

SSO and ISSU--MPLS VPN 6VPE and 6PE Support

This document provides information about configuring stateful switchover (SSO) and In Service Software Upgrade (ISSU) support for Cisco IOS XE VPN IPv6 provider edge (6VPE) and Cisco IOS XE IPv6 provider edge (6PE) routers over Multiprotocol Label Switching (MPLS).

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Prerequisites for SSO and ISSU--MPLS VPN 6VPE and 6PE Support

- Your networking device must be running Cisco IOS XE 3.2S or a later release.
- Your network must be configured for a supported MPLS VPN. For information, see Configuring MPLS Layer 3 VPNs and Implementing IPv6 VPN over MPLS.
- SSO must be configured on the Route Processor (RP). For information, see Stateful Switchover.
- Your networking device must support the following:
  - IPv6 Cisco Express Forwarding (CEF)
  - IPv6 nonstop forwarding (NSF)
  - Label Distribution Protocol (LDP) Graceful Restart
- NSF must be enabled on the Border Gateway Protocol (BGP) and static routes that run between the provider (P), PE, and the customer edge (CE) routers. For configuration information, see Cisco Nonstop Forwarding.
- LDP Graceful Restart must be enabled if LDP is the protocol used in the MPLS core. For configuration information, see NSF/SSO-MPLS LDP and MPLS LDP Graceful Restart.

Restrictions for SSO and ISSU--MPLS VPN 6VPE and 6PE Support

- Only LDP sessions are supported.
- MPLS VPN 6VPE and 6PE Carrier Supporting Carrier (CSC) VPNs support only BGP. CSC configurations that use LDP are not supported.
- Only BGP and static routes are supported for 6VPE and 6PE.

Information About SSO and ISSU--MPLS VPN 6VPE and 6PE Support

Elements Supporting SSO and ISSU--MPLS VPN 6VPE and 6PE Support Features

The major elements supporting the functionality of the SSO and ISSU for Cisco IOS XE VPN 6vPE and 6PE features are the following:

- MPLS VPN--Forwards IP traffic using a VPN label that instructs the routers and switches in the network where to forward the packets based on preestablished IP routing information.
- BGP Graceful Restart--The BGP Graceful Restart feature is responsible for negotiating graceful restart capabilities, exchanging forwarding preservation states, and coordinating advertisements after session restarts. MPLS VPNs interact with BGP to exchange VPN routing and forwarding (VRF) routes and labels.
- IPv6 NSF--IPv6 NSF support enables IPv6 cache rebuilds during switchover using checkpointed Cisco Express Forwarding adjacencies.
- CEF/MFI--CEF and the MPLS Forwarding Infrastructure (MFI) are responsible for preserving forwarding entries and local labels across RP switchover.



Note If a router does not support the SSO and ISSU--MPLS VPN 6VPE and 6PE Support feature, prefix and label information is not preserved. After a switchover, BGP has to restart, relearn all routes, and install labels in the forwarding database. This can cause the loss of some network traffic.

How BGP Graceful Restart Works for MPLS VPN 6vPE and 6PE

BGP Graceful Restart behavior for IPv6 and VPNv6 is essentially the same as Graceful Restart behavior for IPv4 and VPNv4; the only difference is the addition of support for IPv6 and VPNv6 address families.

When you configure BGP Graceful Restart, BGP includes the Graceful Restart capability and negotiates the preservation states of address families, such as IPv4/VPNv4 and IPv6/VPNv6 address families.

Both BGP peers must agree on a Graceful Restart timer. After a BGP session comes up and finishes sending initial updates, each BGP peer sends an end-of-Routing Information Base (RIB) marker.

The SSO and ISSU--MPLS VPN 6VPE and 6PE Support features use the mechanisms defined in RFC 4724, *Graceful Restart Mechanism for BGP*.

How BGP Graceful Restart Preserves Prefix Information During a Restart

When a router that is capable of BGP Graceful Restart loses connectivity, the following happens to the restarting router:

1. The router establishes BGP sessions with other routers and relearns the BGP routes from other routers that are also capable of Graceful Restart. The restarting router waits to receive updates from the neighboring routers. When the neighboring routers send end-of-RIB markers to indicate that they are done sending updates, the restarting router starts sending its own updates.
2. The restarting router recovers labels from the MFI database for each prefix. If the router finds the label, it advertises the label to the neighboring router. If the router does not find the label, it allocates a new label from the database and advertises it.
3. The restarting router removes any stale prefixes after a timer for stale entries expires.

When a peer router that is capable of BGP Graceful Restart encounters a restarting router, it does the following:

1. The peer router sends all of the routing updates to the restarting router. When it has finished sending updates, the peer router sends an end-of RIB marker to the restarting router.
2. The peer router does not immediately remove the BGP routes learned from the restarting router from its BGP routing table. As it learns the prefixes from the restarting router, the peer refreshes the stale routes if the new prefix and label information matches the old information.

ISSU Support for MPLS VPN 6vPE and 6PE

The ISSU process allows Cisco IOS XE software to be updated or otherwise modified while packet forwarding continues. In most networks, planned software upgrades are a significant cause of downtime. ISSU allows Cisco IOS XE software to be modified while packet forwarding continues, which increases network availability and reduces downtime caused by planned software upgrades.

ISSU support for MPLS 6vPE and 6PE relies on 6vPE and 6PE NFS/SSO capability on the platform to minimize disruption on the forwarding plane.

SSO Support for MPLS VPN 6VPE and 6PE

SSO for 6VPE and 6PE supports the following configurations:

- NSF/SSO for IPv4 and VPNv4 coexistence
- Basic 6VPE and 6PE over MPLS core technology
- BGP multipath configuration

SSO for 6VPE supports the following configurations:

- Per-VRF label configuration
- Interautonomous systems (Inter-AS) topologies, including options B and C

- CSC when IPv6 + labels is configured on the PE-CE link

Because the SSO feature maintains stateful protocol and application information, user session information is maintained during a switchover and line cards continue to forward network traffic with no loss of sessions, providing improved network availability. SSO initializes and configures the standby RP and synchronizes state information, which can reduce the time required for routing protocols to converge. Network stability may be improved with the reduction in the number of route flaps created when routers in the network fail and lose their routing tables.

When RP switchover happens, forwarding information is preserved by MFI and Cisco Express Forwarding on both line cards and the standby RP. VPNv6 prefix and local label mapping is preserved in the forwarding database. When the standby RP becomes the new active RP, 6PE and 6vPE traffic continues to be forwarded with minimal interruption.

When a BGP session restarts on the new active RP, the new active RP does not have any prior state information about prefixes or labels. The new active RP must relearn VPNv6 prefixes from its peers. As the new active RP learns the VPNv6 prefixes, it tries to get new local labels the same way it does when it first comes up. If the MFI database has the preserved copy of the local label for a prefix, the MFI database gives the local label to BGP and BGP then maintains the same local label. If the MFI database does not have a preserved local label for the prefix, MFI allocates a new one.

BGP Graceful Restart Support for MPLS VPN Configurations

Graceful Restart Support for a Basic 6VPE Setup

For PE- to-CE external BGP (eBGP), Graceful Restart capability is supported for IPv6 address families. For PE-to-PE interior BGP (iBGP) sessions with or without a route reflector (RR) in the core, BGP Graceful Restart capability supports VPNv6 address families.

When the PE router resets, the connected CE router retains IPv6 prefixes that it received from the PE router and marks the prefixes as stale. If the eBGP session does not reestablish within the specified restart time or the session reestablishes but does not set the restart or forwarding state bit, the CE router removes the stale IPv6 routes. If the eBGP session reestablishes within the specified restart time and has both the forwarding and restart bits set, the CE router removes the stale state from the IPv6 routes when it receives the updates from PE router. After the CE router receives the end-of-RIB marker, it removes or withdraws the rest of the stale information, if any exists.

The restarting PE router waits for an end-of-RIB marker from all BGP-capable peers including iBGP peers and eBGP peers. The PE router begins to calculate the best path and send out initial updates only after receiving an end-of-RIB marker from all BGP capable peers.

Graceful Restart for 6VPE in Carrier Supporting Carrier and Interautonomous System Setups

The same Graceful Restart capabilities for route preservation that apply to a basic 6VPE setup apply to a CSC and Inter-AS setup. IPv6 or VPNv6 routes and labels are preserved during switchover.

In a CSC configuration, when send-labels are configured between a CSC-PE and CSC-CE eBGP connection, labels are preserved along with IPv6 BGP routes when one of the peers restarts.

In Inter-AS option B and options C setups, VPNv6 routes and labels are preserved on an Autonomous System Border Router (ASBR) or route reflector when the VPNv6 peer restarts.

How to Configure SSO and ISSU--MPLS VPN 6VPE and 6PE Support

Note Unlike SSO, which is a mode of operation for the device and a prerequisite for performing ISSU, the ISSU process is a series of steps performed while the router or switch is in operation. For information on performing ISSU upgrades on the Cisco ASR 1000 Series Aggregation Services Router, see the "In Service Software Upgrade (ISSU)" module in the *Cisco ASR 1000 Series Aggregation Services Routers Software Configuration Guide*.

Configuring SSO for a Basic MPLS 6VPE and 6PE Setup

Perform this task to configure SSO for a basic MPLS 6VPE and 6PE setup.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ip cef distributed**
4. **ipv6 unicast-routing**
5. **ipv6 cef distributed**
6. **redundancy**
7. **mode sso**
8. **exit**
9. **router bgp** *autonomous-system-number*
10. **bgp graceful-restart restart-time** *seconds*
11. **bgp graceful-restart stalepath-time** *seconds*
12. **bgp graceful-restart**
13. **end**

DETAILED STEPS

Procedure

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

	Command or Action	Purpose
	`Router# configure terminal`	
Step 3	**ip cef distributed** **Example:** `Router(config)# ip cef distributed`	Enables distributed Cisco Express Forwarding.
Step 4	**ipv6 unicast-routing** **Example:** `Router(config)# ipv6 unicast-routing`	Enables the forwarding of IPv6 unicast datagrams.
Step 5	**ipv6 cef distributed** **Example:** `Router(config)# ipv6 cef distributed`	Enables distributed Cisco Express Forwarding for IPv6.
Step 6	**redundancy** **Example:** `Router(config)# redundancy`	Enters redundancy configuration mode.
Step 7	**mode sso** **Example:** `Router(red-config)# mode sso`	Sets the redundancy configuration mode to SSO.
Step 8	**exit** **Example:** `Router(red-config)# exit`	Exits to global configuration mode.
Step 9	**router bgp** *autonomous-system-number* **Example:** `Router(config)# router bgp 1000`	Enters router configuration mode and configures the BGP routing process.
Step 10	**bgp graceful-restart restart-time** *seconds* **Example:** `Router(config-router)# bgp graceful-restart restart-time 180`	Enables the BGP graceful restart timer capability globally for all BGP neighbors and sets the maximum time period that the local router will wait for a graceful-restart-capable neighbor to return to normal operation after a restart event occurs.
Step 11	**bgp graceful-restart stalepath-time** *seconds* **Example:**	Enables the BGP graceful restart stale path timer capability globally for all BGP neighbors and sets the maximum time period that the local router will hold stale paths for a restarting peer.

	Command or Action	Purpose
	`Router(config-router)# bgp graceful-restart stalepath-time 420`	
Step 12	**bgp graceful-restart** **Example:** `Router(config-router)# bgp graceful-restart`	Enables the BGP graceful restart capability globally for all BGP neighbors.
Step 13	**end** **Example:** `Router(config-router)# end`	Exits to privileged EXEC mode.

Verifying SSO and ISSU Support for 6VPE and 6PE

Perform this task to verify SSO and ISSU support for 6VPE and 6PE routers.

SUMMARY STEPS

1. **enable**
2. **show ip bgp neighbor**
3. **show ip bgp vpnv6 unicast vrf** *vrf-name*
4. **show ip bgp ipv6 unicast**
5. **show mpls forwarding**
6. **show ipv6 cef vrf** *vrf-name*

DETAILED STEPS

Procedure

Step 1 **enable**

Use this command to enable privileged EXEC mode. Enter your password if prompted. For example:

Example:

```
Router> enable
Router#
```

Step 2 **show ip bgp neighbor**

Use this command to verify that the IPv6 address family and VPNv6 address family entries are preserved. For example:

Example:

```
Router# show ip bgp neighbor
BGP neighbor is 10.2.2.2, remote AS 100, internal link
  BGP version 4, remote router ID 10.2.2.2
```

```
  BGP state = Established, up for 00:02:42
  Last read 00:00:36, last write 00:00:36, hold time is 180, keepalive
.
.
.
  Neighbor capabilities:
.
.
.
    Graceful Restart Capability: advertised and received
      Remote Restart timer is 120 seconds
      Address families advertised by peer:
        IPv6 Unicast (was preserved), VPNv6 Unicast (was preserved)
```

IPv6 Unicast (was preserved), VPNv6 Unicast (was preserved) is displayed in the Graceful Restart Capability section of the output only after the peer restarts.

Step 3 **show ip bgp vpnv6 unicast vrf** *vrf-name*

Use this command to verify that VPNv6 entries are marked as stale during switchover. For example:

Example:

```
Router# show ip bgp vpnv6 unicast vrf vpn1
BGP table version is 10, local router ID is 10.4.4.4
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
Network          Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 1:1 (default for vrf vpn1)
S>iA::1/128         ::FFFF:10.2.2.2          0    100      0 200 ?
*> A::5/128         A::4:5:5                 0             0 200 ?
S>iA::1:2:0/112     ::FFFF:10.2.2.2          0    100      0 ?
*  A::4:5:0/112     A::4:5:5                 0             0 200 ?
```

Step 4 **show ip bgp ipv6 unicast**

Use this command to verify that VPNv6 entries are marked as stale during switchover. For example:

Example:

```
Router# show ip bgp ipv6 unicast
BGP table version is 9, local router ID is 10.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete
   Network          Next Hop            Metric LocPrf Weight Path
*> A::1/128         ::                       0         32768 ?
S  A::1:2:0/112     A::1:2:2                 0             0 100 ?
*>                  ::                       0         32768 ?
S> A::4:5:0/112     A::1:2:2                               0 100 ?
Router#
```

Step 5 **show mpls forwarding**

Use this command to show preserved forwarding entries for IPv6 and VPNv6 prefixes. The sample output is from a PE router in a CSC configuration. Enter the command on the active and the standby router. Compare the sample output from the active router with the sample output from the standby router. Following is sample output from the active router;

Example:

```
Router# show mpls forwarding
```

```
Local      Outgoing   Prefix           Bytes Label   Outgoing   Next Hop
Label      Label      or Tunnel Id     Switched      interface
18         Pop Label      10.3.3.3/32      0             FEt1/0/0      10.2.3.3
19         Pop Label      10.3.4.0/24      0             FEt1/0/0      10.2.3.3
20         17             10.4.4.4/32      0             FEt1/0/0      10.2.3.3
21         Pop Label      10.1.2.1/32[V]   0             FEt0/0/0      10.1.2.1
22         Pop Label      A::1:2:0/112[V]  0             aggregate/vpn1
23         Pop Label      A::1:2:1/128[V]  0             FEt0/0/0      A::1:2:1
24         Pop Label      10.1.2.0/24[V]   0             aggregate/vpn1
25         Pop Label      A::1:2:2/128[V]  0             aggregate/vpn1
26         18             A::1/128[V]      0             FEt0/0/0
FE80::A8BB:CCFF:FE03:2101
27         26             10.4.5.5/32[V]   0             FEt1/0/0      10.2.3.3
28         25             10.4.5.0/24[V]   0             FEt1/0/0      10.2.3.3
29         22             A::4:5:5/128[V]  0             FEt1/0/0      10.2.3.3
30         21             A::4:5:0/112[V]  0             FEt1/0/0      10.2.3.3
31         23             A::4:5:4/128[V]  0             FEt1/0/0      10.2.3.3
32         24             A::5/128[V]      0             FEt1/0/0      10.2.3.3
33         Pop Label      10.1.2.2/32[V]   0             aggregate/vpn1
34         Pop Label      10.1.1.1/32[V]   0             FEt0/0/0      10.1.2.1
35         27             10.4.5.4/32[V]   0             FEt1/0/0      10.2.3.3
Local      Outgoing   Prefix           Bytes Label   Outgoing   Next Hop
Label      Label      or Tunnel Id     Switched      interface
36         28             10.5.5.5/32[V]   0             FEt1/0/0      10.2.3.3
```

Following is sample output from the standby router:

Example:

```
Standby-Router# show mpls forwarding
Local      Outgoing   Prefix           Bytes Label   Outgoing   Next Hop
Label      Label      or Tunnel Id     Switched      interface
18         Pop Label      10.3.3.3/32      0             FEt1/0/0      10.2.3.3
19         Pop Label      10.3.4.0/24      0             FEt1/0/0      10.2.3.3
20         17             10.4.4.4/32      0             FEt1/0/0      10.2.3.3
21         Pop Label      10.1.2.1/32[V]   0             FEt0/0/0      10.1.2.1
22         Pop Label      A::1:2:0/112[V]  0             aggregate/vpn1
23         Pop Label      A::1:2:1/128[V]  0             FEt0/0/0      A::1:2:1
24         Pop Label      10.1.2.0/24[V]   0             aggregate/vpn1
25         Pop Label      A::1:2:2/128[V]  0             aggregate/vpn1
26         18             A::1/128[V]      0             FEt0/0/0
FE80::A8BB:CCFF:FE03:2101
27         26             10.4.5.5/32[V]   0             FEt1/0/0      10.2.3.3
28         25             10.4.5.0/24[V]   0             FEt1/0/0      10.2.3.3
29         22             A::4:5:5/128[V]  0             FEt1/0/0      10.2.3.3
30         21             A::4:5:0/112[V]  0             FEt1/0/0      10.2.3.3
31         23             A::4:5:4/128[V]  0             FEt1/0/0      10.2.3.3
32         24             A::5/128[V]      0             FEt1/0/0      10.2.3.3
33         Pop Label      10.1.2.2/32[V]   0             aggregate/vpn1
34         Pop Label      10.1.1.1/32[V]   0             FEt0/0/0      10.1.2.1
35         27             10.4.5.4/32[V]   0             FEt1/0/0      10.2.3.3
Local      Outgoing   Prefix           Bytes Label   Outgoing   Next Hop
Label      Label      or Tunnel Id     Switched      interface
36         28             10.5.5.5/32[V]   0             FEt1/0/0      10.2.3.3
```

Step 6 **show ipv6 cef vrf** *vrf-name*

Use this command to show preserved forwarding entries for IPv6 and VPNv6 prefixes. This sample output is also from a PE router in a CSC configuration. Enter the command on the active and the standby router. Compare the sample output from the active router with the sample output from the standby router. Following is the output from the active router:

Example:

```
Router# show ipv6 cef vrf vrf1
::/0
  no route
::/127
  discard
A::1/128
  nexthop FE80::A8BB:CCFF:FE03:2101 FastEthernet0/0/0 label 18
A::5/128
  nexthop 10.2.3.3 FastEthernet1/0/0 label 17 24
A::1:2:0/112
  attached to FastEthernet0/0/0
A::1:2:1/128
  attached to FastEthernet0/0/0
A::1:2:2/128
  receive for FastEthernet0/0/0
A::4:5:0/112
  nexthop 10.2.3.3 FastEthernet1/0/0 label 17 21
A::4:5:4/128
  nexthop 10.2.3.3 FastEthernet1/0/0 label 17 23
A::4:5:5/128
  nexthop 10.2.3.3 FastEthernet1/0/0 label 17 22
FE80::/10
```

Following is sample output from the standby router:

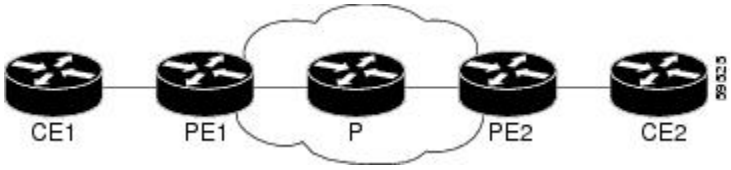
Example:

```
Standby-Router# show ipv6 cef vrf vrf1
::/0
  no route
::/127
  discard
A::1/128
  nexthop FE80::A8BB:CCFF:FE03:2101 FastEthernet0/0/0 label 18
A::5/128
  nexthop 10.2.3.3 FastEthernet1/0/0 label 17 24
A::1:2:0/112
  attached to FastEthernet0/0/0
A::1:2:1/128
  attached to FastEthernet0/0/0
A::1:2:2/128
  receive for FastEthernet0/0/0
A::4:5:0/112
  nexthop 10.2.3.3 FastEthernet1/0/0 label 17 21
A::4:5:4/128
  nexthop 10.2.3.3 FastEthernet1/0/0 label 17 23
A::4:5:5/128
  nexthop 10.2.3.3 FastEthernet1/0/0 label 17 22
FE80::/10
```

Configuration Examples for Configuring SSO and ISSU--MPLS VPN 6VPE and 6PE Support

The figure below illustrates a basic 6VPE or 6PE network configuration.

Figure 1: Sample Basic 6VPE/6PE Network Configuration



This section provides the following configuration examples for PE1 routers in a basic 6VPE or 6PE network configuration:

Example Configuring SSO for a Basic 6VPE Setup

The following is a configuration example for a PE1 router in a basic 6VPE setup (see the figure above) that includes VPNv6 and VPNv6 address families:

```
vrf definition vpn1
 rd 1:1
 route-target export 1:1
 route-target import 1:1
 !
 address-family ipv4
 exit-address-family
 !
 address-family ipv6
 exit-address-family
!
!
ip cef distributed
!
ipv6 unicast-routing
ipv6 cef distributed
mpls ldp graceful-restart ! <==+ Command to configure LDP Graceful Restart
mpls label protocol ldp
redundancy
 mode sso
interface Loopback0
 ip address 10.2.2.2 255.255.255.255
 ipv6 address A::2/128
!
interface FastEthernet0/0/0
 vrf forwarding vpn1
 ip address 10.1.2.2 255.255.255.0
 ipv6 address A::1:2:2/112
!interface FastEthernet1/0/0
 ip address 10.2.3.2 255.255.255.0
 mpls label protocol ldp
 mpls ip
!router ospf 10
 log-adjacency-changes
 nsf
 network 0.0.0.0 255.255.255.255 area 0
!
router bgp 100
 no synchronization
 bgp log-neighbor-changes
 bgp graceful-restart restart-time 120      ! <=== This command,
 bgp graceful-restart stalepath-time 360    ! <=== this command, and
 bgp graceful-restart            ! <=== this command configures NFS/SSO for a 6VPE router.
 neighbor 10.4.4.4 remote-as 100
```

```
 neighbor 10.4.4.4 update-source Loopback0
 no auto-summary
 !
 address-family vpnv4
  neighbor 10.4.4.4 activate
  neighbor 10.4.4.4 send-community extended
 exit-address-family
 !
 address-family vpnv6
  neighbor 10.4.4.4 activate
  neighbor 10.4.4.4 send-community extended
 exit-address-family
 !
 address-family ipv4 vrf vpn1
  no synchronization
  redistribute connected
  redistribute static
  neighbor 10.1.2.1 remote-as 200
  neighbor 10.1.2.1 update-source FastEthernet0/0/0
  neighbor 10.1.2.1 activate
 exit-address-family
 !
 address-family ipv6 vrf vpn1
  redistribute connected
  redistribute static
  no synchronization
  neighbor A::1:2:1 remote-as 200
  neighbor A::1:2:1 update-source FastEthernet0/0/0
  neighbor A::1:2:1 activate
 exit-address-family
```

Example Configuring SSO for a Basic 6PE Setup

This following is a configuration example for the PE1 router in a basic 6PE setup (see the figure above):

```
ip cef distributed
!
ipv6 unicast-routing
ipv6 cef distributed
mpls ldp graceful-restart ! <=== Command to configure LDP Graceful Restart
mpls label protocol ldp
redundancy
 mode sso
interface Loopback0
 ip address 10.11.11.1 255.255.255.255
 ipv6 address BEEF:11::1/64
interface FastEthernet0/0/0
 ip address 10.50.1.2 255.255.255.0
 ipv6 address 4000::72B/64
 ipv6 address 8008::72B/64
!
interface FastEthernet1/0/0
 ip address 10.40.1.2 255.255.255.0
 mpls ip
!
router ospf
nsf
network 0.0.0.0 0.0.0.0 area 0
!
router bgp 100
 bgp log-neighbor-changes
 bgp graceful-restart restart-time 120              ! <=== This command,
```

```
bgp graceful-restart stalepath-time 360             ! <=== this command, and
bgp graceful-restart             ! <=== this command configures NFS/SSO for a 6PE router.

neighbor 8008::72A remote-as 200
neighbor 10.10.10.1 remote-as 100
neighbor 10.10.10.1 update-source Loopback0
!
address-family ipv4
 no synchronization
 redistribute connected
 no neighbor 8008::72A activate
 neighbor 10.10.10.1 activate
 no auto-summary
exit-address-family
!
address-family ipv6
 redistribute connected
 no synchronization
 neighbor 8008::72A activate
 neighbor 10.10.10.1 activate
 neighbor 10.10.10.1 send-label
exit-address-family
```

Additional References

Related Documents

Related Topic	Document Title
6VPE over MPLS	Implementing IPv6 VPN over MPLS
6PE over MPLS	Implementing IPv6 over MPLS
Cisco IOS XE commands	Cisco IOS Master Command List, All Releases
Cisco IOS XE MPLS commands	*Cisco IOS Multiprotocol Label Switching Command Reference*
Cisco nonstop forwarding	Cisco Nonstop Forwarding
ISSU	• Cisco IOS XE In Service Software Upgrade Process • "In Service Software Upgrade (ISSU)" module in the *Cisco ASR 1000 Series Aggregation Services Routers Software Configuration Guide*
MPLS LDP NSF/SSO and Graceful Restart	NSF/SSO-MPLS LDP and MPLS LDP Graceful Restart
MPLS VPNs	Configuring MPLS Layer 3 VPNs
NFS/SSO for MPLS VPN	NSF/SSO--MPLS VPN
SSO	Stateful Switchover

Standards

Standard	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

MIBs

MIB	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
RFC 4659	BGP-MPLS IP Virtual Private Network (VPN) Extension for IPv6 VPN
RFC 4724	Graceful Restart Mechanism for BGP
RFC 4781	Graceful Restart Mechanism for BGP with MPLS
FRC 4798	Connecting IPv6 Islands over IPv4 MPLS Using IPv6 Provider Edge Routers (6PE)

Technical Assistance

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

Feature Information for SSO and ISSU--MPLS VPN 6VPE and 6PE Support

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

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

Table 1: Feature Information for SSO and ISSU--MPLS VPN 6VPE and 6PE Support

Feature Name	Releases	Feature Information
ISSU--MPLS VPN 6VPE and 6PE ISSU Support	Cisco IOS XE 3.2S	This feature provides ISSU support for Cisco IOS XE VPN IPv6 provider edge router (6VPE) over MPLS and Cisco IOS XE IPv6 provider edge router (6PE) over MPLS. In Cisco IOS XE 3.2S, this feature was introduced for Cisco ASR 1000 Series Aggregation Services Routers. This feature introduced no new or modified commands.
SSO--MPLS VPN 6VPE and 6PE SSO Support	Cisco IOS XE 3.2S	This feature provides SSO support for Cisco IOS XE VPN IPv6 provider edge router (6VPE) over MPLS and Cisco IOS XE IPv6 provider edge router (6PE) over MPLS. In Cisco IOS XE 3.2S, this feature was introduced for Cisco ASR 1000 Series Aggregation Services Routers. This feature introduced no new or modified commands.

Glossary

6PE router --IPv6 provider edge (PE) router. A router running a Border Gateway Protocol (BGP)-based mechanism to interconnect IPv6 islands over a Multiprotocol Label Switching (MPLS)-enabled IPv4 cloud.

6VPE router --Provider edge router providing Border Gateway Protocol (BGP)-Multiprotocol Label Switching (MPLS) IPv6 Virtual Private Network (VPN) service over an IPv4-based MPLS core. It is a IPv6 VPN provider edge (PE), dual-stack router that implements 6PE concepts on the core-facing interfaces.

BGP --Border Gateway Protocol. An interdomain routing protocol designed for the global Internet. Exterior Border Gateway Protocols (eBGPs) communicate among different autonomous systems. Interior Border Gateway Protocols (iBGPs) communicate among routers within a single autonomous system.

CE router --customer edge router. A router that is part of a customer network and interfaces to a provider edge (PE) router.

Cisco Express Forwarding --An advanced Layer 3 IP switching technology. It optimizes network performance and scalability for all kinds of networks.

eBGP --external Border Gateway Protocol.

graceful restart --A process for helping an RP restart after a node failure has occurred.

iBGP --Interior Border Gateway Protocol.

ISSU --In Service Software Upgrade. Software upgrade without service interruption.

LDP --Label Distribution Protocol. A standard protocol between Multiprotocol Label Switching (MPLS)-enabled routers to negotiate the labels (addresses) used to forward packets.

MPLS --Multiprotocol Label Switching. A switching method that forwards IP traffic using a label. This label instructs the routers and switches in the network where to forward the packets based on preestablished IP routing information.

NSF --nonstop forwarding. The ability of a router to continue to forward traffic to a router that may be recovering from a failure. Also, the ability of a router recovering from a failure to continue to correctly forward traffic sent to it by a peer.

PE router --provider edge router. The PE router is the entry point into the service provider network. The PE router is typically deployed on the edge of the network and is administered by the service provider. The PE router is the redistribution point between EIGRP and BGP in PE to CE networking.

RIB --Routing Information Base. Also called the routing table.

SSO --stateful switchover. SSO refers to the implementation of Cisco IOS XE software that allows applications and features to maintain a defined state between an active and standby RP. When a switchover occurs, forwarding and sessions are maintained. Along with NSF, SSO makes an RP failure undetectable to the network.

VPN --Enables IP traffic to travel securely over a public TCP/IP network by encrypting traffic from one network to another. A VPN uses tunneling to encrypt all information at the IP level.

VRF --Virtual Private Network (VPN) routing and forwarding instance. A VRF consists of an IP routing table, a derived routing table, a set of interfaces that use the forwarding table. and a set of rules and routing information that defines a customer VPN site that is attached to a provider edge (PE) router.