



## BGP NSF Awareness

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Nonstop Forwarding (NSF) awareness allows a router to assist NSF-capable neighbors to continue forwarding packets during a Stateful Switchover (SSO) operation. The BGP Nonstop Forwarding Awareness feature allows an NSF-aware router that is running BGP to forward packets along routes that are already known for a router that is performing an SSO operation. This capability allows the BGP peers of the failing router to retain the routing information that is advertised by the failing router and continue to use this information until the failed router has returned to normal operating behavior and is able to exchange routing information. The peering session is maintained throughout the entire NSF operation.

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## Information About BGP NSF Awareness

### Cisco NSF Routing and Forwarding Operation

Cisco NSF is supported by the BGP, EIGRP, OSPF, and IS-IS protocols for routing and by Cisco Express Forwarding (CEF) for forwarding. Of the routing protocols, BGP, EIGRP, OSPF, and IS-IS have been enhanced with NSF capability and awareness, which means that devices running these protocols can detect a switchover and take the necessary actions to continue forwarding network traffic and to recover route information from the peer devices.

In this module, a networking device is said to be NSF-aware if it is running NSF-compatible software. A device is said to be NSF-capable if it has been configured to support NSF; therefore, it rebuilds routing information from NSF-aware or NSF-capable neighbors.

Each protocol depends on CEF to continue forwarding packets during switchover while the routing protocols rebuild the Routing Information Base (RIB) tables. Once the routing protocols have converged, CEF updates the Forwarding Information Base (FIB) table and removes stale route entries. CEF then updates the line cards with the new FIB information.

## Cisco Express Forwarding for NSF

A key element of NSF is packet forwarding. In a Cisco networking device, packet forwarding is provided by CEF. CEF maintains the FIB and uses the FIB information that was current at the time of the switchover to continue forwarding packets during a switchover. This feature reduces traffic interruption during the switchover.

During normal NSF operation, CEF on the active RP synchronizes its current FIB and adjacency databases with the FIB and adjacency databases on the standby RP. Upon switchover of the active RP, the standby RP initially has FIB and adjacency databases that are mirror images of those that were current on the active RP. For platforms with intelligent line cards, the line cards will maintain the current forwarding information over a switchover; for platforms with forwarding engines, CEF will keep the forwarding engine on the standby RP current with changes that are sent to it by CEF on the active RP. In this way, the line cards or forwarding engines will be able to continue forwarding after a switchover as soon as the interfaces and a data path are available.

As the routing protocols start to repopulate the RIB on a prefix-by-prefix basis, the updates in turn cause prefix-by-prefix updates for CEF, which it uses to update the FIB and adjacency databases. Existing and new entries will receive the new version (epoch) number, indicating that they have been refreshed. The forwarding information is updated on the line cards or forwarding engine during convergence. The RP signals when the RIB has converged. The software removes all FIB and adjacency entries that have an epoch older than the current switchover epoch. The FIB now represents the newest routing protocol forwarding information.

The routing protocols run only on the active RP, and they receive routing updates from their neighbor routers. Routing protocols do not run on the standby RP. After a switchover, the routing protocols request that the NSF-aware neighbor devices send state information to help rebuild the routing tables.



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**Note** For NSF operation, the routing protocols depend on CEF to continue forwarding packets while the routing protocols rebuild the routing information.

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## BGP Graceful Restart for NSF

When an NSF-capable router begins a BGP session with a BGP peer, it sends an OPEN message to the peer. Included in the message is a declaration that the NSF-capable or NSF-aware router has graceful restart capability. Graceful restart is the mechanism by which BGP routing peers avoid a routing flap after a switchover. If the BGP peer has received this capability, it is aware that the device sending the message is NSF-capable. Both the NSF-capable router and its BGP peer(s) (NSF-aware peers) need to exchange the graceful restart capability in their OPEN messages, at the time of session establishment. If both peers do not exchange the graceful restart capability, the session will not be graceful restart capable.

If the BGP session is lost during the RP switchover, the NSF-aware BGP peer marks all the routes associated with the NSF-capable router as stale; however, it continues to use these routes to make forwarding decisions for a set period of time. This functionality means that no packets are lost while the newly active RP is waiting for convergence of the routing information with the BGP peers.

After an RP switchover occurs, the NSF-capable router reestablishes the session with the BGP peer. In establishing the new session, it sends a new graceful restart message that identifies the NSF-capable router as having restarted.

At this point, the routing information is exchanged between the two BGP peers. Once this exchange is complete, the NSF-capable device uses the routing information to update the RIB and the FIB with the new forwarding

information. The NSF-aware device uses the network information to remove stale routes from its BGP table. Following that, the BGP protocol is fully converged.

If a BGP peer does not support the graceful restart capability, it will ignore the graceful restart capability in an OPEN message but will establish a BGP session with the NSF-capable device. This functionality will allow interoperability with non-NSF-aware BGP peers (and without NSF functionality), but the BGP session with non-NSF-aware BGP peers will not be graceful restart capable.

## BGP NSF Awareness

BGP support for NSF requires that neighbor routers are NSF-aware or NSF-capable. NSF awareness in BGP is also enabled by the graceful restart mechanism. A router that is NSF-aware functions like a router that is NSF-capable with one exception: an NSF-aware router is incapable of performing an SSO operation. However, a router that is NSF-aware is capable of maintaining a peering relationship with an NSF-capable neighbor during an NSF SSO operation, as well as holding routes for this neighbor during the SSO operation.

The BGP Nonstop Forwarding Awareness feature provides an NSF-aware router with the capability to detect a neighbor that is undergoing an SSO operation, maintain the peering session with this neighbor, retain known routes, and continue to forward packets for these routes. The deployment of BGP NSF awareness can minimize the effects of Route Processor (RP) failure conditions and improve the overall network stability by reducing the amount of resources that are normally required for reestablishing peering with a failed router.

NSF awareness for BGP is not enabled by default. The **bgp graceful-restart** command is used to globally enable NSF awareness on a router that is running BGP. NSF-aware operations are also transparent to the network operator and to BGP peers that do not support NSF capabilities.



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**Note** NSF awareness is enabled automatically in supported software images for Interior Gateway Protocols, such as EIGRP, IS-IS, and OSPF. In BGP, global NSF awareness is not enabled automatically and must be started by issuing the **bgp graceful-restart** command in router configuration mode.

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## How to Configure BGP NSF Awareness

### Configuring BGP Nonstop Forwarding Awareness Using BGP Graceful Restart

The tasks in this section show how configure BGP Nonstop Forwarding (NSF) awareness using the BGP graceful restart capability.

- The first task enables BGP NSF globally for all BGP neighbors and suggests a few troubleshooting options.
- The second task describes how to adjust the BGP graceful restart timers, although the default settings are optimal for most network deployments.
- The next three tasks demonstrate how to enable or disable BGP graceful restart for individual BGP neighbors, including peer session templates and peer groups.
- The final task verifies the local and peer router configurations of BGP NSF.

## Enabling BGP Global NSF Awareness Using BGP Graceful Restart

Perform this task to enable BGP NSF awareness globally for all BGP neighbors. BGP NSF awareness is part of the graceful restart mechanism and BGP NSF awareness is enabled by issuing the **bgp graceful-restart** command in router configuration mode. BGP NSF awareness allows NSF-aware routers to support NSF-capable routers during an SSO operation. NSF-awareness is not enabled by default and should be configured on all neighbors that participate in BGP NSF.



**Note** The configuration of the restart and stale-path timers is not required to enable the BGP graceful restart capability. The default values are optimal for most network deployments, and these values should be adjusted only by an experienced network operator.



**Note** Configuring both Bidirectional Forwarding Detection (BFD) and BGP graceful restart for NSF on a device running BGP may result in suboptimal routing.

### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *autonomous-system-number*
4. **bgp graceful-restart** [*restart-time seconds*] [*stalepath-time seconds*]
5. **end**

### DETAILED STEPS

#### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>enable</b> <b>Example:</b> <pre>Device&gt; enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> <li>• Enter your password if prompted.</li> </ul>
<b>Step 2</b>	<b>configure terminal</b> <b>Example:</b> <pre>Device# configure terminal</pre>	Enters global configuration mode.
<b>Step 3</b>	<b>router bgp</b> <i>autonomous-system-number</i> <b>Example:</b> <pre>Device(config)# router bgp 45000</pre>	Enters router configuration mode and creates a BGP routing process.

	Command or Action	Purpose
Step 4	<b>bgp graceful-restart</b> [ <b>restart-time</b> <i>seconds</i> ] [ <b>stalepath-time</b> <i>seconds</i> ] <b>Example:</b> <pre>Device(config-router)# bgp graceful-restart</pre>	Enables the BGP graceful restart capability and BGP NSF awareness. <ul style="list-style-type: none"> <li>• If you enter this command after the BGP session has been established, you must restart the session for the capability to be exchanged with the BGP neighbor.</li> <li>• Use this command on the restarting router and all of its peers (NSF-capable and NSF-aware).</li> </ul>
Step 5	<b>end</b> <b>Example:</b> <pre>Device(config-router)# end</pre>	Exits router configuration mode and enters privileged EXEC mode.

### Troubleshooting Tips

To troubleshoot the NSF feature, use the following commands in privileged EXEC mode, as needed:

- **debug ip bgp** —Displays open messages that advertise the graceful restart capability.
- **debug ip bgp event** —Displays graceful restart timer events, such as the restart timer and the stalepath timer.
- **debug ip bgp updates** —Displays sent and received EOR messages. The EOR message is used by the NSF-aware router to start the stalepath timer, if configured.
- **show ip bgp** —Displays entries in the BGP routing table. The output from this command displays routes that are marked as stale by displaying the letter “S” next to each stale route.
- **show ip bgp neighbor** —Displays information about the TCP and BGP connections to neighbor devices. When enabled, the graceful restart capability is displayed in the output of this command.

### What to Do Next

If the **bgp graceful-restart** command has been issued after the BGP session has been established, you must reset by issuing the **clear ip bgp \*** command or by reloading the router before graceful restart capabilities will be exchanged. For more information about resetting BGP sessions and using the **clear ip bgp** command, see the “Configuring a Basic BGP Network” module.

## Configuring BGP NSF Awareness Timers

Perform this task to adjust the BGP graceful restart timers. There are two BGP graceful restart timers that can be configured. The optional **restart-time** keyword and *seconds* argument determine how long peer routers will wait to delete stale routes before a BGP open message is received. The default value is 120 seconds. The optional **stalepath-time** keyword and *seconds* argument determine how long a router will wait before deleting stale routes after an end of record (EOR) message is received from the restarting router. The default value is 360 seconds.



**Note** The configuration of the restart and stale-path timers is not required to enable the BGP graceful restart capability. The default values are optimal for most network deployments, and these values should be adjusted only by an experienced network operator.

## SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **router bgp** *autonomous-system-number*
4. **bgp graceful-restart** [**restart-time** *seconds*]
5. **bgp graceful-restart** [**stalepath-time** *seconds*]
6. **end**

## DETAILED STEPS

### Procedure

	Command or Action	Purpose
<b>Step 1</b>	<b>enable</b> <b>Example:</b> Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> <li>• Enter your password if prompted.</li> </ul>
<b>Step 2</b>	<b>configure terminal</b> <b>Example:</b> Device# configure terminal	Enters global configuration mode.
<b>Step 3</b>	<b>router bgp</b> <i>autonomous-system-number</i> <b>Example:</b> Device(config)# router bgp 45000	Enters router configuration mode and creates a BGP routing process.
<b>Step 4</b>	<b>bgp graceful-restart</b> [ <b>restart-time</b> <i>seconds</i> ] <b>Example:</b> Device(config-router)# bgp graceful-restart restart-time 130	Enables the BGP graceful restart capability and BGP NSF awareness. <ul style="list-style-type: none"> <li>• The <b>restart-time</b> argument determines how long peer routers will wait to delete stale routes before a BGP open message is received.</li> <li>• The default value is 120 seconds. The range is from 1 to 3600 seconds.</li> </ul> <p><b>Note</b> Only the syntax applicable to this step is used in this example. For more details, see the <i>Cisco IOS IP Routing: BGP Command Reference</i>.</p>

	Command or Action	Purpose
Step 5	<b>bgp graceful-restart</b> [stalepath-time seconds] <b>Example:</b> <pre>Device(config-router)# bgp graceful-restart stalepath-time 350</pre>	<p>Enables the BGP graceful restart capability and BGP NSF awareness.</p> <ul style="list-style-type: none"> <li>The <b>stalepath-time</b> argument determines how long a router will wait before deleting stale routes after an end of record (EOR) message is received from the restarting router.</li> <li>The default value is 360 seconds. The range is from 1 to 3600 seconds.</li> </ul> <p><b>Note</b> Only the syntax applicable to this step is used in this example. For more details, see the <i>Cisco IOS IP Routing: BGP Command Reference</i>.</p>
Step 6	<b>end</b> <b>Example:</b> <pre>Device(config-router)# end</pre>	Exits router configuration mode and enters privileged EXEC mode.

## What to Do Next

If the **bgp graceful-restart** command has been issued after the BGP session has been established, you must reset the peer sessions by issuing the **clear ip bgp \*** command or by reloading the router before graceful restart capabilities will be exchanged. For more information about resetting BGP sessions and using the **clear ip bgp** command, see the “Configuring a Basic BGP Network” module.

## Verifying the Configuration of BGP Nonstop Forwarding Awareness

Use the following steps to verify the local configuration of BGP NSF awareness on a router and to verify the configuration of NSF awareness on peer routers in a BGP network.

### SUMMARY STEPS

1. **enable**
2. **show running-config** [options]
3. **show ip bgp neighbors** [ip-address [received-routes | routes | advertised-routes | paths [regex] | dampened-routes | flap-statistics | received prefix-filter | policy [detail]]]

### DETAILED STEPS

#### Procedure

#### Step 1

**enable**

Enables privileged EXEC mode. Enter your password if prompted.

**Example:**

```
Router> enable
```

## Step 2 **show running-config** [options]

Displays the running configuration on the local router. The output will display the configuration of the **bgp graceful-restart** command in the BGP section. Repeat this command on all BGP neighbor routers to verify that all BGP peers are configured for BGP NSF awareness. In this example, BGP graceful restart is enabled globally and the external neighbor at 192.168.1.2 is configured to be a BGP peer and will have the BGP graceful restart capability enabled.

### Example:

```
Router# show running-config
.
.
.
router bgp 45000
  bgp router-id 172.17.1.99
  bgp log-neighbor-changes
  bgp graceful-restart restart-time 130
  bgp graceful-restart stalepath-time 350
  bgp graceful-restart
  timers bgp 70 120
  neighbor 192.168.1.2 remote-as 40000
  neighbor 192.168.1.2 activate
.
.
.
```

## Step 3 **show ip bgp neighbors** [ip-address] [received-routes | routes | advertised-routes | paths [regex] | dampened-routes | flap-statistics | received prefix-filter | policy [detail]]

Displays information about TCP and BGP connections to neighbors. “Graceful Restart Capability: advertised” will be displayed for each neighbor that has exchanged graceful restart capabilities with this router. In Cisco IOS Releases 12.2(33)SRC, 12.2(33)SB, or later releases, the ability to enable or disable the BGP graceful restart capability for an individual BGP neighbor, peer group or peer session template was introduced and output was added to this command to show the BGP graceful restart status.

The following partial output example using a Cisco IOS Release 12.2(33)SRC image, displays the graceful restart information for internal BGP neighbor 172.21.1.2 at Router C in the figure above. Note the “Graceful-Restart is enabled” message.

### Example:

```
Router# show ip bgp neighbors 172.21.1.2

BGP neighbor is 172.21.1.2, remote AS 45000, internal link
  BGP version 4, remote router ID 172.22.1.1
  BGP state = Established, up for 00:01:01
  Last read 00:00:02, last write 00:00:07, hold time is 180, keepalive intervals
  Neighbor sessions:
    1 active, is multisession capable
  Neighbor capabilities:
    Route refresh: advertised and received(new)
    Address family IPv4 Unicast: advertised and received
    Graceful Restart Capability: advertised
    Multisession Capability: advertised and received
!
  Address tracking is enabled, the RIB does have a route to 172.21.1.2
  Connections established 1; dropped 0
  Last reset never
```



```
Transport(tcp) path-mtu-discovery is enabled
Graceful-Restart is enabled, restart-time 120 seconds, stalepath-time 360 secs
```

## Configuration Examples for BGP NSF Awareness

### Example: Enabling BGP Global NSF Awareness Using Graceful Restart

The following example enables BGP NSF awareness globally on all BGP neighbors. The restart time is set to 130 seconds, and the stale path time is set to 350 seconds. The configuration of these timers is optional, and the preconfigured default values are optimal for most network deployments.

```
configure terminal
router bgp 45000
  bgp graceful-restart
  bgp graceful-restart restart-time 130
  bgp graceful-restart stalepath-time 350
end
```

## Additional References

### Related Documents

Related Topic	Document Title
Cisco IOS commands	<a href="#">Cisco IOS Master Command List, All Releases</a>
BGP commands	<a href="#">Cisco IOS IP Routing: BGP Command Reference</a>

### MIBs

MIB	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a>

**Technical Assistance**

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

## Feature Information for BGP NSF Awareness

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

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

Table 1: Feature Information for BGP NSF Awareness

Feature Name	Releases	Feature Information
BGP NSF Awareness		<p>Nonstop Forwarding (NSF) awareness allows a device to assist NSF-capable neighbors to continue forwarding packets during a Stateful Switchover (SSO) operation. The BGP Nonstop Forwarding Awareness feature allows an NSF-aware device that is running BGP to forward packets along routes that are already known for a device that is performing an SSO operation. This capability allows the BGP peers of the failing device to retain the routing information that is advertised by the failing device and continue to use this information until the failed device has returned to normal operating behavior and is able to exchange routing information. The peering session is maintained throughout the entire NSF operation.</p> <p>The following commands were introduced or modified: <b>bgp graceful-restart</b>, <b>show ip bgp</b>, <b>show ip bgp neighbors</b>.</p>

