BIG-IP® Advanced Routing™
Bidirectional Forwarding Detection Configuration Guide

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Table of Contents

Preface

This configuration guide is for network administrators and application developers intending to configure the ZebOS® BFD protocol. This guide attempts to make configuration simpler by adding topology illustrations and configuration samples. It covers basic configurations for Basic Access Networking Services. Use this guide in conjunction with the *ZebOS Bidirectional Forwarding Detection Command Line Interface Reference Guide t*o get complete information on the commands used in the configurations displayed in this guide.

Conventions

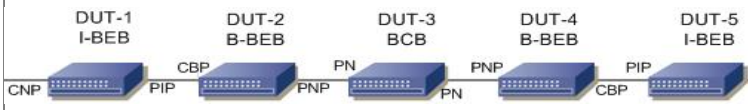
The following table displays the conventions for the syntax and procedures describing how to enter information, and how information displays on the console.

Convention	**Description**
`command syntax`	The `new courier` font represents command strings entered on a command line, and sample source code.
UPPERCASE	A variable parameter. Enter a value according to the descriptions that follow.
`lowercase`	A keyword parameter. Enter lowercase values exactly as shown
|	The vertical bar. Delimits choices; select one from the list.
( )	Parenthesis. Delimits optional parameters. Do not enter parentheses as part of any command.
[]	Square brackets: groups parameters and keywords into a single unit. Take all parts within these brackets. Do not enter brackets as part of any command.
< >	Angle brackets: enclose a numeric range for a keyword. Do not enter angle brackets as part of any command.
description	Proportional font gives specific details about a parameter.
=	Equal sign: separates the command syntax from explanatory text.

Note: Unless otherwise stated, press Enter after each command entry.

Configuration Format

The following table describes the configuration format used in this guide.

Format	Description	Example
Scenario Description	This section includes a description of both the topology and the configuration.	**Enabling RIP** This example shows the minimum configuration required for enabling RIP on an interface.
Topology	This section is an illustration of the topology. The figure might include the IP addresses and names of the devices used in the example.	
Configuration	This section has the complete configuration involved in the example. The prompt shows the execution modes of the commands.	R1 **ZebOS#**`configure terminal` **ZebOS(config)#**`router rip` **ZebOS(config-router)#**`net...` **ZebOS(config-router)#**`net...`
Explanation	The grey section next to the configuration provides an explanation of the action performed by a configuration.	Configure interface in bridge group Configure interface mode as `trunk`. Allow all VLANs on interface `eth2`.
Commands Used	This section lists the names of the commands used in the example. Users can look up the details of these commands in the specific command line reference guide. To avoid repetition, this section does not include common commands, such as “configure terminal. “	**Commands Used** router rip, network
Validation Commands	This section has the show commands that display the validation output.	**Validation Commands** show ip rip

Command Line Interface

The ZebOS^{TM} Command Line Interface (CLI) is a text-based interface that is used to interact with systems. Users can utilize many of the commands in scripts to automate many configuration tasks. Each command associates with a specific function or a common function performing a specific task. Multiple users can telnet and issue commands using the Exec mode and the Privileged Exec mode. The VTY shell, described in the ZebOSVTY Shell User Guide, gives users and administrators the ability to issue commands to several daemons from a single telnet session.

Command Line Help

The ZebOSCLI contains a text-based help facility. Access this help by typing in the full or partial command string, then typing “?”. The ZebOSCLI displays the command keywords or parameters plus a short description. For example, at the CLI command prompt, type `show ?` (the CLI does not display the question mark). The CLI displays this keyword list with short descriptions for each keyword:

```
bgpd#show
```

Syntax Help

The ZebOSCLI can complete the spelling of command or parameter keywords. Begin typing the command or parameter, then press TAB. At the CLI command prompt, type `sh`:

```
Router> sh
```

Press TAB. The CLI shows:

```
Router> show
```

If the command or parameter partial spelling is ambiguous, the CLI displays the choices that match the abbreviation. Type `show i`. Press TAB. The CLI shows:

```
Router> show i
interface ip
Router> show i
```

The CLI displays the `interface` and `ip` keywords. Type `n` to select `interface` and press TAB. The CLI shows:

```
Router> show in
Router> show interface
```

Now type ? and the CLI shows a list of parameters for the `show interface` command.

```
 [IFNAME] Interface name
Router> show interface
```

Command Abbreviations

The CLI accepts abbreviations for commands. For example, the following is an abbreviation for `show interface.`

```
sh in
```

Command line errors

If the router does not recognize the command after ENTER is pressed, it displays this message:

```
% Invalid input detected at ‘^‘ marker.
```

If a command is incomplete, it displays this message:

```
% Incomplete command.
```

Some commands are too long for the display line, and can wrap in mid-parameter or mid-keyword, if necessary:

```
area 10.10.0.18 virtual-link 10.10.0.19 authentication-key 57393
```

Command Modes

The commands available for each protocol separate into several modes (nodes) arranged in a hierarchy; Exec is the lowest. Each mode has its own special commands; in some modes, commands from a lower mode are available.

Modes Common to Protocols

Mode	Description
Exec	Also called the View mode, use this mode to perform basic commands, such as, show, exit, quit, help, list, and enable. This is the initial mode when users log in to any ZebOSCLI.
Privileged Exec	Also called the Enable mode, this mode allows users to perform debugging commands, write commands (for saving and viewing the configuration), and show commands.
Configure	Also called the Configure Terminal, this mode includes configuration commands and serves as a gateway to other configuration modes, including Interface, Router, Line, Route Map, Key Chain and Address Family modes. All ZebOSdaemons have this mode.
Interface	Use this mode to configure protocol-specific settings for a particular interface. Any attribute configured in this mode overrides an attribute configured in the router mode.
Line	Use this mode to make access-class commands available.

Modes Specific to Protocols

The following command modes are specific to a variety of protocols. The command used to enter these modes is different for each protocol.

Mode	Description
Router	Known as the Configure Router mode, this mode is available for the LDP, BGP, OSPF, RSVP-TE and RIP protocols. It provides access to router and routing command.
Route-map	Use this mode to set route metric, route-length and cost data. It is available for the BGP, OSPF, and RIP protocols.
Address Family	Use this mode for multiprotocol BGP extension. It includes address family-specific commands.
Key Chain	Use this mode to manage the key chain. It is available for the RIP and ISIS protocols.
Trunk	Use this mode to create or modify RSVP trunks. A trunk is the static definition for a Labeled Switch Path (LSP).
Path	Use this mode to create or modify RSVP paths.

CHAPTER 1 Base BFD Configuration

This chapter provides the steps for configuring the base Bidirectional Forwarding Detection (BFD) setup.

Topology

Figure 1: Basic Topology of Three Routers

BFD Echo Function

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#bfd echo`	Enable BFD echo mode.

BFD Slow Timer

`ZebOS#configure terminal`	Enter the the Configure mode.
`ZebOS(config)#bfd slow-timer 1000`	Configure BFD `slow-timer` in milliseconds.

BFD Multihop Peer Timer

`ZebOS#configure terminal`	Enter Configure mode.
`ZebOS(config)#bfd multihop-peer 20.1.1.3 interval 100 minrx 100 multiplier 3`	Configure BFD `multihop-peer` timer and reception intervals in milliseconds, and the Hello multiplier.

BFD Single-hop Session Timer

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#interface eth1`	Enter the Interface mode.
`ZebOS(config-if)#bfd interval 100 minrx 100 multiplier 4`	Configure BFD single-hop sessions timer and reception interval in millisecond, and the Hello multiplier.

BFD Echo Interval

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#interface eth1`	Enter the Interface mode.
`ZebOS(config-if)#bfd echo interval 100`	Configure BFD echo interval in milliseconds.

CHAPTER 2 BFD Protocol Configurations

This chapter describes the BFD protocol configurations.

OSPF—BFD Single-Hop Session

This section provides the steps for configuring BFD for Single-Hop OSPF.

Topology

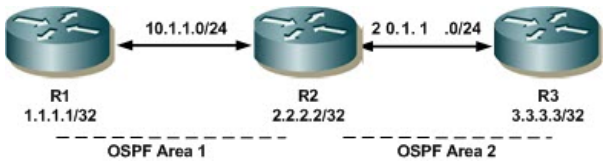


Figure 2: Single-Hop OSPF Topology

Configuration for R1

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#router ospf 100`	Enter the Router mode for OSPF.
`ZebOS(config-router)#network 10.1.1.0/24 area 1`	Advertise network `10.1.1.0/24` in OSPF `area 1`.
`ZebOS(config-router)#network 1.1.1.1/32 area 1`	Advertise loopback to network `1.1.1.1/32` in OSPF `area 1`.
`ZebOS(config-router)#bfd all-interfaces`	Enable BFD for all neighbors.

Configuration for R2

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#router ospf 100`	Enter the Router mode for OSPF.
`ZebOS(config-router)#network 10.1.1.0/24 area 1`	Advertise network `10.1.1.0/24` in OSPF `area 1`.
`ZebOS(config-router)#network 20.1.1.0/24 area 1`	Advertise network `20.1.1.0/24 in` OSPF `area 1`.
`ZebOS(config-router)#network 2.2.2.2/32 area 1`	Advertise loopback to network `2.2.2.2/32` in OSPF `area 1`.
`ZebOS(config-router)#bfd all-interfaces`	Enable BFD for all neighbors.

Configuration for R3

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#router ospf 100`	Enter the Router mode for OSPF.

`ZebOS(config-router)#network 20.1.1.0/24 area 1`	Advertise network `20.1.1.0/24` in OSPF `area 1.`
`ZebOS(config-router)#network 3.3.3.3/32 area 1`	Advertise loopback to network `3.3.3.3/32` in OSPF `area 1.`
`ZebOS(config-router)#bfd all-interfaces`	Enable BFD for all neighbors

Validation

The example that follows is the output of the command:

```
ZebOS#show bfd session
Session Interface Index : 3     Session Index: 1
Lower Layer: IPv4     Single Hop
Session State : Up
Local Discriminator : 1 Remote Discriminator: 1
Local Address : 10.1.1.67/32    Remote Address: 10.1.1.66/32
Local Port : 49152      Remote Port: 3784
Timers in Milliseconds
Min Tx: 20 Min Rx: 20  Multiplier: 5
UP Count: 1 UPTIME: 00:14:12
Session Interface Index : 4     Session Index: 4
Lower Layer:  IPv4     Single Hop
Session State : Up
Local Discriminator : 4 Remote Discriminator: 4
Local Address : 20.1.1.67/32    Remote Address: 20.1.1.68/32
Local Port : 49155      Remote Port: 3784
Timers in Milliseconds
Min Tx: 20 Min Rx: 20 Multiplier: 5
UP Count: 1  UPTIME: 00:01:12
Number of Sessions:    2
```

OSPF—BFD Multi-Hop Session

This section provides the steps for configuring BFD for OSPF multi-hop sessions.

Topology

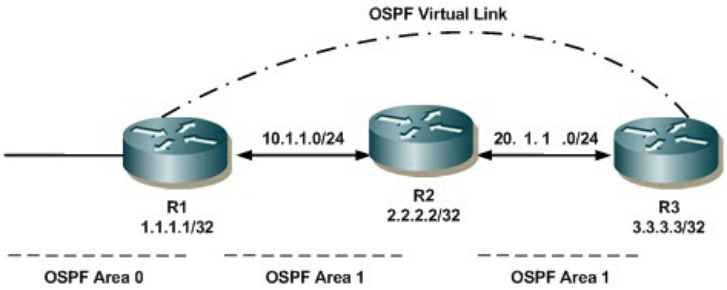


Figure 3: Multi-hop OSPFv3 Topology

Configuration for R1

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#router ospf 100`	Enter the Router mode for OSPF.
`ZebOS(config-router)#network 10.1.1.0/24 area 1`	Advertise network `20.1.1.0/24` in OSPF `area 1`.
`ZebOS(config-router)#network 1.1.1.1/32 area 1`	Advertise loopback to network `1.1.1.1/32` in OSPF `area 1.`
`ZebOS(config-router)#network 30.1.1.0/24 area 0`	Advertise network `30.1.1.0/24` in OSPF `area 0`.
`ZebOS(config-router)#area 1 virtual-link 3.3.3.3 fall-over bfd`	Create a virtual link to R3 with BFD.

Configuration for R2

`ZebOS#configure terminal`	Enter the Configure mode
`ZebOS(config)#router ospf 100`	Enter the Router mode for OSPF.
`ZebOS(config-router)#network 10.1.1.0/24 area 1`	Advertise network `10.1.1.0/24` in OSPF `area 1`.
`ZebOS(config-router)#network 20.1.1.0/24 area 1`	Advertise network `20.1.1.0/24` in OSPF `area 1`.
`ZebOS(config-router)#network 2.2.2.2/32 area 1`	Advertise loopback to network `2.2.2.2/32` in OSPF `area 1`.

Configuration for R3

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#router ospf 100`	Enter the Router mode for OSPF.
`ZebOS(config-router)#network 20.1.1.0/24 area 1`	Advertise network `20.1.1.0/24` in OSPF `area 1`.
`ZebOS(config-router)#network 3.3.3.3/32 area 1`	Advertise loopback to network `3.3.3.3/32` in OSPF `area 1`.
`ZebOS(config-router)#area 1 virtual-link 1.1.1.1 fall-over bfd`	Create a virtual link to R1 with BFD.

Validation

The example that follows is the output of the command:

```
ZebOS#show bfd session
Session Interface Index : 0     Session Index: 2
Lower Layer:  IPv4     Multihop Arbit Path
Session State : Up
Local Discriminator : 2 Remote Discriminator: 1
Local Address : 10.1.1.66/32    Remote Address: 20.1.1.68/32
Local Port : 49153      Remote Port: 4784
Min Tx: 2 Min Rx: 20  Multiplier: 5
UP Count: 1  UPTIME: 00:03:58
Number of Sessions:    1
```

OSPFv3—BFD Single-Hop Session

This section provides the steps for configuring BFD for single-hop OSPFv3.

Topology

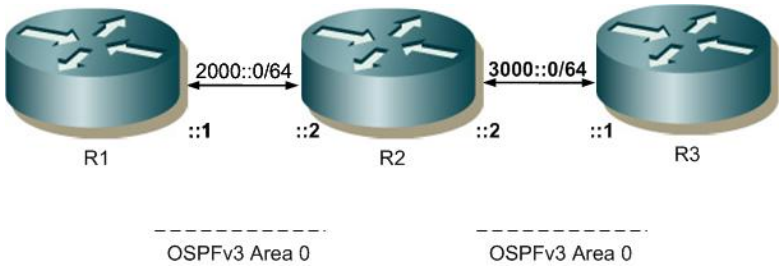


Figure 4: Single-Hop OSPFv3 Topology

Configuration for R1

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#interface eth1`	Enter the Interface mode for `eth1`.
`ZebOS(config-if)#ipv6 address 2000::1/64`	Configure IPv6 address for the interface `eth1`.
`ZebOS(config-if)#ipv6 router ospf area 0`	Enable OSPFv3 on the interface in `area 0`.
`ZebOS(config-if)#exit`	Exit from the Interface mode.
`ZebOS(config)#router ipv6 ospf 100`	Enter the Router mode for OSPFv3.
`ZebOS(config-router)#router-id 1.1.1.1`	Configure OSPFv3 Router-ID.
`ZebOS(config-router)#bfd all-interfaces`	Enable BFD on all OSPFv3 enabled interfaces.
`ZebOS(config-router)#exit`	Exit from the Router mode.

Configuration for R2

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#interface eth1`	Enter the Interface mode eth1.
`ZebOS(config-if)#ipv6 address 2000::2/64`	Configure IPv6 address for the interface `eth1`.
`ZebOS(config-if)#ipv6 router ospf area 0`	Enable OSPFv3 on the interface in `area 0`.
`ZebOS(config-if)#exit`	Exit from the Interface mode.
`ZebOS(config)#interface eth2`	Enter the Interface mode for `eth2`.
`ZebOS(config-if)#ipv6 address 3000::2/64`	Configure IPv6 address for the interface `eth2`.
`ZebOS(config-if)#ipv6 router ospf area 0`	Enable OSPFv3 on the interface in `area 0`.
`ZebOS(config-if)#exit`	Exit from the Interface mode.
`ZebOS(config)#router ipv6 ospf 100`	Enter the Router mode for OSPFv3.
`ZebOS(config-router)#router-id 2.2.2.2`	Configure OSPFv3 Router-ID.
`ZebOS(config-router)#bfd all-interfaces`	Enable BFD on all OSPFv3 enabled interfaces.
`ZebOS(config-router)#exit`	Exit from the Router mode.

Configuration for R3

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#interface eth1`	Enter the Interface mode for eth1.
`ZebOS(config-if)#ipv6 address 3000::1/64`	Configure IPv6 address for the interface eth1.
`ZebOS(config-if)#ipv6 router ospf area 0`	Enable OSPFv3 on the interface in area 0.
`ZebOS(config-if)#exit`	Exit from the Interface mode.
`ZebOS(config)#router ipv6 ospf 100`	Enter the Router mode for OSPFv3.
`ZebOS(config-router)#router-id 3.3.3.3`	Configure OSPFv3 Router-ID.
`ZebOS(config-router)#bfd all-interfaces`	Enable BFD on all OSPFv3 enabled interfaces.
`ZebOS(config-router)#exit`	Exit from the Router mode.

Validation

This section provides the output of show commands used to confirm the configurations for BFD for single-hop OSPFv3.

```
ZebOS#show bfd session
Sess-Idx   Remote-Disc  Lower-Layer  Sess-Type   Sess-State  UP-Time   Remote-Addr
20         12           IPv6         Single-Hop  Up          00:00:33
fe80::5054:ff:fe31:3233/128
21         1            IPv6         Single-Hop  Up          00:00:26
fe80::7074:ff:fe72:7374/128
Number of Sessions:    2

ZebOS#show bfd session detail
=====================================================

Session Interface Index : 3              Session Index : 10
Lower Layer : IPv6                       Version : 1
Session Type : Single Hop                Session State : Up
Local Discriminator : 10                 Local Address : fe80::5054:ff:fe31:3233/128
Remote Discriminator : 12                Remote Address : fe80::7074:ff:fe72:7374/128
Local Port : 49161                       Remote Port : 13784
Options :

Diagnostics : None

Timers in Milliseconds :
Min Tx: 1000              Min Rx: 1000              Multiplier: 2
Neg Tx: 1000              Neg Rx: 1000              Neg detect mult: 2
Min echo Tx: 20           Min echo Rx: 10           Neg echo intrvl: 0
Storage type : 2
Sess down time : 00:00:00
Sess discontinue time : 00:00:00
Bfd GTSM Disabled
Bfd Authentication Disabled
   BFD Protocol Configurations

Counters values:
Pkt In : 0000000000000000                Pkt Out : 0000000000000000
Echo Out : 0000000000000000              IPv6 Echo Out : 0000000000000000
IPv6 Pkt In : 0000000000000494           IPv6 Pkt Out : 00000000000004e3
UP Count : 4                             UPTIME : 00:15:09


Protocol Client Info:
OSPF6-> Client ID: 5     Flags: 4
-----------------------------------------------------------

Session Interface Index : 3              Session Index : 19
Lower Layer : IPv4                       Version : 1
Session Type : Single Hop                Session State : Up
Local Discriminator : 19                 Local Address : 2.2.2.1/32
Remote Discriminator : 13                Remote Address : 2.2.2.2/32
```

```
Local Port : 49170                      Remote Port : 3784
Options :

Diagnostics : None

Timers in Milliseconds :
Min Tx: 1000              Min Rx: 1000              Multiplier: 2
Neg Tx: 1000              Neg Rx: 1000              Neg detect mult: 2
Min echo Tx: 20           Min echo Rx: 10           Neg echo intrvl: 0
Storage type : 2
Sess down time : 00:00:00
Sess discontinue time : 00:00:00
Bfd GTSM Disabled
Bfd Authentication Disabled

Counters values:
Pkt In : 000000000000006f               Pkt Out : 000000000000006c
Echo Out : 0000000000000000             IPv6 Echo Out : 0000000000000000
IPv6 Pkt In : 0000000000000000          IPv6 Pkt Out : 0000000000000000
UP Count : 1                            UPTIME : 00:01:36

Protocol Client Info:
RIP-> Client ID: 2       Flags: 4
------------------------------------------------------------
Number of Sessions:    2
```

OSPFv3—BFD Multi-Hop Sessions

This section provides the steps for configuring BFD for OSPFv3 multi-hop sessions.

Topology

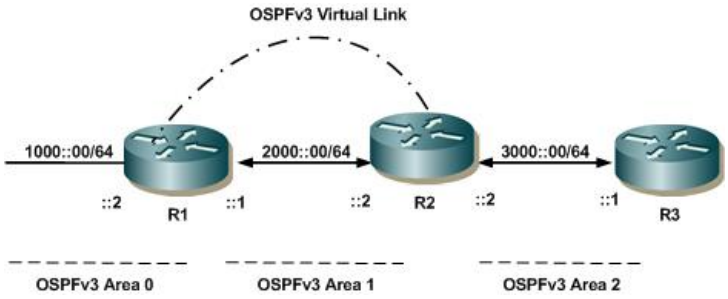


Figure 5: Multi-Hop OSPFv3 Topology

Configuration for R1

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#interface eth2`	Enter the Interface mode `eth2`.
`ZebOS(config-if)#ipv6 address 1000::1/64`	Configure IPv6 address for the interface `eth2`.
`ZebOS(config-if)#ipv6 router ospf area 0`	Enable OSPFv3 on the interface in `area 0`.
`ZebOS(config-if)#exit`	Exit from the Interface mode.
`ZebOS(config)#interface eth1`	Enter the Interface mode for `eth1`.
`ZebOS(config-if)#ipv6 address 2000::1/64`	Configure IPv6 address for the interface `eth1`.
`ZebOS(config-if)#ipv6 router ospf area 1`	Enable OSPFv3 on the interface in `area 1`.
`ZebOS(config-if)#exit`	Exit from the Interface mode.
`ZebOS(config)#router ipv6 ospf 100`	Enter the Router mode for OSPFv3.
`ZebOS(config-router)#router-id 1.1.1.1`	Configure OSPFv3 Router-ID.
`ZebOS(config-router)#area 1 virtual-link 2.2.2.2 fall-over bfd`	Create an OSPFv3 virtual-link to R2 with BFD.
`ZebOS(config-router)#exit`	Exit from the Router mode.

Configuration for R2

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#interface eth1`	Enter the Interface mode `eth1`.
`ZebOS(config-if)#ipv6 address 2000::2/64`	Configure IPv6 address for the interface `eth1`.
`ZebOS(config-if)#ipv6 router ospf area 1`	Enable OSPFv3 on the interface in `area 1`.
`ZebOS(config-if)#exit`	Exit from the Interface mode.
`ZebOS(config)#interface eth2`	Enter the Interface mode for `eth2`.
`ZebOS(config-if)#ipv6 address 3000::2/64`	Configure IPv6 address for the interface `eth2`.
`ZebOS(config-if)#ipv6 router ospf area 2`	Enable OSPFv3 on the interface in `area 2`.
`ZebOS(config-if)#exit`	Exit from the Interface mode.

`ZebOS(config)#router ipv6 ospf 100`	Enter the Router mode for OSPFv3.
`ZebOS(config-router)#router-id 2.2.2.2`	Configure OSPFv3 Router-ID.
`ZebOS(config-router)#area 1 virtual-link 1.1.1.1 fall-over bfd`	Create an OSPFv3 virtual-link to R1 with BFD.
`ZebOS(config-router)#exit`	Exit from the Router mode.

Configuration for R3

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#interface eth1`	Enter the Interface mode for `eth1`.
`ZebOS(config-if)#ipv6 address 3000::1/64`	Configure IPv6 address for the interface `eth1`.
`ZebOS(config-if)#ipv6 router ospf area 2`	Enable OSPFv3 on the interface in `area 2`.
`ZebOS(config-if)#exit`	Exit from the Interface mode.
`ZebOS(config)#router ipv6 ospf 100`	Enter the Router mode for OSPFv3.
`ZebOS(config-router)#router-id 3.3.3.3`	Configure OSPFv3 Router-ID.
`ZebOS(config-router)#exit`	Exit from the Router mode.

Validation

This section provides the output of show commands used to confirm the configurations for BFD for OSPFv3 multi-hop sessions.

```
ZebOS#show bfd session
Sess-Idx   Remote-Disc  Lower-Layer  Sess-Type   Sess-State  UP-Time   Remote-Addr
14             24                    IPv6               Multi-Hop   Up
00:01:14  2000::2/128
Number of Sessions:    1

ZebOS#show bfd session detail
=====================================================

Session Interface Index : 3              Session Index : 10
Lower Layer : IPv6                       Version : 1
Session Type : Multi Hop                Session State : Up
Local Discriminator : 10                 Local Address : 2000::1/128
Remote Discriminator : 12                Remote Address : 2000::2/128
Local Port : 49161                       Remote Port : 13784
Options :

Diagnostics : None

Timers in Milliseconds :
Min Tx: 1000              Min Rx: 1000             Multiplier: 2
Neg Tx: 1000              Neg Rx: 1000             Neg detect mult: 2
Min echo Tx: 20           Min echo Rx: 10          Neg echo intrvl: 0
Storage type : 2
Sess down time : 00:00:00
Sess discontinue time : 00:00:00
Bfd GTSM Disabled
```

```
Bfd Authentication Disabled

BFD Protocol Configurations


Counters values:
Pkt In : 0000000000000000                Pkt Out : 0000000000000000
Echo Out : 0000000000000000              IPv6 Echo Out : 0000000000000000
IPv6 Pkt In : 0000000000000494           IPv6 Pkt Out : 00000000000004e3
UP Count : 4                             UPTIME : 00:15:09

Protocol Client Info:
OSPF6-> Client ID: 5     Flags: 4
```

BFD Configuration in IS-IS

This section provides the steps for configuring BFD for the IS-IS protocol.

Topology

Figure 6: Basic Topology for BFD-ISIS

Configuration for R1

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#router isis`	Enter the Router mode for IS-IS.
`ZebOS(config-router)#net 10.0000.0000.0001.00`	Advertise network `10.0000.0000.0001.00` in IS-IS.
`ZebOS(config-router)#bfd all-interface`	Enable BFD for all neighbors.

Configuration for R2

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#router isis`	Enter the Router mode for IS-IS.
`ZebOS(config-router)#net 10.0000.0000.0002.00`	Advertise network `10.0000.0000.0001.00` in IS-IS.
`ZebOS(config-router)#bfd all-interface`	Enable BFD for all neighbors.

BFD Configuration in BGP

This section provides the steps for configuring BFD for the BGP protocol.

Topology

Figure 7: Basic Topology for BFD in BGP

Configuration for R1

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#router bgp 100`	Enter the Router mode for BGP.
`ZebOS(config-router)#neighbor 3.3.3.3 remote-as 100`	Add the neighbor `3.3.3.3/32` to remote-as `100`.
`ZebOS(config-router)#neighbor 3.3.3.3 fall-over bfd multihop`	Enable the BFD option for the neighbor.

Configuration for R2

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#router bgp 100`	Enter the Router mode for BGP.
`ZebOS(config-router)#neighbor 2.2.2.2 remote-as 100`	Add the neighbor `2.2.2.2` to remote-as `100`.
`ZebOS(config-router)#neighbor 2.2.2.2 fall-over bfd multihop`	Enable the BFD option for the neighbor.

Configuration for R3

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#router bgp 100`	Enter the Router mode for BGP.
`ZebOS(config)#router bgp 100`	Configure BGP.
`ZebOS(config-router)#neighbor 1.1.1.1 remote-as 100`	Add the neighbor `1.1.1.1` to remote-as `100`.
`ZebOS(config-router)#neighbor 1.1.1.1 fall-over bfd multihop`	Enable the BFD option for the neighbor.

BFD Configuration in RIP

This section provides the steps for configuring BFD for the RIP protocol.

Topology

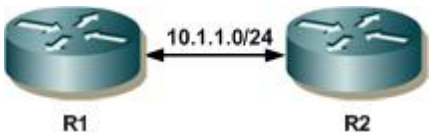


Figure 8: Basic Topology for BFD in RIP

Configuration for R1

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#router rip`	Enter the Router mode for RIP.
`ZebOS(config-router)#network 10.1.1.0/24`	Advertise network `10.1.1.0/24` in RIP.
`ZebOS(config-router)#bfd all-interfaces`	Enable BFD for all neighbors.
	or
`ZebOS(config-router)#neighbor 10.1.1.2 fall-over bfd`	Enable BFD for a specific RIP neighbor

Configuration for R2

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#router rip`	Enter the Router mode for RIP.
`ZebOS(config-router)#network 10.1.1.0/24`	Advertise network `10.1.1.0/24` in RIP.
`ZebOS(config-router)#bfd all-interfaces`	Enable BFD for all neighbors.
	or
`ZebOS(config-router)#neighbor 10.1.1.1 fall-over bfd`	Enable BFD for a specific RIP neighbor.

Validation

This section provides the output of show commands used to confirm the configurations for BFD for the RIP protocol.

```
ZebOS#show bfd session
Sess-Idx   Remote-Disc  Lower-Layer  Sess-Type   Sess-State  UP-Time   Remote-Addr
1              1                      IPv4                Single-Hop Up
00:05:01   10.1.1.1/32
Number of Sessions:    2
```

```
ZebOS#show bfd session detail
=====================================================

Session Interface Index : 4              Session Index : 18
Lower Layer : IPv4                       Version : 1
Session Type : Single Hop                Session State : Up




BFD Protocol Configurations


Local Discriminator : 18                 Local Address : 3.3.3.1/32
Remote Discriminator : 14                Remote Address : 3.3.3.2/32
Local Port : 49169                       Remote Port : 3784
Options :

Diagnostics : None

Timers in Milliseconds :
Min Tx: 1000              Min Rx: 1000              Multiplier: 2
Neg Tx: 1000              Neg Rx: 1000              Neg detect mult: 5
Min echo Tx: 20           Min echo Rx: 10           Neg echo intrvl: 0
Storage type : 2
Sess down time : 00:00:00
Sess discontinue time : 00:00:00
Bfd GTSM Disabled
Bfd Authentication Disabled

Counters values:
Pkt In : 0000000000000702                Pkt Out : 0000000000000704
Echo Out : 0000000000000000              IPv6 Echo Out : 0000000000000000
IPv6 Pkt In : 0000000000000000           IPv6 Pkt Out : 0000000000000000
UP Count : 1                             UPTIME : 00:01:37

Protocol Client Info:
RIP-> Client ID: 2       Flags: 4
-----------------------------------------------------------
```

CHAPTER 3 BFD Static Route Configuration

This chapter describes the configurations for BFD static routes.

In order to establish alternate paths to destinations that have the least possible delay it is important to quickly detect any changes to static route validity. BFD detects the liveliness of a static route's nexthop and then uses the nexthop's reachability information to determine whether routes are valid. Using BFD to reach a static route's nexthop also ensures that a static route is inserted in the forwarding database only when the nexthop neighbor is reachable.

Topology

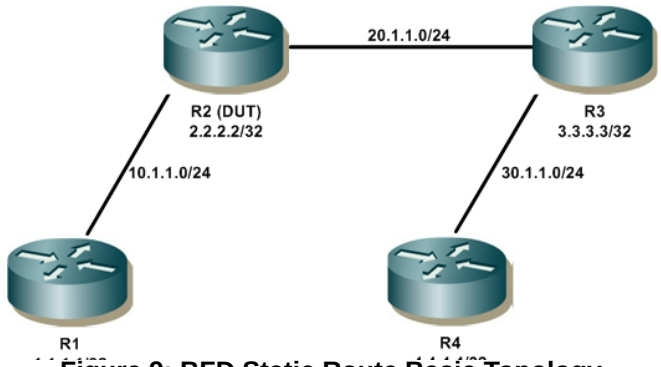


Figure 9: BFD Static Route Basic Topology

Configuration for R2

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#ip router 30.1.1.0/24 20.1.1.3`	Configure static route.
`ZebOS(config)#ip bfd static all-interfaces`	Enable BFD for all static routes.
`ZebOS(config)#interface eth1`	Enter the Interface configuration mode for `eth1`.
`ZebOS(config-if)#ip static bfd`	Enable static BFD on the interface.
`ZebOS(config-if)#exit`	Exit the Interface configuration mode.
`ZebOS(config)#ip static 30.1.1.0/24 20.1.1.3 fall-over bfd`	Enable static BFD at static route level.

Configuration for R3

`ZebOS#configure terminal`	Enter the Configure mode.
`ZebOS(config)#ip route 10.1.1.0/24 20.1.1.2`	Configure static route.
`ZebOS(config)#ip bfd static all-interfaces`	Enable BFD for all static routes.
`ZebOS(config)#int eth1`	Enter the Interface configuration mode for `eth1`.
`ZebOS(config-if)#ip static bfd`	Enable static BFD at interface level.

`ZebOS(config-if)#exit`	Exit the Interface configuration mode.
`ZebOS(config)#ip static 20.1.1.0/24 10.1.1.2 fall-over bfd`	Enable static BFD at static route level.

Verification and Validation

Enter the commands listed in the following section to confirm the configurations.

Verify Traffic Class Groups Configuration

Show IP Route

```
ZebOS#show ip route
Codes: K - kernel, C - connected, S - static, R - RIP, B - BGP
       O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default
Gateway of last resort is 10.1.2.1 to network 0.0.0.0
K*      0.0.0.0/0 via 10.1.2.1, eth0
C       10.1.2.0/24 is directly connected, eth0
C       127.0.0.0/8 is directly connected, lo
K       169.254.0.0/16 is directly connected, eth0
ZebOS#
```

Show BFD Session Detail

```
ZebOS#show bfd session detail
-----------------------------------------
Session Interface Index: 5     Session Index: 1
Lower Layer:  IPv4      Version: 1     Session Type: Single Hop
Session State: Up
Local Discriminator: 1 Remote Discriminator: 1
Local Address: 20.1.1.2/32    Remote Address: 20.1.1.3/32
Local Port: 49152      Remote Port: 3784
Options:
Diagnostics: None
Timers in Milliseconds
Min Tx: 20  Min Rx: 20  Multiplier: 5
Min echo Tx: 20   Min echo Rx: 10   Neg Tx: 20
Neg echo intrvl: 0      Neg detect mult: 5
Storage type: 2
Last sess down time: 00:00:00
Sess discontinue time: 00:00:00
Counters values:
Pkt In 0000000000007675 Pkt Out 0000000000007612
Echo Out 0000000000000000
IPv6 Pkt In 0000000000000000 IPv6 Pkt Out 0000000000000000
IPv6 Echo Out 0000000000000000
UP Count: 1  UPTIME: 00:09:37
NSM-> Client ID: 1 Flags: 4
Number of Sessions:    1
```

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