Configuring Seamless MPLS

- Information about Seamless MPLS, on page 1
- How to configure Seamless MPLs, on page 2
- Configuration Examples for Seamless MPLS, on page 8
- Feature History for Seamless MPLS, on page 10

Information about Seamless MPLS

The following sections provide information about Seamless MPLS.

Overview of Seamless MPLS

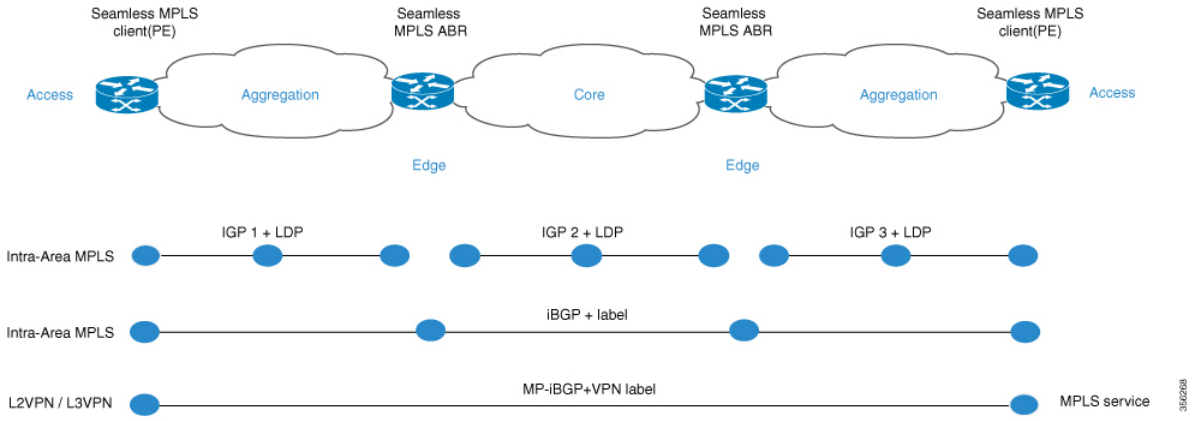
Seamless MPLS provides a highly flexible and scalable architecture to integrate multiple networks into a single MPLS domain. It is based on existing and well known protocols.

A large MPLS network can have several types of platforms and services in different parts of the network. Such a network would usually be divided into areas such as a core area and aggregation areas, and each of these areas have different Interior Gateway Protocols (IGPs). The IGP prefixes from one area cannot be distributed to another area. If the IGP prefixes cannot be distributed, then end-to-end Label-Switched-Paths (LSP) cannot be established. This affects the scalability of the network.

Seamless MPLS introduces greater scalability by establishing end-to-end LSPs. Seamless MPLS uses the Border Gateway Protocol (BGP) instead of IGP to forward the loopback prefixes of the Provider Edge (PE) routers. BGP distributes the prefixes end-to-end. This eliminates the need to install IGP prefixes of one domain in another domain.

Seamless MPLS introduces separation of the service and transport planes and provides end to end service independent transport. It removes the need for service specific configurations in network transport nodes.

Architecture for Seamless MPLS



The figure shows a network with three different areas: one core and two aggregation areas on the side. Each area runs its own IGP, with no redistribution between them on the Area Border Router (ABR). Use of BGP is needed in order to provide an end-to-end MPLS LSP. BGP advertises the loopbacks of the PE routers with a label across the whole domain, and provides an end-to-end LSP. BGP is deployed between the PEs and ABRs.

Seamless MPLs uses BGP to provide an end-to-end MPLS LSP. BGP is deployed between the PEs and the ABRs. BGP sends the IPv4 prefix and label. BGP advertises the loopbacks of the PE routers with a label across the whole domain and provides an end-to-end LSP.

When using IGP in the network, the next-hop address of the prefixes is the loopback prefix of the PE routers. This prefix is not known to the IGP being used in other parts of the network. The next hop address cannot be used to recurse to an IGP prefix. To avoid this the prefixes are carried in BGP. The ABRs are configured as Route Reflectors (RR). And the RRs are configured to set the next hop to self even for the reflected iBGP prefixes.

There are two possible scenarios.

- The ABR does not set the next hop to self for the prefixes advertised (reflected by BGP) by the ABR into the aggregation part of the network. The ABR needs to redistribute the loopback prefixes of the ABRs from the core IGP into the aggregation IGP. Only the ABR loopback prefixes (from the core) need to be advertised into the aggregation part, not the loopback prefixes from the PE routers from the remote aggregation parts.
- The ABR sets the next hop to self for the prefixes advertised (reflected by BGP) by the ABR into the aggregation part. Because of this, the ABR does not need to redistribute the loopback prefixes of the ABRs from the core IGP into the aggregation IGP.

In both scenarios, the ABR sets the next hop to self for the prefixes advertised (reflected by BGP) by the ABR from the aggregation part of the network into the core part.

How to configure Seamless MPLs

The following sections provide information on how to configure Seamless MPLS.

Configuring Seamless MPLS on the PE Router

The following steps can be used to configure Seamless MPLS on the PE Router

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface loopback** *slot/port* **Example:** `Device(config-if)# interface Loopback0`	Configures a Loopback interface and enters interface configuration mode.
Step 4	**ip address** *ip-address subnet-mask* **Example:** `Device(config-if)ip address 10.100.1.4 255.255.255.255`	Enters the IP address for the interface.
Step 5	**interface ethernet** *slot/port* **Example:** `Device(config-if)# interface Ethernet1/0`	Configures an Ethernet interface and enters interface configuration mode.
Step 6	**no ip address** **Example:** `Device(config-if)# no ip address`	Removes an IP address definition.
Step 7	**xconnect** *peer-ip-address vcid* **encapsulation mpls** **Example:** `Device(config-if)# xconnect 10.100.1.5 100 encapsulation mpls`	Specifies MPLS as the tunneling method to encapsulate.
Step 8	**router ospf** *process-id* **Example:** `Device(config)# router ospf 2`	Configures the OSPF routing process.
Step 9	**network** *ip-address wild-mask* **area** *area-id* **Example:**	Defines the interfaces on which OSPF runs and defines the area ID for those interfaces.

	Command or Action	Purpose
	`Device(config-router)# network 10.2.0.0 0.0.255.255 area 0`	
Step 10	**network** *ip-address wild-mask* **area** *area-id* **Example:** `Device(config-router)# network 10.100.1.4 0.0.0.0 area 0`	Defines the interfaces on which OSPF runs and defines the area ID for those interfaces.
Step 11	**router bgp** *autonomous-system-number* **Example:** `Device(config)# router bgp 1`	Configures the BGP routing process.
Step 12	**bgp log neighbor changes** **Example:** `Device(config-router)# bgp log neighbor changes`	Enables logging of BGP neighbor resets.
Step 13	**address-family ipv4** **Example:** `Device(config-router)# address-family ipv4`	Enters address family configuration mode.
Step 14	**network** *network-number* **mask** *network-mask* **Example:** `Device(config-router-af)# network 10.100.1.4 mask 255.255.255.255`	Specifies the networks to be advertised by BGP and multiprotocol BGP routing processes.
Step 15	**no bgp default ipv4 unicast** **Example:** `Device(config-router-af)# no bgp default ipv4 unicast`	Disables default IPv4 unicast address family for peering session establishment
Step 16	**no bgp default route-target filter** **Example:** `Device(config-router-af)# no bgp default route-target filter`	Disables automatic BGP route-target community filtering.
Step 17	**neighbor** *ip-address* **remote-as** *autonomous-system-number* **Example:** `Device(config-router-af)# neighbor 10.100.1.1 remote-as 1`	Adds an entry to the BGP or multiprotocol BGP neighbor table.
Step 18	**neighbor** *ip-address* **update-source** *interface-type interface-number* **Example:** `Device(config-router-af)# neighbor 10.100.1.1 update-source Loopback0`	Allows BGP sessions to use any operational interface for TCP connections.

	Command or Action	Purpose
Step 19	**neighbor** *ip-address* **send-label** **Example:** `Device(config-router-af)# neighbor 10.100.1.1 send-label`	Enables a BGP router to send MPLS labels with BGP routes to a neighboring BGP router.

Configuring Seamless MPLS on the Route Reflector

The following steps can be used to configure Seamless MPLS on the Route Reflector.

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface loopback** *slot/port* **Example:** `Device(config-if)# interface Loopback0`	Configures a Loopback interface and enters interface configuration mode.
Step 4	**ip address** *ip-address subnet-mask* **Example:** `Device(config-if)# ip address 10.100.1.1 255.255.255.255`	Enters the IP address for the interface.
Step 5	**router ospf** *process-id* **Example:** `Device(config)# router ospf 1`	Configures the OSPF routing process.
Step 6	**network** *ip-address wild-mask* **area** *area-id* **Example:** `Device(config-router)# network 10.1.0.0 0.0.255.255 area 0`	Defines the interfaces on which OSPF runs and defines the area ID for those interfaces.
Step 7	**network** *ip-address wild-mask* **area** *area-id* **Example:** `Device(config-router)# 10.100.1.1 0.0.0.0 area 0`	Defines the interfaces on which OSPF runs and defines the area ID for those interfaces.

	Command or Action	Purpose
Step 8	**exit** **Example:** `Device(config-router)#exit`	Exits the configuration mode.
Step 9	**router ospf** *process-id* **Example:** `Device(config)# router ospf 2`	Configures the OSPF routing process.
Step 10	**redistribute ospf** *instance-tag* **route-map** *map-name* **Example:** `Device(config-router)# redistribute ospf 1 subnets match internal route-map ospf1-into-ospf2`	Injects routes from one routing domain into OSPF.
Step 11	**network** *ip-address wild-mask* **area** *area-id* **Example:** `Device(config-router)# network 10.2.0.0 0.0.255.255 area 0`	Defines the interfaces on which OSPF runs and defines the area ID for those interfaces.
Step 12	**exit** **Example:** `Device(config-router)#exit`	Exits the configuration mode.
Step 13	**router bgp** *autonomous-system-number* **Example:** `Device(config)# router bgp 1`	Configures the BGP routing process.
Step 14	**bgp log neighbor changes** **Example:** `Device(config-router)# bgp log neighbor changes`	Enables logging of BGP neighbor resets.
Step 15	**address-family ipv4** **Example:** `Device(config-router)# address family ipv4`	Enters address family configuration mode.
Step 16	**neighbor** *ip-address* **remote-as** *autonomous-system-number* **Example:** `Device(config-route-af)# neighbor 10.100.1.2 remote-as 1`	Adds an entry to the BGP or multiprotocol BGP neighbor table.

	Command or Action	Purpose
Step 17	**neighbor** *ip-address* **update-source** *interface-type interface-number* **Example:** `Device(config-router-af)# neighbor 10.100.1.2 update-source Loopback0`	Allows BGP sessions to use any operational interface for TCP connections.
Step 18	**neighbor** *ip-address* **next-hop-self all** **Example:** `Device(config-router-af)# neighbor 10.100.1.2 next-hop-self all`	Configures a router as the next hop for a BGP-speaking neighbor or peer group.
Step 19	**neighbor** *ip-address* **send-label** **Example:** `Device(config-router-af)# neighbor 10.100.1.2  send-label`	Enables a BGP router to send MPLS labels with BGP routes to a neighboring BGP router.
Step 20	**neighbor** *ip-address* **remote-as** *autonomous-system-number* **Example:** `Device(config-router-af)# neighbor 10.100.1.4 remote-as 1`	Adds an entry to the BGP or multiprotocol BGP neighbor table.
Step 21	**neighbor** *ip-address* **update-source** *interface-type interface-number* **Example:** `Device(config-router-af)# neighbor 10.100.1.4 update-source Loopback0`	Allows BGP sessions to use any operational interface for TCP connections.
Step 22	**neighbor** *ip-address* **route-reflector-client** **Example:** `Device(config_router-af)# neighbor 10.100.1.4 route-reflector-client`	Configures the router as a BGP route reflector and configure the specified neighbor as its client.
Step 23	**neighbor** *ip-address* **next-hop-self all** **Example:** `Device(config-router-af)# neighbor 10.100.1.4 next-hop-self all`	Configures a router as the next hop for a BGP-speaking neighbor or peer group.
Step 24	**neighbor** *ip-address* **send-label** **Example:** `Device(config-router-af)# neighbor 10.100.1.4 send-label`	Enables a BGP router to send MPLS labels with BGP routes to a neighboring BGP router.
Step 25	**exit** **Example:** `Device(config-router)#exit`	Exits the configuration mode.

	Command or Action	Purpose
Step 26	**ip prefix-list** *name* **seq** *number* **permit** *prefix* **Example:** `Device(config)# ip prefix-list prefix-list-ospf1-into-ospf2 seq 5 permit 10.100.1.1/32`	Creates a prefix list to match IP packets or routes against.
Step 27	**route-map** *name* **permit** *sequence-number* **Example:** `Device(config)# route-map ospf1-into-ospf2 permit 10`	Creates the route map entry. Enters route-map configuration mode.
Step 28	**match ip address prefix-list** *prefix-list-name* **Example:** `Device(config-route-map)# match ip address prefix-list prefix-list-ospf1-into-ospf2`	Distributes routes that have a destination IP network number address that is permitted by a prefix list.

Configuration Examples for Seamless MPLS

The following sections provide examples for configuring Seamless MPLS.

Example: Configuring Seamless MPLS on PE Router 1

The following example shows how to configure Seamless MPLS on PE router 1.

```
Device(config-if)#interface Loopback0
 Device(config-if)#ip address 10.100.1.4 255.255.255.255
!
Device(config-if)# interface Ethernet1/0
Device(config-if)# no ip address
Device(config-if)# xconnect 10.100.1.5 100 encapsulation mpls
!
Device(config)# router ospf 2
Device(config-router)# network 10.2.0.0 0.0.255.255 area 0
Device(config-router)# network 10.100.1.4 0.0.0.0 area 0
!
Device(config)#router bgp 1
Device(config-router)# bgp log-neighbor-changes
Device(config-router)# address family ipv4
Device(config-router-af)# network 10.100.1.4 mask 255.255.255.255
Device(config-router-af)# no bgp default ipv4 unicast
Device(config-router-af)# no bgp default route-target filter
Device(config-router-af)# neighbor 10.100.1.1 remote-as 1
Device(config-router-af)# neighbor 10.100.1.1 update-source Loopback0
Device(config-router-af)# neighbor 10.100.1.1 send-label
```

Example: Configuring Seamless MPLS on Route Reflector 1

The following examples shows how to configure Seamless MPLS on route reflector 1.

```
Device(cofig-if)# interface Loopback0
Device(cofig-if)# ip address 10.100.1.1 255.255.255.255
Device(config)# router ospf 1
Device(config-router)# network 10.1.0.0 0.0.255.255 area 0
Device(config-router)# network 10.100.1.1 0.0.0.0 area 0
!
Device(config)# router ospf 2
Device(config-router)# redistribute ospf 1 subnets match internal route-map ospf1-into-ospf2
Device(config-router)# network 10.2.0.0 0.0.255.255 area 0
!
Device(config)# router bgp 1
Device(config-router)# bgp log-neighbor-changes
Device(config-router)# address family ipv4
Device(config-router-af)# neighbor 10.100.1.2 remote-as 1
Device(config-router-af)# neighbor 10.100.1.2 update-source Loopback0
Device(config-router-af)# neighbor 10.100.1.2 next-hop-self all
Device(config-router-af)# neighbor 10.100.1.2 send-label
Device(config-router-af)# neighbor 10.100.1.4 remote-as 1
Device(config-router-af)# neighbor 10.100.1.4 update-source Loopback0
Device(config-router-af)# neighbor 10.100.1.4 route-reflector-client
Device(config-router-af)# neighbor 10.100.1.4 next-hop-self all
Device(config-router-af)# neighbor 10.100.1.4 send-label

Device(config)# ip prefix-list prefix-list-ospf1-into-ospf2 seq 5 permit 10.100.1.1/32

Device(config)# route-map ospf1-into-ospf2 permit 10
Device(conifg-route-mao)# match ip address prefix-list prefix-list-ospf1-into-ospf2
```

Example: Configuring Seamless MPLS on PE Router 2

The following example shows how to configure Seamless MPLS on PE router 2.

```
Device(config-if)#interface Loopback0
 Device(config-if)#ip address 10.100.1.5 255.255.255.255
!
Device(config-if)# interface Ethernet1/0
Device(config-if)# no ip address
Device(config-if)# xconnect 10.100.1.4 100 encapsulation mpls
!
Device(config)# router ospf 3
Device(config-router)# network 10.3.0.0 0.0.255.255 area 0
Device(config-router)# network 10.100.1.5 0.0.0.0 area 0
!
Device(config)#router bgp 1
Device(config-router)# bgp log-neighbor-changes
Device(config-router)# address family ipv4
Device(config-router-af)# network 10.100.1.5 mask 255.255.255.255
Device(config-router-af)# no bgp default ipv4 unicast
Device(config-router-af)# no bgp default route-target filter
Device(config-router-af)# neighbor 10.100.1.2 remote-as 1
Device(config-router-af)# neighbor 10.100.1.2 update-source Loopback0
Device(config-router-af)# neighbor 10.100.1.2 send-label
```

Example: Configuring Seamless MPLS on Route Reflector 2

The following examples shows how to configure Seamless MPLS on route reflector 2.

```
Device(cofig-if)# interface Loopback0
Device(cofig-if)# ip address 10.100.1.2 255.255.255.255
Device(config)# router ospf 1
Device(config-router)# network 10.1.0.0 0.0.255.255 area 0
```

```
Device(config-router)# network 10.100.1.2 0.0.0.0 area 0
!
Device(config)# router ospf 3
Device(config-router)# redistribute ospf 1 subnets match internal route-map ospf1-into-ospf3
Device(config-router)# network 10.3.0.0 0.0.255.255 area 0
!
Device(config)# router bgp 1
Device(config-router)# bgp log-neighbor-changes
Device(config-router)# address family ipv4
Device(config-router-af)# neighbor 10.100.1.1 remote-as 1
Device(config-router-af)# neighbor 10.100.1.1 update-source Loopback0
Device(config-router-af)# neighbor 10.100.1.1 next-hop-self all
Device(config-router-af)# neighbor 10.100.1.1  send-label
Device(config-router-af)# neighbor 10.100.1.5 remote-as 1
Device(config-router-af)# neighbor 10.100.1.5 update-source Loopback0
Device(config-router-af)# neighbor 10.100.1.5 route-reflector-client
Device(config-router-af)# neighbor 10.100.1.5 next-hop-self all
Device(config-router-af)# neighbor 10.100.1.5 send-label

Device(config)# ip prefix-list prefix-list-ospf1-into-ospf3 seq 5 permit 10.100.1.1/32

Device(config)# route-map ospf1-into-ospf3 permit 10
Device(conifg-route-mao)# match ip address prefix-list prefix-list-ospf1-into-ospf3
```

Feature History for Seamless MPLS

This table provides release and related information for features explained in this module.

These features are available on all releases subsequent to the one they were introduced in, unless noted otherwise.

Release	Feature	Feature Information
Cisco IOS XE Gibraltar 16.12.1	Seamless MPLS	Seamless MPLS provides a highly flexible and scalable architecture to integrate multiple networks into a single MPLS domain. It is based on existing and well known protocols.

Use Cisco Feature Navigator to find information about platform and software image support.