lt-1/2/0 unit 1]
user@host:A# set description to-B
user@host:A# set encapsulation ethernet
user@host:A# set peer-unit 2
user@host:A# set family inet address 10.10.10.1/30
[edit interfaces lo0 unit 1]
user@host:A# set family inet address 192.168.6.5/32
```

3. Configure BGP.

   The **neighbor** statements are included for both Device B and Device C, even though Device A is not directly connected to Device C.

```
[edit protocols bgp group internal-peers]
user@host:A# set type internal
user@host:A# set local-address 192.168.6.5
user@host:A# set export send-direct
user@host:A# set neighbor 192.163.6.4
user@host:A# set neighbor 192.168.40.4
```

4. Configure BFD.

```
[edit protocols bgp group internal-peers]
user@host:A# set bfd-liveness-detection minimum-interval 1000
```

   You must configure the same minimum interval on the connecting peer.

5. (Optional) Configure BFD tracing.

```
[edit protocols bgp group internal-peers]
user@host:A# set traceoptions file bgp-bfd
user@host:A# set traceoptions flag bfd detail
```

6. Configure OSPF.

```
[edit protocols ospf area 0.0.0.0]
user@host:A# set interface lo0.1 passive
user@host:A# set interface lt-1/2/0.1
```

7. Configure a policy that accepts direct routes.

   Other useful options for this scenario might be to accept routes learned through OSPF or local routes.

```
[edit policy-options policy-statement send-direct term 2]
user@host:A# set from protocol direct
user@host:A# set then accept
```

8. Configure the router ID and the autonomous system (AS) number.

```
[edit routing-options]
user@host:A# set router-id 192.168.6.5
```

```
user@host:A# set autonomous-system 17
```

9. If you are done configuring the device, enter **commit** from configuration mode.
   Repeat these steps to configure Device B and Device C.

Results

From configuration mode, confirm your configuration by entering the **show interfaces**, **show policy-options**, **show protocols**, and **show routing-options** commands. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@host:A# show interfaces
lt-1/2/0 {
    unit 1 {
        description to-B;
        encapsulation ethernet;
        peer-unit 2;
        family inet {
            address 10.10.10.1/30;
        }
    }
}
lo0 {
    unit 1 {
        family inet {
            address 192.168.6.5/32;
        }
    }
}
```

```
user@host:A# show policy-options
policy-statement send-direct {
    term 2 {
        from protocol direct;
        then accept;
    }
}
```

```
user@host:A# show protocols
bgp {
    group internal-peers {
        type internal;
```

```
        traceoptions {
            file bgp-bfd;
            flag bfd detail;
        }
        local-address 192.168.6.5;
        export send-direct;
        bfd-liveness-detection {
            minimum-interval 1000;
        }
        neighbor 192.163.6.4;
        neighbor 192.168.40.4;
    }
}
ospf {
    area 0.0.0.0 {
        interface lo0.1 {
            passive;
        }
        interface lt-1/2/0.1;
    }
}
```

```
user@host:A# show routing-options
router-id 192.168.6.5;
autonomous-system 17;
```

Verification

IN THIS SECTION

- Verifying That BFD Is Enabled | 148
- Verifying That BFD Sessions Are Up | 148
- Viewing Detailed BFD Events | 149
- Viewing Detailed BFD Events After Deactivating and Reactivating a Loopback Interface | 150

Confirm that the configuration is working properly.

Verifying That BFD Is Enabled

Purpose

Verify that BFD is enabled between the IBGP peers.

Action

From operational mode, enter the **show bgp neighbor** command. You can use the **| match bfd** filter to narrow the output.

`user@host:A>` **show bgp neighbor | match bfd**

```
Options: <BfdEnabled>
  BFD: enabled, up
  Trace file: /var/log/A/bgp-bfd size 131072 files 10
  Options: <BfdEnabled>
  BFD: enabled, up
  Trace file: /var/log/A/bgp-bfd size 131072 files 10
```

Meaning

The output shows that Logical System A has two neighbors with BFD enabled. When BFD is not enabled, the output displays **BFD: disabled, down**, and the **<BfdEnabled>** option is absent. If BFD is enabled and the session is down, the output displays **BFD: enabled, down**. The output also shows that BFD-related events are being written to a log file because trace operations are configured.

Verifying That BFD Sessions Are Up

Purpose

Verify that the BFD sessions are up, and view details about the BFD sessions.

Action

From operational mode, enter the **show bfd session extensive** command.

`user@host:A>` **show bfd session extensive**

```
                                                  Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
192.163.6.4              Up                       3.000     1.000        3
 Client BGP, TX interval 1.000, RX interval 1.000
 Session up time 00:54:40
 Local diagnostic None, remote diagnostic None
 Remote state Up, version 1
 Logical system 12, routing table index 25
```

```
 Min async interval 1.000, min slow interval 1.000
 Adaptive async TX interval 1.000, RX interval 1.000
 Local min TX interval 1.000, minimum RX interval 1.000, multiplier 3
 Remote min TX interval 1.000, min RX interval 1.000, multiplier 3
 Local discriminator 10, remote discriminator 9
 Echo mode disabled/inactive
 Multi-hop route table 25, local-address 192.168.6.5

                                                  Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
192.168.40.4             Up                       3.000     1.000        3
 Client BGP, TX interval 1.000, RX interval 1.000
 Session up time 00:48:03
 Local diagnostic None, remote diagnostic None
 Remote state Up, version 1
 Logical system 12, routing table index 25
 Min async interval 1.000, min slow interval 1.000
 Adaptive async TX interval 1.000, RX interval 1.000
 Local min TX interval 1.000, minimum RX interval 1.000, multiplier 3
 Remote min TX interval 1.000, min RX interval 1.000, multiplier 3
 Local discriminator 14, remote discriminator 13
 Echo mode disabled/inactive
 Multi-hop route table 25, local-address 192.168.6.5

2 sessions, 2 clients
Cumulative transmit rate 2.0 pps, cumulative receive rate 2.0 pps
```

Meaning

The **TX interval 1.000, RX interval 1.000** output represents the setting configured with the **minimum-interval** statement. All of the other output represents the default settings for BFD. To modify the default settings, include the optional statements under the **bfd-liveness-detection** statement.

Viewing Detailed BFD Events

Purpose

View the contents of the BFD trace file to assist in troubleshooting, if needed.

Action

From operational mode, enter the **file show /var/log/A/bgp-bfd** command.

`user@host:A>` **file show /var/log/A/bgp-bfd**

```
Aug 15 17:07:25 trace_on: Tracing to "/var/log/A/bgp-bfd" started
Aug 15 17:07:26.492190 bgp_peer_init: BGP peer 192.163.6.4 (Internal AS 17) local
 address 192.168.6.5 not found.  Leaving peer idled
Aug 15 17:07:26.493176 bgp_peer_init: BGP peer 192.168.40.4 (Internal AS 17) local
 address 192.168.6.5 not found.  Leaving peer idled
Aug 15 17:07:32.597979 task_connect: task BGP_17.192.163.6.4+179 addr
192.163.6.4+179: No route to host
Aug 15 17:07:32.599623 bgp_connect_start: connect 192.163.6.4 (Internal AS 17):
No route to host
Aug 15 17:07:36.869394 task_connect: task BGP_17.192.168.40.4+179 addr
192.168.40.4+179: No route to host
Aug 15 17:07:36.870624 bgp_connect_start: connect 192.168.40.4 (Internal AS 17):
No route to host
Aug 15 17:08:04.599220 task_connect: task BGP_17.192.163.6.4+179 addr
192.163.6.4+179: No route to host
Aug 15 17:08:04.601135 bgp_connect_start: connect 192.163.6.4 (Internal AS 17):
No route to host
Aug 15 17:08:08.869717 task_connect: task BGP_17.192.168.40.4+179 addr
192.168.40.4+179: No route to host
Aug 15 17:08:08.869934 bgp_connect_start: connect 192.168.40.4 (Internal AS 17):
No route to host
Aug 15 17:08:36.603544 advertising receiving-speaker only capabilty to neighbor
192.163.6.4 (Internal AS 17)
Aug 15 17:08:36.606726 bgp_read_message: 192.163.6.4 (Internal AS 17): 0 bytes
buffered
Aug 15 17:08:36.609119 Initiated BFD session to peer 192.163.6.4 (Internal AS 17):
 address=192.163.6.4 ifindex=0 ifname=(none) txivl=1000 rxivl=1000 mult=3 ver=255
Aug 15 17:08:36.734033 advertising receiving-speaker only capabilty to neighbor
192.168.40.4 (Internal AS 17)
Aug 15 17:08:36.738436 Initiated BFD session to peer 192.168.40.4 (Internal AS
17): address=192.168.40.4 ifindex=0 ifname=(none) txivl=1000 rxivl=1000 mult=3
ver=255
Aug 15 17:08:40.537552 BFD session to peer 192.163.6.4 (Internal AS 17) up
Aug 15 17:08:40.694410 BFD session to peer 192.168.40.4 (Internal AS 17) up
```

Meaning

Before the routes are established, the **No route to host** message appears in the output. After the routes are established, the last two lines show that both BFD sessions come up.

Viewing Detailed BFD Events After Deactivating and Reactivating a Loopback Interface

Purpose

Check to see what happens after bringing down a router or switch and then bringing it back up. To simulate bringing down a router or switch, deactivate the loopback interface on Logical System B.

Action

1. From configuration mode, enter the **deactivate logical-systems B interfaces lo0 unit 2 family inet** command.

   user@host:A# **deactivate logical-systems B interfaces lo0 unit 2 family inet**

   user@host:A# **commit**

2. From operational mode, enter the **file show /var/log/A/bgp-bfd** command.

   user@host:A> **file show /var/log/A/bgp-bfd**

```
...
Aug 15 17:20:55.995648 bgp_read_v4_message:9747: NOTIFICATION received from
192.163.6.4 (Internal AS 17): code 6 (Cease) subcode 6 (Other Configuration
Change)
Aug 15 17:20:56.004508 Terminated BFD session to peer 192.163.6.4 (Internal AS
 17)
Aug 15 17:21:28.007755 task_connect: task BGP_17.192.163.6.4+179 addr
192.163.6.4+179: No route to host
Aug 15 17:21:28.008597 bgp_connect_start: connect 192.163.6.4 (Internal AS 17):
 No route to host
```

3. From configuration mode, enter the **activate logical-systems B interfaces lo0 unit 2 family inet** command.

   user@host:A# **activate logical-systems B interfaces lo0 unit 2 family inet**

   user@host:A# **commit**

4. From operational mode, enter the **file show /var/log/A/bgp-bfd** command.

   user@host:A> **file show /var/log/A/bgp-bfd**

```
...
Aug 15 17:25:53.623743 advertising receiving-speaker only capabilty to neighbor
 192.163.6.4 (Internal AS 17)
Aug 15 17:25:53.631314 Initiated BFD session to peer 192.163.6.4 (Internal AS
17): address=192.163.6.4 ifindex=0 ifname=(none) txivl=1000 rxivl=1000 mult=3
ver=255
Aug 15 17:25:57.570932 BFD session to peer 192.163.6.4 (Internal AS 17) up
```

RELATED DOCUMENTATION

Example: Configuring BFD Authentication for BGP

Example: Configuring BFD for OSPF

IN THIS SECTION

- Requirements | 152
- Overview | 153
- Configuration | 154
- Verification | 156

This example shows how to configure the Bidirectional Forwarding Detection (BFD) protocol for OSPF.

Requirements

Before you begin:

- Configure the device interfaces. See the *Junos OS Network Interfaces Library for Routing Devices*.
- Configure the router identifiers for the devices in your OSPF network. See *Example: Configuring an OSPF Router Identifier*.
- Control OSPF designated router election. See *Example: Controlling OSPF Designated Router Election*.
- Configure a single-area OSPF network. See *Example: Configuring a Single-Area OSPF Network*.
- Configure a multiarea OSPF network. See *Example: Configuring a Multiarea OSPF Network*.
- Configure a multiarea OSPF network. See *Example: Configuring a Multiarea OSPF Network*.

Overview

An alternative to adjusting the OSPF hello interval and dead interval settings to increase route convergence is to configure BFD. The BFD protocol is a simple hello mechanism that detects failures in a network. The BFD failure detection timers have shorter timer limits than the OSPF failure detection mechanisms, thereby providing faster detection.

BFD is useful on interfaces that are unable to detect failure quickly, such as Ethernet interfaces. Other interfaces, such as SONET interfaces, already have built-in failure detection. Configuring BFD on those interfaces is unnecessary.

You configure BFD on a pair of neighboring OSPF interfaces. Unlike the OSPF hello interval and dead interval settings, you do not have to enable BFD on all interfaces in an OSPF area.

In this example, you enable failure detection by including the **bfd-liveness-detection** statement on the neighbor OSPF interface **fe-0/1/0** in area 0.0.0.0 and configure the BFD packet exchange interval to 300 milliseconds, configure 4 as the number of missed hello packets that causes the originating interface to be declared down, and configure BFD sessions only for OSPF neighbors with full neighbor adjacency by including the following settings:

- **full-neighbors-only**—In Junos OS Release 9.5 and later, configures the BFD protocol to establish BFD sessions only for OSPF neighbors with full neighbor adjacency. The default behavior is to establish BFD sessions for all OSPF neighbors.
- **minimum-interval**—Configures the minimum interval, in milliseconds, after which the local routing device transmits hello packets as well as the minimum interval after which the routing device expects to receive a reply from the neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds. You can also specify the minimum transmit and receive intervals separately using the **transmit-interval minimum-interval** and **minimum-receive-interval** statements.

NOTE: BFD is an intensive protocol that consumes system resources. Specifying a minimum interval for BFD of less than 100 ms for Routing Engine-based sessions and 10 ms for distributed BFD sessions can cause undesired BFD flapping.

Depending on your network environment, these additional recommendations might apply:

- For large-scale network deployments with a large number of BFD sessions, specify a minimum interval of no less than 500 ms. An interval of 1000 ms is recommended to avoid any instability issues.

  NOTE:
  - For the bfdd process, the detection time interval set is lower than 300 ms. If there is a high priority process such as ppmd running on the system, the CPU might spend time on the ppmd process rather than the bfdd process.
  - For branch SRX Series devices, we recommend 1000 ms as the minimum keepalive time interval for BFD packets.

- For very large-scale network deployments with a large number of BFD sessions, contact Juniper Networks customer support for more information.
- For BFD sessions to remain up during a Routing Engine switchover event when nonstop active routing (NSR) is configured, specify a minimum interval of 2500 ms for Routing Engine-based sessions. For distributed BFD sessions with NSR configured, the minimum interval recommendations are unchanged and depend only on your network deployment.

- **multiplier**—Configures the number of hello packets not received by a neighbor that causes the originating interface to be declared down. By default, three missed hello packets cause the originating interface to be declared down. You can configure a value in the range from 1 through 255.

Configuration

CLI Quick Configuration

To quickly configure the BFD protocol for OSPF, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, copy and paste the commands into the CLI at the [edit] hierarchy level, and then enter **commit** from configuration mode.

```
[edit]
```

```
set protocols ospf area 0.0.0.0 interface fe-0/0/1 bfd-liveness-detection minimum-interval 300
set protocols ospf area 0.0.0.0 interface fe-0/0/1 bfd-liveness-detection multiplier 4
set protocols ospf area 0.0.0.0 interface fe-0/0/1 bfd-liveness-detection full-neighbors-only
```

Step-by-Step Procedure

To configure the BFD protocol for OSPF on one neighboring interface:

1. Create an OSPF area.

   NOTE: To specify OSPFv3, include the **ospf3** statement at the **[edit protocols]** hierarchy level.

   ```
   [edit]
   user@host# edit protocols ospf area 0.0.0.0
   ```

2. Specify the interface.

   ```
   [edit protocols ospf area 0.0.0.0]
   user@host# set interface fe-0/0/1
   ```

3. Specify the minimum transmit and receive intervals.

   ```
   [edit protocols ospf area 0.0.0.0 ]
   user@host# set interface fe-0/0/1 bfd-liveness-detection minimum-interval 300
   ```

4. Configure the number of missed hello packets that cause the originating interface to be declared down.

   ```
   [edit protocols ospf area 0.0.0.0 ]
   user@host# set interface fe-0/0/1 bfd-liveness-detection multiplier 4
   ```

5. Configure BFD sessions only for OSPF neighbors with full neighbor adjacency.

   ```
   [edit protocols ospf area 0.0.0.0 ]
   user@host# set interface fe-0/0/1 bfd-liveness-detection full-neighbors-only
   ```

6. If you are done configuring the device, commit the configuration.

```
[edit protocols ospf area 0.0.0.0 ]
user@host# commit
```

NOTE: Repeat this entire configuration on the other neighboring interface.

Results

Confirm your configuration by entering the **show protocols ospf** command. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@host# show protocols ospf
area 0.0.0.0 {
    interface fe-0/0/1.0 {
        bfd-liveness-detection {
            minimum-interval 300;
            multiplier 4;
            full-neighbors-only;
        }
    }
}
```

To confirm your OSPFv3 configuration, enter the **show protocols ospf3** command.

Verification

Confirm that the configuration is working properly.

Verifying the BFD Sessions

Purpose

Verify that the OSPF interfaces have active BFD sessions, and that session components have been configured correctly.

Action

From operational mode, enter the **show bfd session detail** command.

Meaning

The output displays information about the BFD sessions.

- The Address field displays the IP address of the neighbor.
- The Interface field displays the interface you configured for BFD.
- The State field displays the state of the neighbor and should show Full to reflect the full neighbor adjacency that you configured.
- The Transmit Interval field displays the time interval you configured to send BFD packets.
- The Multiplier field displays the multiplier you configured.

Example: Configuring BFD for IS-IS

IN THIS SECTION

- Requirements | 157
- Overview | 158
- Configuration | 158
- Verification | 162

This example describes how to configure the Bidirectional Forwarding Detection (BFD) protocol to detect failures in an IS-IS network.

NOTE: BFD is not supported with ISIS for IPV6 on QFX10000 series switches.

Requirements

Before you begin, configure IS-IS on both routers. See *Example: Configuring IS-IS* for information about the required IS-IS configuration.

This example uses the following hardware and software components:

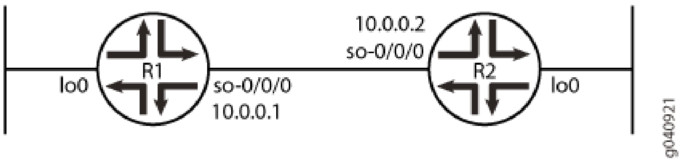
- Junos OS Release 7.3 or later
- M Series, MX Series, and T Series routers

Overview

This example shows two routers connected to each other. A loopback interface is configured on each router. IS-IS and BFD protocols are configured on both routers.

Figure 3 on page 60 shows the sample network.

Figure 8: Configuring BFD for IS-IS



Configuration

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

Router R1

```
set protocols isis interface so-0/0/0 bfd-liveness-detection detection-time threshold 5
set protocols isis interface so-0/0/0 bfd-liveness-detection minimum-interval 2
set protocols isis interface so-0/0/0 bfd-liveness-detection minimum-receive-interval 1
set protocols isis interface so-0/0/0 bfd-liveness-detection no-adaptation
set protocols isis interface so-0/0/0 bfd-liveness-detection transmit-interval threshold 3
set protocols isis interface so-0/0/0 bfd-liveness-detection transmit-interval minimum-interval 1
set protocols isis interface so-0/0/0 bfd-liveness-detection multiplier 2
set protocols isis interface so-0/0/0 bfd-liveness-detection version automatic
```

Router R2

```
set protocols isis interface so-0/0/0 bfd-liveness-detection detection-time threshold 6
set protocols isis interface so-0/0/0 bfd-liveness-detection minimum-interval 3
set protocols isis interface so-0/0/0 bfd-liveness-detection minimum-receive-interval 1
set protocols isis interface so-0/0/0 bfd-liveness-detection no-adaptation
set protocols isis interface so-0/0/0 bfd-liveness-detection transmit-interval threshold 4
set protocols isis interface so-0/0/0 bfd-liveness-detection transmit-interval minimum-interval 1
set protocols isis interface so-0/0/0 bfd-liveness-detection multiplier 2
```

```
set protocols isis interface so-0/0/0 bfd-liveness-detection version automatic
```

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see *Using the CLI Editor in Configuration Mode*.

> **NOTE:** To simply configure BFD for IS-IS, only the **minimum-interval** statement is required. The BFD protocol selects default parameters for all the other configuration statements when you use the **bfd-liveness-detection** statement without specifying any parameters.

> **NOTE:** You can change parameters at any time without stopping or restarting the existing session. BFD automatically adjusts to the new parameter value. However, no changes to BFD parameters take place until the values resynchronize with each BFD peer.

To configure BFD for IS-IS on Routers R1 and R2:

1. Enable BFD failure detection for IS-IS.

   ```
   [edit protocols isis]
   user@R1# set interface so-0/0/0 bfd-liveness-detection
   ```

   ```
   [edit protocols isis]
   user@R2# set interface so-0/0/0 bfd-liveness-detection
   ```

2. Configure the threshold for the adaptation of the detection time, which must be greater than the multiplier number multiplied by the minimum interval.

   ```
   [edit protocols isis interface so-0/0/0 bfd-liveness-detection]
   user@R1# set detection-time threshold 5
   ```

   ```
   [edit protocols isis interface so-0/0/0 bfd-liveness-detection]
   user@R2# set detection-time threshold 6
   ```

3. Configure the minimum transmit and receive intervals for failure detection.

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R1# set minimum-interval 2
```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set minimum-interval 3
```

4. Configure only the minimum receive interval for failure detection.

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R1# set minimum-receive-interval 1
```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set minimum-receive-interval 1
```

5. Disable BFD adaptation.

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R1# set no-adaptation
```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set no-adaptation
```

6. Configure the threshold for the transmit interval, which must be greater than the minimum transmit interval.

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R1# set transmit-interval threshold 3
```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set transmit-interval threshold 4
```

7. Configure the minimum transmit interval for failure detection.

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R1# set transmit-interval minimum-interval 1
```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set transmit-interval minimum-interval 1
```

8. Configure the multiplier number, which is the number of hello packets not received by the neighbor that causes the originating interface to be declared down.

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R1# set multiplier 2
```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set multiplier 2
```

9. Configure the BFD version used for detection.

   The default is to have the version detected automatically.

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R1# set version automatic
```

```
[edit protocols isis interface so-0/0/0 bfd-liveness-detection]
user@R2# set version automatic
```

Results

From configuration mode, confirm your configuration by issuing the **show protocols isis interface** command. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

`user@R1#` **show protocols isis interface so-0/0/0**

```
    bfd-liveness-detection {
        version automatic;
        minimum-interval 2;
        minimum-receive-interval 1;
        multiplier 2;
        no-adaptation;
        transmit-interval {
            minimum-interval 1;
```

```
            threshold 3;
        }
        detection-time {
            threshold 5;
        }
}
...
```

user@R2# **show protocols isis interface so-0/0/0**

```

    bfd-liveness-detection {
        version automatic;
        minimum-interval 3;
        minimum-receive-interval 1;
        multiplier 2;
        no-adaptation;
        transmit-interval {
            minimum-interval 1;
            threshold 4;
        }
        detection-time {
            threshold 6;
        }
}
...
```

Verification

IN THIS SECTION

- Verifying the Connection Between Routers R1 and R2 | 163
- Verifying That IS-IS Is Configured | 163
- Verifying That BFD Is configured | 165

Confirm that the configuration is working properly.

Verifying the Connection Between Routers R1 and R2

Purpose

Make sure that Routers R1 and R2 are connected to each other.

Action

Ping the other router to check the connectivity between the two routers as per the network topology.

`user@R1>` **ping 10.0.0.2**

```
PING 10.0.0.2 (10.0.0.2): 56 data bytes
64 bytes from 10.0.0.2: icmp_seq=0 ttl=64 time=1.367 ms
64 bytes from 10.0.0.2: icmp_seq=1 ttl=64 time=1.662 ms
64 bytes from 10.0.0.2: icmp_seq=2 ttl=64 time=1.291 ms
^C
--- 10.0.0.2 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max/stddev = 1.291/1.440/1.662/0.160 ms
```

`user@R2>` **ping 10.0.0.1**

```
PING 10.0.0.1 (10.0.0.1): 56 data bytes
64 bytes from 10.0.0.1: icmp_seq=0 ttl=64 time=1.287 ms
64 bytes from 10.0.0.1: icmp_seq=1 ttl=64 time=1.310 ms
64 bytes from 10.0.0.1: icmp_seq=2 ttl=64 time=1.289 ms
^C
--- 10.0.0.1 ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max/stddev = 1.287/1.295/1.310/0.010 ms
```

Meaning

Routers R1 and R2 are connected to each other.

Verifying That IS-IS Is Configured

Purpose

Make sure that the IS-IS instance is running on both routers.

Action

Use the **show isis database** statement to check if the IS-IS instance is running on both routers, R1 and R2.

`user@R1>` **show isis database**

```

IS-IS level 1 link-state database:
LSP ID          Sequence Checksum Lifetime Attributes
R1.00-00        0x4a571   0x30c5     1195 L1 L2
R2.00-00        0x4a586   0x4b7e     1195 L1 L2
R2.02-00        0x330ca1  0x3492     1196 L1 L2
  3 LSPs

IS-IS level 2 link-state database:
LSP ID          Sequence Checksum Lifetime Attributes
R1.00-00        0x4a856   0x5db0     1194 L1 L2
R2.00-00        0x4a89d   0x149b     1194 L1 L2
R2.02-00        0x1fb2ff  0xd302     1194 L1 L2
  3 LSPs
```

`user@R2>` **show isis database**

```

IS-IS level 1 link-state database:
LSP ID             Sequence Checksum Lifetime Attributes
R1.00-00           0x4b707   0xcc80     1195 L1 L2
R2.00-00           0x4b71b   0xeb37     1198 L1 L2
R2.02-00           0x33c2ce  0xb52d     1198 L1 L2
  3 LSPs

IS-IS level 2 link-state database:
LSP ID              Sequence Checksum Lifetime Attributes
R1.00-00            0x4b9f2   0xee70     1192 L1 L2
R2.00-00            0x4ba41   0x9862     1197 L1 L2
R2.02-00                0x3   0x6242     1198 L1 L2
  3 LSPs
```

Meaning

IS-IS is configured on both routers, R1 and R2.

Verifying That BFD Is configured

Purpose

Make sure that the BFD instance is running on both routers, R1 and R2.

Action

Use the **show bfd session detail** statement to check if BFD instance is running on the routers.

user@R1> **show bfd session detail**

```
                                                  Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
10.0.0.2                 Up        so-0/0/0     2.000     1.000        2
 Client ISIS R2, TX interval 0.001, RX interval 0.001
 Client ISIS R1, TX interval 0.001, RX interval 0.001
 Session down time 00:00:00, previous up time 00:00:15
 Local diagnostic NbrSignal, remote diagnostic NbrSignal
 Remote state AdminDown, version 1
 Router 3, routing table index 17

1 sessions, 2 clients
Cumulative transmit rate 1.0 pps, cumulative receive rate 1.0 pps
```

user@R2> **show bfd session detail**

```
                                                  Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
10.0.0.1                 Up        so-0/0/0     2.000     1.000        2
 Client ISIS R2, TX interval 0.001, RX interval 0.001
 Session down time 00:00:00, previous up time 00:00:05
 Local diagnostic NbrSignal, remote diagnostic NbrSignal
 Remote state AdminDown, version 1
 Router 2, routing table index 15

1 sessions, 1 clients
Cumulative transmit rate 1.0 pps, cumulative receive rate 1.0 pps
```

Meaning

BFD is configured on Routers R1 and R2 for detecting failures in the IS-IS network.

RELATED DOCUMENTATION

Understanding BFD for IS-IS | 20

Example: Configuring BFD for RIP

IN THIS SECTION

- Requirements | 166
- Overview | 166
- Configuration | 168
- Verification | 172

This example shows how to configure Bidirectional Forwarding Detection (BFD) for a RIP network.

Requirements

No special configuration beyond device initialization is required before configuring this example.

Overview

To enable failure detection, include the **bfd-liveness-detection** statement:

```
bfd-liveness-detection {
    detection-time {
        threshold milliseconds;
    }
    minimum-interval milliseconds;
    minimum-receive-interval milliseconds;
    multiplier number;
    no-adaptation;
    transmit-interval {
```

```
        threshold milliseconds;
        minimum-interval milliseconds;
    }
    version (1 | automatic);
}
```

Optionally, you can specify the threshold for the adaptation of the detection time by including the **threshold** statement. When the BFD session detection time adapts to a value equal to or greater than the threshold, a single trap and a system log message are sent.

To specify the minimum transmit and receive interval for failure detection, include the **minimum-interval** statement. This value represents the minimum interval at which the local routing device transmits hello packets as well as the minimum interval at which the routing device expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds. This examples sets a minimum interval of 600 milliseconds.

NOTE: BFD is an intensive protocol that consumes system resources. Specifying a minimum interval for BFD of less than 100 ms for Routing Engine-based sessions and 10 ms for distributed BFD sessions can cause undesired BFD flapping.

Depending on your network environment, these additional recommendations might apply:

- For large-scale network deployments with a large number of BFD sessions, specify a minimum interval of 300 ms for Routing Engine-based sessions and 100 ms for distributed BFD sessions.
- For very large-scale network deployments with a large number of BFD sessions, contact Juniper Networks customer support for more information.
- For BFD sessions to remain up during a Routing Engine switchover event when nonstop active routing (NSR) is configured, specify a minimum interval of 2500 ms for Routing Engine-based sessions. For distributed BFD sessions with nonstop active routing configured, the minimum interval recommendations are unchanged and depend only on your network deployment.

You can optionally specify the minimum transmit and receive intervals separately.

To specify only the minimum receive interval for failure detection, include the **minimum-receive-interval** statement. This value represents the minimum interval at which the local routing device expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,00 milliseconds.

To specify only the minimum transmit interval for failure detection, include the **transmit-interval minimum-interval** statement. This value represents the minimum interval at which the local routing device transmits hello packets to the neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds.

To specify the number of hello packets not received by a neighbor that causes the originating interface to be declared down, include the **multiplier** statement. The default is 3, and you can configure a value in the range from 1 through 255.

To specify the threshold for detecting the adaptation of the transmit interval, include the **transmit-interval threshold** statement. The threshold value must be greater than the transmit interval.

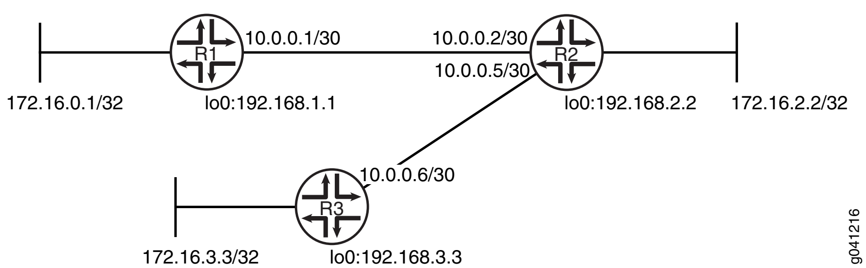
To specify the BFD version used for detection, include the **version** statement. The default is to have the version detected automatically.

You can trace BFD operations by including the **traceoptions** statement at the **[edit protocols bfd]** hierarchy level.

In Junos OS Release 9.0 and later, you can configure BFD sessions not to adapt to changing network conditions. To disable BFD adaptation, include the **no-adaptation** statement. We recommend that you not disable BFD adaptation unless it is preferable not to have BFD adaptation enabled in your network.

Figure 4 on page 70 shows the topology used in this example.

Figure 9: RIP BFD Network Topology



"CLI Quick Configuration" on page 70 shows the configuration for all of the devices in Figure 4 on page 70. The section "Step-by-Step Procedure" on page 71 describes the steps on Device R1.

Configuration

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

Device R1

```
set interfaces fe-1/2/0 unit 1 family inet address 10.0.0.1/30
set protocols bfd traceoptions file bfd-trace
set protocols bfd traceoptions flag all
set protocols rip group rip-group export advertise-routes-through-rip
set protocols rip group rip-group neighbor fe-1/2/0.1
set protocols rip group rip-group bfd-liveness-detection minimum-interval 600
set policy-options policy-statement advertise-routes-through-rip term 1 from protocol direct
set policy-options policy-statement advertise-routes-through-rip term 1 from protocol rip
set policy-options policy-statement advertise-routes-through-rip term 1 then accept
```

Device R2

```
set interfaces fe-1/2/0 unit 2 family inet address 10.0.0.2/30
set interfaces fe-1/2/1 unit 5 family inet address 10.0.0.5/30
set protocols rip group rip-group export advertise-routes-through-rip
set protocols rip group rip-group neighbor fe-1/2/0.2
set protocols rip group rip-group neighbor fe-1/2/1.5
set protocols rip group rip-group bfd-liveness-detection minimum-interval 600
set policy-options policy-statement advertise-routes-through-rip term 1 from protocol direct
set policy-options policy-statement advertise-routes-through-rip term 1 from protocol rip
set policy-options policy-statement advertise-routes-through-rip term 1 then accept
```

Device R3

```
set interfaces fe-1/2/0 unit 6 family inet address 10.0.0.6/30
set protocols rip group rip-group export advertise-routes-through-rip
set protocols rip group rip-group neighbor fe-1/2/0.6
set protocols rip group rip-group bfd-liveness-detection minimum-interval 600
set policy-options policy-statement advertise-routes-through-rip term 1 from protocol direct
set policy-options policy-statement advertise-routes-through-rip term 1 from protocol rip
set policy-options policy-statement advertise-routes-through-rip term 1 then accept
```

Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see *Using the CLI Editor in Configuration Mode* in the *CLI User Guide*.

To configure a BFD for a RIP network:

1. Configure the network interfaces.

```
[edit interfaces]
user@R1# set fe-1/2/0 unit 1 family inet address 10.0.0.1/30
```

2. Create the RIP group and add the interface.

   To configure RIP in Junos OS, you must configure a group that contains the interfaces on which RIP is enabled. You do not need to enable RIP on the loopback interface.

```
[edit protocols rip group rip-group]
user@R1# set neighbor fe-1/2/0.1
```

3. Create the routing policy to advertise both direct and RIP-learned routes.

```
[edit policy-options policy-statement advertise-routes-through-rip term 1]
user@R1# set from protocol direct
user@R1# set from protocol rip
user@R1# set then accept
```

4. Apply the routing policy.

   In Junos OS, you can only apply RIP export policies at the group level.

```
[edit protocols rip group rip-group]
user@R1# set export advertise-routes-through-rip
```

5. Enable BFD.

```
[edit protocols rip group rip-group]
user@R1# set bfd-liveness-detection minimum-interval 600
```

6. Configure tracing operations to track BFD messages.

```
[edit protocols bfd traceoptions]
user@R1# set file bfd-trace
```

```
user@R1# set flag all
```

Results

From configuration mode, confirm your configuration by entering the **show interfaces**, **show protocols**, and **show policy-options** commands. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
user@R1# show interfaces
fe-1/2/0 {
    unit 1 {
        family inet {
            address 10.0.0.1/30;
        }
    }
}
```

```
user@R1# show protocols
bfd {
    traceoptions {
        file bfd-trace;
        flag all;
    }
}
rip {
    group rip-group {
        export advertise-routes-through-rip;
        bfd-liveness-detection {
            minimum-interval 600;
        }
        neighbor fe-1/2/0.1;
    }
}
```

```
user@R1# show policy-options
policy-statement advertise-routes-through-rip {
    term 1 {
        from protocol [ direct rip ];
        then accept;
    }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

Verification

IN THIS SECTION

- Verifying That the BFD Sessions Are Up | 172
- Checking the BFD Trace File | 172

Confirm that the configuration is working properly.

Verifying That the BFD Sessions Are Up

Purpose

Make sure that the BFD sessions are operating.

Action

From operational mode, enter the **show bfd session** command.

user@R1> **show bfd session**

```
                                                  Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
10.0.0.2                 Up        fe-1/2/0.1     1.800     0.600        3

1 sessions, 1 clients
Cumulative transmit rate 1.7 pps, cumulative receive rate 1.7 pps
```

Meaning

The output shows that there are no authentication failures.

Checking the BFD Trace File

Purpose

Use tracing operations to verify that BFD packets are being exchanged.

Action

From operational mode, enter the **show log** command.

user@R1> **show log bfd-trace**

```
Feb 16 10:26:32 PPM Trace: BFD periodic xmit to 10.0.0.2 (IFL 124, rtbl 53,
single-hop port)
Feb 16 10:26:32 Received Downstream TraceMsg (24) len 86:
Feb 16 10:26:32    IfIndex (3) len 4: 0
Feb 16 10:26:32    Protocol (1) len 1: BFD
Feb 16 10:26:32    Data (9) len 61: (hex) 42 46 44 20 70 61 63 6b 65 74 20 66 72
6f 6d 20 31 30 2e
Feb 16 10:26:32 PPM Trace: BFD packet from 10.0.0.1 (IFL 73, rtbl 56, ttl 255)
absorbed
Feb 16 10:26:32 Received Downstream TraceMsg (24) len 60:
Feb 16 10:26:32    IfIndex (3) len 4: 0
Feb 16 10:26:32    Protocol (1) len 1: BFD
Feb 16 10:26:32    Data (9) len 35: (hex) 42 46 44 20 70 65 72 69 6f 64 69 63 20
78 6d 69 74 20 6f
...
```

Meaning

The output shows the normal functioning of BFD.

Configuring Micro BFD Sessions for LAG

The Bidirectional Forwarding Detection (BFD) protocol is a simple detection protocol that quickly detects failures in the forwarding paths. A link aggregation group (LAG) combines multiple links between devices that are in point-to-point connections, thereby increasing bandwidth, providing reliability, and allowing load balancing. To run a BFD session on LAG interfaces, configure an independent, asynchronous mode BFD session on every LAG member link in a LAG bundle. Instead of a single BFD session monitoring the status of the UDP port, independent micro BFD sessions monitor the status of individual member links.

NOTE: Starting in Junos OS Evolved Release 20.1R1, independent micro Bidirectional Forwarding Detection (BFD) sessions are enabled on a per member link basis of a Link Aggregation Group (LAG) bundle.

To enable failure detection for aggregated Ethernet interfaces:

1. Include the following statement in the configuration at the **[edit interfaces *aex* aggregated-ether-options]** hierarchy level:

```
bfd-liveness-detection
```

2. Configure the authentication criteria of the BFD session for LAG.

   To specify the authentication criteria, include the **authentication** statement:

```
bfd-liveness-detection {
  authentication {
    algorithm algorithm-name;
    key-chain key-chain-name;
    loose-check;
  }
}
```

   - Specify the algorithm to be used to authenticate the BFD session. You can use one of the following algorithms for authentication:
     - keyed-md5
     - keyed-sha-1
     - meticulous-keyed-md5

  - meticulous-keyed-sha-1
  - simple-password

- To configure the key chain, specify the name that is associated with the security key for the BFD session. The name you specify must match one of the key chains configured in the **authentication-key-chains *key-chain*** statement at the **[edit security]** hierarchy level.
- Configure loose authentication checking on the BFD session. Use only for transitional periods when authentication might not be configured at both ends of the BFD session.

3. Configure BFD timers for aggregated Ethernet interfaces.

   To specify the BFD timers, include the **detection-time** statement:

```
bfd-liveness-detection {
   detection-time {
      threshold  milliseconds;
   }
}
```

   Specify the threshold value. This is the maximum time interval for detecting a BFD neighbor. If the transmit interval is greater than this value, the device triggers a trap.

4. Configure a hold-down interval value to set the minimum time that the BFD session must remain up before a state change notification is sent to the other members in the LAG network.

   To specify the hold-down interval, include the **holddown-interval** statement:

```
bfd-liveness-detection {
   holddown-interval milliseconds;
}
```

   You can configure a number in the range from 0 through 255,000 milliseconds, and the default is 0. If the BFD session goes down and then comes back up during the hold-down interval, the timer is restarted.

   This value represents the minimum interval at which the local routing device transmits BFD packets, as well as the minimum interval in which the routing device expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds. You can also specify the minimum transmit and receive intervals separately.

5. Configure the source address for the BFD session.

   To specify a local address, include the **local-address** statement:

```
bfd-liveness-detection {
   local-address bfd-local-address;
```

```
}
```

The BFD local address is the loopback address of the source of the BFD session.

> **NOTE:** Beginning with Junos OS Release 16.1, you can also configure this feature with the AE interface address as the local address in a micro BFD session. For the IPv6 address family, disable duplicate address detection before configuring this feature with the AE interface address. To disable duplicate address detection, include the **dad-disable** statement at the **[edit interface *aex* unit *y* family inet6]** hierarchy level.
>
> Beginning with Release 16.1R2, Junos OS checks and validates the configured micro BFD **local-address** against the interface or loopback IP address before the configuration commit. Junos OS performs this check on both IPv4 and IPv6 micro BFD address configurations, and if they do not match, the commit fails.

6. Specify the minimum interval that indicates the time interval for transmitting and receiving data.

   This value represents the minimum interval at which the local routing device transmits BFD packets, as well as the minimum interval in which the routing device expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds. You can also specify the minimum transmit and receive intervals separately.

   To specify the minimum transmit and receive intervals for failure detection, include the **minimum-interval** statement:

   ```
   bfd-liveness-detection {
     minimum-interval milliseconds;
   }
   ```

NOTE: BFD is an intensive protocol that consumes system resources. Specifying a minimum interval for BFD less than 100 ms for Routing Engine-based sessions and 10 ms for distributed BFD sessions can cause undesired BFD flapping.

Depending on your network environment, these additional recommendations might apply:

- For large-scale network deployments with a large number of BFD sessions, specify a minimum interval of 300 ms for Routing Engine-based sessions and 100 ms for distributed BFD sessions.
- For very large-scale network deployments with a large number of BFD sessions, contact Juniper Networks customer support for more information.
- For BFD sessions to remain up during a Routing Engine switchover event when nonstop active routing is configured, specify a minimum interval of 2500 ms for Routing Engine-based sessions. For distributed BFD sessions with nonstop active routing configured, the minimum interval recommendations are unchanged and depend only on your network deployment.

7. Specify only the minimum receive interval for failure detection by including the **minimum-receive-interval** statement:

   ```
   bfd-liveness-detection {
     minimum-receive-interval milliseconds;
   }
   ```

   This value represents the minimum interval in which the local routing device expects to receive a reply from a neighbor with which it has established a BFD session. You can configure a number in the range from 1 through 255,000 milliseconds.

8. Specify the number of BFD packets that were not received by the neighbor that causes the originating interface to be declared down by including the **multiplier** statement:

   ```
   bfd-liveness-detection {
     multiplier number;
   }
   ```

   The default value is 3. You can configure a number in the range from 1 through 255.

9. Configure the neighbor in a BFD session.

   The neighbor address can be either an IPv4 or an IPv6 address.

   To specify the next hop of the BFD session, include the **neighbor** statement:

```
bfd-liveness-detection {
    neighbor bfd-neighbor-address;
}
```

The BFD neighbor address is the loopback address of the remote destination of the BFD session.

> **NOTE:** Beginning with Junos OS Release 16.1, you can also configure the AE interface address of the remote destination as the BFD neighbor address in a micro BFD session.

10. (Optional) Configure BFD sessions not to adapt to changing network conditions.

    To disable BFD adaptation, include the **no-adaptation** statement:

```
bfd-liveness-detection {
    no-adaptation;
}
```

> **NOTE:** We recommend that you do not disable BFD adaptation unless it is preferable not to have BFD adaptation in your network.

11. Specify a threshold for detecting the adaptation of the detection time by including the **threshold** statement:

```
bfd-liveness-detection {
    detection-time {
        threshold milliseconds;
    }
}
```

    When the BFD session detection time adapts to a value equal to or greater than the threshold, a single trap and a system log message are sent. The detection time is based on the multiplier of the minimum-interval or the minimum-receive-interval value. The threshold must be a higher value than the multiplier for either of these configured values. For example, if the minimum-receive-interval is 300 ms and the multiplier is 3, the total detection time is 900 ms. Therefore, the detection time threshold must have a value greater than 900.

12. Specify only the minimum transmit interval for failure detection by including the **transmit-interval minimum-interval** statement:

```
bfd-liveness-detection {
    transmit-interval {
        minimum-interval milliseconds;
    }
}
```

This value represents the minimum interval at which the local routing device transmits BFD packets to the neighbor with which it has established a BFD session. You can configure a value in the range from 1 through 255,000 milliseconds.

13. Specify the transmit threshold for detecting the adaptation of the transmit interval by including the **transmit-interval threshold** statement:

```
bfd-liveness-detection {
    transmit-interval {
        threshold milliseconds;
    }
}
```

The threshold value must be greater than the transmit interval. When the BFD session detection time adapts to a value greater than the threshold, a single trap and a system log message are sent. The detection time is based on the multiplier of the minimum-interval or the minimum-receive-interval value. The threshold must be a higher value than the multiplier for either of these configured values.

14. Specify the BFD version by including the **version** statement:

```
bfd-liveness-detection {
    version (1 | automatic);
}
```

The default is to have the version detected automatically.

NOTE:

- The **version** option is not supported on the QFX Series. Starting in Junos OS Release 17.2R1, a warning will appear if you attempt to use this command.
- This feature works when both the devices support BFD. If BFD is configured at only one end of the LAG, this feature does not work.

RELATED DOCUMENTATION

authentication

bfd-liveness-detection

detection-time

Example: Configuring Independent Micro BFD Sessions for LAG

Example: Configuring Independent Micro BFD Sessions for LAG

IN THIS SECTION

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This example shows how to configure an independent micro BFD session for aggregated Ethernet interfaces.

Requirements

This example uses the following hardware and software components:

- MX Series routers with Junos Trio chipset
- T Series routers with Type 4 FPC or Type 5 FPC

  BFD for LAG is supported on the following PIC types on T-Series:

  - PC-1XGE-XENPAK (Type 3 FPC),
  - PD-4XGE-XFP (Type 4 FPC),
  - PD-5-10XGE-SFPP (Type 4 FPC),
  - 24x10GE (LAN/WAN) SFPP, 12x10GE (LAN/WAN) SFPP, 1X100GE Type 5 PICs

- PTX Series routers with 24X10GE (LAN/WAN) SFPP
- Junos OS Release 13.3 or later running on all devices

Overview

The example includes two routers that are directly connected. Configure two aggregated Ethernet interfaces, AE0 for IPv4 connectivity and AE1 for IPv6 connectivity. Configure micro BFD session on the AE0 bundle using IPv4 addresses as local and neighbor endpoints on both routers. Configure micro BFD session on the AE1 bundle using IPv6 addresses as local and neighbor endpoints on both routers. This example verifies that independent micro BFD sessions are active in the output.

Topology

Figure 5 on page 82 shows the sample topology.

Figure 10: Configuring an Independent Micro BFD Session for LAG

Configuration

CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

Router R0

```
set interfaces ge-1/0/1 unit 0 family inet address 20.20.20.1/30
set interfaces ge-1/0/1 unit 0 family inet6 address 3ffe::1:1/126
set interfaces xe-4/0/0 gigether-options 802.3ad ae0
set interfaces xe-4/0/1 gigether-options 802.3ad ae0
set interfaces xe-4/1/0 gigether-options 802.3ad ae1
```

```
set interfaces xe-4/1/1 gigether-options 802.3ad ae1
set interfaces lo0 unit 0 family inet address 10.255.106.107/32
set interfaces lo0 unit 0 family inet6 address 201:DB8:251::aa:aa:1/126
set interfaces ae0 aggregated-ether-options bfd-liveness-detection minimum-interval 100
set interfaces ae0 aggregated-ether-options bfd-liveness-detection neighbor 10.255.106.102
set interfaces ae0 aggregated-ether-options bfd-liveness-detection local-address 10.255.106.107
set interfaces ae0 aggregated-ether-options minimum-links 1
set interfaces ae0 aggregated-ether-options link-speed 10g
set interfaces ae0 aggregated-ether-options lacp active
set interfaces ae0 unit 0 family inet address 10.0.0.1/30
set interfaces ae1 aggregated-ether-options bfd-liveness-detection minimum-interval 100
set interfaces ae1 aggregated-ether-options bfd-liveness-detection multiplier 3
set interfaces ae1 aggregated-ether-options bfd-liveness-detection neighbor 201:DB8:251::bb:bb:1
set interfaces ae1 aggregated-ether-options bfd-liveness-detection local-address 201:DB8:251::aa:aa:1
set interfaces ae1 aggregated-ether-options minimum-links 1
set interfaces ae1 aggregated-ether-options link-speed 10g
set interfaces ae1 aggregated-ether-options lacp active
set interfaces ae1 unit 0 family inet6 address 5555::1/126
set interface ae1 unit 0 family inet6 dad-disable
set routing-options nonstop-routing
set routing-options static route 30.30.30.0/30 next-hop 10.0.0.2
set routing-options rib inet6.0 static route 3ffe::1:2/126 next-hop 5555::2
set protocols bfd traceoptions file bfd
set protocols bfd traceoptions file size 100m
set protocols bfd traceoptions file files 10
set protocols bfd traceoptions flag all
```

Router R1

```
set interfaces ge-1/1/8 unit 0 family inet address 30.30.30.1/30
set interfaces ge-1/1/8 unit 0 family inet6 address 3ffe::1:2/126
set interfaces xe-0/0/0 gigether-options 802.3ad ae0
set interfaces xe-0/0/1 gigether-options 802.3ad ae0
set interfaces xe-0/0/2 gigether-options 802.3ad ae1
set interfaces xe-0/0/3 gigether-options 802.3ad ae1
set interfaces lo0 unit 0 family inet address 10.255.106.102/32
set interfaces lo0 unit 0 family inet6 address 201:DB8:251::bb:bb:1/126
set interfaces ae0 aggregated-ether-options bfd-liveness-detection minimum-interval 150
set interfaces ae0 aggregated-ether-options bfd-liveness-detection multiplier 3
set interfaces ae0 aggregated-ether-options bfd-liveness-detection neighbor 10.255.106.107
```

```
set interfaces ae0 aggregated-ether-options bfd-liveness-detection local-address 10.255.106.102
set interfaces ae0 aggregated-ether-options minimum-links 1
set interfaces ae0 aggregated-ether-options link-speed 10g
set interfaces ae0 aggregated-ether-options lacp passive
set interfaces ae0 unit 0 family inet address 10.0.0.2/30
set interfaces ae1 aggregated-ether-options bfd-liveness-detection minimum-interval 200
set interfaces ae1 aggregated-ether-options bfd-liveness-detection multiplier 3
set interfaces ae1 aggregated-ether-options bfd-liveness-detection neighbor 201:DB8:251::aa:aa:1
set interfaces ae1 aggregated-ether-options bfd-liveness-detection local-address 201:DB8:251::bb:bb:1
set interfaces ae1 aggregated-ether-options minimum-links 1
set interfaces ae1 aggregated-ether-options link-speed 10g
set interfaces ae1 aggregated-ether-options lacp passive
set interfaces ae1 unit 0 family inet6 address 5555::2/126
set routing-options static route 20.20.20.0/30 next-hop 10.0.0.1
set routing-options rib inet6.0 static route 3ffe::1:1/126 next-hop 5555::1
```

Configuring a Micro BFD Session for Aggregated Ethernet Interfaces

Step-by-Step Procedure

The following example requires that you navigate various levels in the configuration hierarchy. For information about navigating the CLI, see "*Using the CLI Editor in Configuration Mode*" in the *CLI User Guide*.

NOTE: Repeat this procedure for Router R1, modifying the appropriate interface names, addresses, and any other parameters for each router.

To configure a micro BFD session for aggregated Ethernet interfaces on Router R0:

1. Configure the physical interfaces.

```
[edit interfaces]
user@R0# set ge-1/0/1 unit 0 family inet address 20.20.20.1/30
user@R0# set ge-1/0/1 unit 0 family inet6 address 3ffe::1:1/126
user@R0# set xe-4/0/0 gigether-options 802.3ad ae0
user@R0# set xe-4/0/1 gigether-options 802.3ad ae0
user@R0# set xe-4/1/0 gigether-options 802.3ad ae1
user@R0# set xe-4/1/1 gigether-options 802.3ad ae1
```

2. Configure the loopback interface.

```
[edit interfaces]
user@R0# set lo0 unit 0 family inet address 10.255.106.107/32
user@R0# set lo0 unit 0 family inet6 address 201:DB8:251::aa:aa:1/128
```

3. Configure an IP address on the aggregated Ethernet interface ae0 with either IPv4 or IPv6 addresses, as per your network requirements.

```
[edit interfaces]
user@R0# set ae0 unit 0 family inet address 10.0.0.1/30
```

4. Set the routing option, create a static route, and set the next-hop address.

> **NOTE:** You can configure either an IPv4 or IPv6 static route, depending on your network requirements.

```
[edit routing-options]
user@R0# set nonstop-routing
user@R0# set static route 30.30.30.0/30 next-hop 10.0.0.2
user@R0# set rib inet6.0 static route 3ffe::1:2/126 next-hop 5555::2
```

5. Configure the Link Aggregation Control Protocol (LACP).

```
[edit interfaces]
user@R0# set ae0 aggregated-ether-options lacp active
```

6. Configure BFD for the aggregated Ethernet interface ae0, and specify the minimum interval, local IP address, and the neighbor IP address.

```
[edit interfaces]
user@R0# set ae0 aggregated-ether-options bfd-liveness-detection minimum-interval 100
user@R0# set ae0 aggregated-ether-options bfd-liveness-detection multiplier 3
user@R0# set ae0 aggregated-ether-options bfd-liveness-detection neighbor 10.255.106.102
user@R0# set ae0 aggregated-ether-options bfd-liveness-detection local-address 10.255.106.107
user@R0# set ae0 aggregated-ether-options minimum-links 1
user@R0# set ae0 aggregated-ether-options link-speed 10g
```

7. Configure an IP addresse on the aggregated Ethernet interface ae1.

You can assign either IPv4 or IPv6 addresses as per your network requirements.

```
[edit interfaces]
user@R0# set ae1 unit 0 family inet6 address 5555::1/126
```

8. Configure BFD for the aggregated Ethernet interface ae1.

```
[edit interfaces]
user@R0# set ae1 aggregated-ether-options bfd-liveness-detection minimum-interval 100
user@R0# set ae1 aggregated-ether-options bfd-liveness-detection multiplier 3
user@R0# set ae1 aggregated-ether-options bfd-liveness-detection neighbor 201:DB8:251::bb:bb:1
user@R0# set ae1 aggregated-ether-options bfd-liveness-detection local-address 201:DB8:251::aa:aa:1
user@R0# set ae1 aggregated-ether-options minimum-links 1
user@R0# set ae1 aggregated-ether-options link-speed 10g
```

NOTE: Beginning with Junos OS Release 16.1, you can also configure this feature with the AE interface address as the local address in a micro BFD session.

Beginning with Release 16.1R2, Junos OS checks and validates the configured micro BFD **local-address** against the interface or loopback IP address before the configuration commit. Junos OS performs this check on both IPv4 and IPv6 micro BFD address configurations, and if they do not match, the commit fails.

9. Configure tracing options for BFD for troubleshooting.

```
[edit protocols]
user@R0# set bfd traceoptions file bfd
user@R0# set bfd traceoptions file size 100m
user@R0# set bfd traceoptions file files 10
user@R0# set bfd traceoptions flag all
```

Results

From configuration mode, enter the **show interfaces**, **show protocols**, and **show routing-options** commands and confirm your configuration. If the output does not display the intended configuration, repeat the instructions in this example to correct the configuration.

```
user@R0> show interfaces
```

```
traceoptions {
    flag bfd-events;
}
ge-1/0/1 {
    unit 0 {
        family inet {
            address 20.20.20.1/30;
        }
        family inet6 {
            address 3ffe::1:1/126;
        }
    }
}
xe-4/0/0 {
    enable;
    gigether-options {
        802.3ad ae0;
    }
}
xe-4/0/1 {
    gigether-options {
        802.3ad ae0;
    }
}
xe-4/1/0 {
    enable;
    gigether-options {
        802.3ad ae1;
    }
}
xe-4/1/1 {
    gigether-options {
        802.3ad ae1;
    }
}
lo0 {
    unit 0 {
        family inet {
            address 10.255.106.107/32;
        }
        family inet6 {
            address 201:DB8:251::aa:aa:1/128;
        }
    }
```

```
}
ae0 {
    aggregated-ether-options {
        bfd-liveness-detection {
            minimum-interval 100;
            neighbor 10.255.106.102;
            local-address 10.255.106.107;
        }
        minimum-links 1;
        link-speed 10g;
        lacp {
            active;
        }
    }
    unit 0 {
        family inet {
            address 10.0.0.1/30;
        }
    }
}
ae1 {
    aggregated-ether-options {
        bfd-liveness-detection {
            minimum-interval 100;
            multiplier 3;
            neighbor 201:DB8:251::bb:bb:1;
            local-address 201:DB8:251::aa:aa:1;
        }
        minimum-links 1
        link-speed 10g;
    }
    unit 0 {
        family inet6 {
            address 5555::1/126;
        }
    }
}
```

```
user@R0> show protocols
bfd {
    traceoptions {
        file bfd size 100m files 10;
        flag all;
    }
```

```
}
```

```
user@R0> show routing-options
nonstop-routing ;
  rib inet6.0 {
  static {
    route 3ffe:1:2/126 {
      next-hop 5555::2;
    }
  }
}
static {
  route 30.30.30.0/30 {
    next-hop 10.0.0.2;
  }
}
```

If you are done configuring the device, commit the configuration.

```
user@R0# commit
```

Verification

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Confirm that the configuration is working properly.

Verifying That the Independent BFD Sessions Are Up

Purpose

Verify that the micro BFD sessions are up, and view details about the BFD sessions.

Action

From operational mode, enter the **show bfd session extensive** command.

`user@R0>` **show bfd session extensive**

```
                                                    Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
10.255.106.102                 Up        xe-4/0/0       9.000     3.000        3

 Client LACPD, TX interval 0.100, RX interval 0.100
 Session up time 4d 23:13, previous down time 00:00:06
 Local diagnostic None, remote diagnostic None
 Remote heard, hears us, version 1
 Replicated
 Session type: Micro BFD
 Min async interval 0.100, min slow interval 1.000
 Adaptive async TX interval 0.100, RX interval 0.100
 Local min TX interval 0.100, minimum RX interval 0.100, multiplier 3
 Remote min TX interval 3.000, min RX interval 3.000, multiplier 3
 Local discriminator 21, remote discriminator 75
 Echo mode disabled/inactive
 Remote is control-plane independent
  Session ID: 0x0

                                                    Detect   Transmit
Address                  State     Interface      Time     Interval  Multiplier
10.255.106.102                 Up        xe-4/0/1       9.000     3.000        3

 Client LACPD, TX interval 0.100, RX interval 0.100
 Session up time 4d 23:13, previous down time 00:00:07
 Local diagnostic None, remote diagnostic None
 Remote heard, hears us, version 1
 Replicated
 Session type: Micro BFD
 Min async interval 0.100, min slow interval 1.000
 Adaptive async TX interval 0.100, RX interval 0.100
 Local min TX interval 0.100, minimum RX interval 0.100, multiplier 3
 Remote min TX interval 3.000, min RX interval 3.000, multiplier 3
 Local discriminator 19, remote discriminator 74
 Echo mode disabled/inactive
 Remote is control-plane independent
  Session ID: 0x0

                                                    Detect   Transmit
```

```
Address                   State     Interface       Time     Interval  Multiplier
201:DB8:251::bb:bb:1                 Up        xe-4/1/1       9.000     3.000
     3
 Client LACPD, TX interval 0.100, RX interval 0.100
 Session up time 4d 23:13
 Local diagnostic None, remote diagnostic None
 Remote not heard, hears us, version 1
 Replicated
 Session type: Micro BFD
 Min async interval 0.100, min slow interval 1.000
 Adaptive async TX interval 0.100, RX interval 0.100
 Local min TX interval 1.000, minimum RX interval 0.100, multiplier 3
 Remote min TX interval 3.000, min RX interval 3.000, multiplier 3
 Local discriminator 17, remote discriminator 67
 Echo mode disabled/inactive, no-absorb, no-refresh
 Remote is control-plane independent
  Session ID: 0x0

                                                         Detect   Transmit
Address                   State     Interface       Time     Interval  Multiplier
201:DB8:251::bb:bb:1                 UP        xe-4/1/0       9.000     3.000
     3
 Client LACPD, TX interval 0.100, RX interval 0.100
 Session up time 4d 23:13
 Local diagnostic None, remote diagnostic None
 Remote not heard, hears us, version 1
 Replicated
 Session type: Micro BFD
 Min async interval 0.100, min slow interval 1.000
 Adaptive async TX interval 0.100, RX interval 0.100
 Local min TX interval 1.000, minimum RX interval 0.100, multiplier 3
 Remote min TX interval 3.000, min RX interval 3.000, multiplier 3
 Local discriminator 16, remote discriminator 66
 Echo mode disabled/inactive, no-absorb, no-refresh
 Remote is control-plane independent
  Session ID: 0x0

4 sessions, 4 clients
Cumulative transmit rate 2.0 pps, cumulative receive rate 1.7 pps
```

Meaning

The Micro BFD field represents the independent micro BFD sessions running on the links in a LAG. The TX interval *item*, RX interval *item* output represents the setting configured with the **minimum-interval** statement. All of the other output represents the default settings for BFD. To modify the default settings, include the optional statements under **bfd-liveness-detection** statement.

Viewing Detailed BFD Events

Purpose

View the contents of the BFD trace file to assist in troubleshooting, if required.

Action

From operational mode, enter the **file show /var/log/bfd** command.

`user@R0>` **file show /var/log/bfd**

```
Jun  5 00:48:59    Protocol (1) len 1: BFD
Jun  5 00:48:59    Data (9) len 41: (hex) 42 46 44 20 6e 65 69 67 68 62 6f 72 20
31 30 2e 30 2e 30
Jun  5 00:48:59 PPM Trace: BFD neighbor 10.255.106.102 (IFL 349) set, 9 0
Jun  5 00:48:59 Received Downstream RcvPkt (19) len 108:
Jun  5 00:48:59    IfIndex (3) len 4: 329
Jun  5 00:48:59    Protocol (1) len 1: BFD
Jun  5 00:48:59    SrcAddr (5) len 8: 10.255.106.102
Jun  5 00:48:59    Data (9) len 24: (hex) 00 88 03 18 00 00 00 4b 00 00 00 15 00
2d c6 c0 00 2d c6
Jun  5 00:48:59    PktError (26) len 4: 0
Jun  5 00:48:59    RtblIdx (24) len 4: 0
Jun  5 00:48:59    MultiHop (64) len 1: (hex) 00
Jun  5 00:48:59    Unknown (168) len 1: (hex) 01
Jun  5 00:48:59    Unknown (171) len 2: (hex) 02 3d
Jun  5 00:48:59    Unknown (172) len 6: (hex) 80 71 1f c7 81 c0
Jun  5 00:48:59    Authenticated (121) len 1: (hex) 01
Jun  5 00:48:59 BFD packet from 10.0.0.2 (IFL 329), len 24
Jun  5 00:48:59    Ver 0, diag 0, mult 3, len 24
Jun  5 00:48:59    Flags: IHU Fate
Jun  5 00:48:59    My discr 0x0000004b, your discr 0x00000015
Jun  5 00:48:59    Tx ivl 3000000, rx ivl 3000000, echo rx ivl 0
Jun  5 00:48:59 [THROTTLE]bfdd_rate_limit_can_accept_pkt: session 10.255.106.102
is up or already in program thread
Jun  5 00:48:59 Replicate: marked session (discr 21) for update
```

Meaning

BFD messages are being written to the specified trace file.

RELATED DOCUMENTATION

authentication

bfd-liveness-detection

detection-time

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