



Configure Segment Routing for OSPF Protocol

Open Shortest Path First (OSPF) is an Interior Gateway Protocol (IGP) developed by the OSPF working group of the Internet Engineering Task Force (IETF). Designed expressly for IP networks, OSPF supports IP subnetting and tagging of externally derived routing information. OSPF also allows packet authentication and uses IP multicast when sending and receiving packets.

This module provides the configuration information to enable segment routing for OSPF.



Note For additional information on implementing OSPF on your Cisco NCS 5500 Series Router, see the *Implementing OSPF* module in the *Routing Configuration Guide for Cisco NCS 5500 Series Routers*.

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Enabling Segment Routing for OSPF Protocol

Segment routing on the OSPF control plane supports the following:

- OSPFv2 control plane
- Multi-area
- IPv4 prefix SIDs for host prefixes on loopback interfaces
- Adjacency SIDs for adjacencies
- MPLS penultimate hop popping (PHP) and explicit-null signaling

This section describes how to enable segment routing MPLS and MPLS forwarding in OSPF. Segment routing can be configured at the instance, area, or interface level.

Before you begin

Your network must support the MPLS Cisco IOS XR software feature before you enable segment routing for OSPF on your router.



Note You must enter the commands in the following task list on every OSPF router in the traffic-engineered portion of your network.

SUMMARY STEPS

1. **configure**
2. **router ospf** *process-name*
3. **segment-routing mpls**
4. **area** *area*
5. **segment-routing mpls**
6. **exit**
7. Use the **commit** or **end** command.

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	router ospf <i>process-name</i> Example: RP/0/RP0/CPU0:router (config)# router ospf 1	Enables OSPF routing for the specified routing process and places the router in router configuration mode.
Step 3	segment-routing mpls Example: RP/0/RP0/CPU0:router (config-ospf)# segment-routing mpls	Enables segment routing using the MPLS data plane on the routing process and all areas and interfaces in the routing process. Enables segment routing forwarding on all interfaces in the routing process and installs the SIDs received by OSPF in the forwarding table.
Step 4	area <i>area</i> Example: RP/0/RP0/CPU0:router (config-ospf)# area 0	Enters area configuration mode.
Step 5	segment-routing mpls Example: RP/0/RP0/CPU0:router (config-ospf-ar)# segment-routing mpls	(Optional) Enables segment routing using the MPLS data plane on the area and all interfaces in the area. Enables segment routing forwarding on all interfaces in the area and installs the SIDs received by OSPF in the forwarding table.
Step 6	exit Example:	

	Command or Action	Purpose
	RP/0/RP0/CPU0:router(config-ospf-ar)# exit RP/0/RP0/CPU0:router(config-ospf)# exit	
Step 7	Use the commit or end command.	<p>commit —Saves the configuration changes and remains within the configuration session.</p> <p>end —Prompts user to take one of these actions:</p> <ul style="list-style-type: none"> • Yes — Saves configuration changes and exits the configuration session. • No —Exits the configuration session without committing the configuration changes. • Cancel —Remains in the configuration session, without committing the configuration changes.

What to do next

Configure the prefix SID.

Configuring a Prefix-SID on the OSPF-Enabled Loopback Interface

A prefix segment identifier (SID) is associated with an IP prefix. The prefix SID is manually configured from the segment routing global block (SRGB) range of labels. A prefix SID is configured under the loopback interface with the loopback address of the node as the prefix. The prefix segment steers the traffic along the shortest path to its destination.

A prefix SID can be a node SID or an Anycast SID. A node SID is a type of prefix SID that identifies a specific node. An Anycast SID is a type of prefix SID that identifies a set of nodes, and is configured with n-flag clear. The set of nodes (Anycast group) is configured to advertise a shared prefix address and prefix SID. Anycast routing enables the steering of traffic toward multiple advertising nodes. Packets addressed to an Anycast address are forwarded to the topologically nearest nodes.

The prefix SID is globally unique within the segment routing domain.

This task describes how to configure prefix segment identifier (SID) index or absolute value on the OSPF-enabled Loopback interface.

Before you begin

Ensure that segment routing is enabled on an instance, area, or interface.

SUMMARY STEPS

1. **configure**
2. **router ospf** *process-name*
3. **area** *value*

4. **interface Loopback** *interface-instance*
5. **prefix-sid** [**algorithm** *algorithm-number*] {**index** *SID-index* | **absolute** *SID-value* } [**n-flag-clear**] [**explicit-null**]
6. Use the **commit** or **end** command.

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	router ospf <i>process-name</i> Example: RP/0/RP0/CPU0:router(config)# router ospf 1	Enables OSPF routing for the specified routing process, and places the router in router configuration mode.
Step 3	area <i>value</i> Example: RP/0/RP0/CPU0:router(config-ospf)# area 0	Enters area configuration mode.
Step 4	interface Loopback <i>interface-instance</i> Example: RP/0/RP0/CPU0:router(config-ospf-ar)# interface Loopback0 passive	Specifies the loopback interface and instance.
Step 5	prefix-sid [algorithm <i>algorithm-number</i>] { index <i>SID-index</i> absolute <i>SID-value</i> } [n-flag-clear] [explicit-null] Example: RP/0/RP0/CPU0:router(config-ospf-ar)# prefix-sid index 1001 RP/0/RP0/CPU0:router(config-ospf-ar)# prefix-sid absolute 17001	Configures the prefix-SID index or absolute value for the interface. Specify algorithm <i>algorithm-number</i> to configure SR Flexible Algorithm. Specify index <i>SID-index</i> for each node to create a prefix SID based on the lower boundary of the SRGB + the index. Specify absolute <i>SID-value</i> for each node to create a specific prefix SID within the SRGB. By default, the n-flag is set on the prefix-SID, indicating that it is a node SID. For specific prefix-SID (for example, Anycast prefix-SID), enter the <code>n-flag-clear</code> keyword. OSPF does not set the N flag in the prefix-SID sub Type Length Value (TLV). To disable penultimate-hop-popping (PHP) and add an explicit-Null label, enter the <code>explicit-null</code> keyword. OSPF sets the E flag in the prefix-SID sub TLV.

	Command or Action	Purpose
Step 6	Use the commit or end command.	<p>commit —Saves the configuration changes and remains within the configuration session.</p> <p>end —Prompts user to take one of these actions:</p> <ul style="list-style-type: none"> • Yes — Saves configuration changes and exits the configuration session. • No —Exits the configuration session without committing the configuration changes. • Cancel —Remains in the configuration session, without committing the configuration changes.

Verify the prefix-SID configuration:

```
RP/0/RP0/CPU0:router# show ospf database opaque-area 7.0.0.1 self-originate
  OSPF Router with ID (10.0.0.1) (Process ID 1)
    Type-10 Opaque Link Area Link States (Area 0)
<...>
  Extended Prefix TLV: Length: 20
    Route-type: 1
    AF          : 0
    Flags       : 0x40
    Prefix      : 10.0.0.1/32

  SID sub-TLV: Length: 8
    Flags       : 0x0
    MTID        : 0
    Algo        : 0
    SID Index   : 1001
```

Configuring an Adjacency SID

An adjacency SID (Adj-SID) is associated with an adjacency to a neighboring node. The adjacency SID steers the traffic to a specific adjacency. Adjacency SIDs have local significance and are only valid on the node that allocates them.

An adjacency SID can be allocated dynamically from the dynamic label range or configured manually from the segment routing local block (SRLB) range of labels.

Adjacency SIDs that are dynamically allocated do not require any special configuration, however there are some limitations:

- A dynamically allocated Adj-SID value is not known until it has been allocated, and a controller will not know the Adj-SID value until the information is flooded by the IGP.
- Dynamically allocated Adj-SIDs are not persistent and can be reallocated after a reload or a process restart.
- Each link is allocated a unique Adj-SID, so the same Adj-SID cannot be shared by multiple links.

Manually allocated Adj-SIDs are persistent over reloads and restarts. They can be provisioned for multiple adjacencies to the same neighbor or to different neighbors. You can specify that the Adj-SID is protected. If the Adj-SID is protected on the primary interface and a backup path is available, a backup path is installed. By default, manual Adj-SIDs are not protected.

Adjacency SIDs are advertised using the existing OSPF Adj-SID sub-TLV. The P-flag is defined for manually allocated Adj-SIDs.

```

 0 1 2 3 4 5 6 7
+-----+-----+
|B|V|L|G|P|      |
+-----+-----+

```

Table 1: Adjacency Segment Identifier (Adj-SID) Flags Sub-TLV Fields

Field	Description
P (Persistent)	This flag is set if the Adj-SID is persistent (manually allocated).

This task explains how to configure an Adj-SID on an interface.

Before you begin

Ensure that segment routing is enabled on the corresponding address family.

Use the **show mpls label table detail** command to verify the SRLB range.

SUMMARY STEPS

1. **configure**
2. **router ospf** *process-name*
3. **area** *area*
4. **interface** *type interface-path-id*
5. **adjacency-sid** {*index adj-SID-index* | **absolute** *adj-SID-value*} [**protected**]
6. Use the **commit** or **end** command.

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	router ospf <i>process-name</i> Example: RP/0/RP0/CPU0:router (config)# router ospf 1	Enables OSPF routing for the specified routing instance, and places the router in router configuration mode.

	Command or Action	Purpose
Step 3	<p>area <i>area</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-ospf)# area 0</pre>	Enters area configuration mode.
Step 4	<p>interface <i>type interface-path-id</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-ospf-ar)# interface HundredGigE0/0/0/1</pre>	Specifies the interface and enters interface configuration mode.
Step 5	<p>adjacency-sid {index <i>adj-SID-index</i> absolute <i>adj-SID-value</i>} [protected]</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-config-ospf-ar-if)# adjacency-sid index 10</pre> <pre>RP/0/RP0/CPU0:router(config-config-ospf-ar-if)# adjacency-sid absolute 15010</pre>	<p>Configures the Adj-SID index or absolute value for the interface.</p> <p>Specify index <i>adj-SID-index</i> for each link to create an Adj-SID based on the lower boundary of the SRLB + the index.</p> <p>Specify absolute <i>adj-SID-value</i> for each link to create a specific Adj-SID within the SRLB.</p> <p>Specify if the Adj-SID is protected. For each primary path, if the Adj-SID is protected on the primary interface and a backup path is available, a backup path is installed. By default, manual Adj-SIDs are not protected.</p>
Step 6	Use the commit or end command.	<p>commit —Saves the configuration changes and remains within the configuration session.</p> <p>end —Prompts user to take one of these actions:</p> <ul style="list-style-type: none"> • Yes — Saves configuration changes and exits the configuration session. • No —Exits the configuration session without committing the configuration changes. • Cancel —Remains in the configuration session, without committing the configuration changes.

What to do next

Configure the SR-TE policy.

Segment Routing ECMP-FEC Optimization

ECMP-FECs are used for any ECMP programming on the system, such as MPLS LSP ECMP, VPN multipath, and [EVPN multi-homing](#).

The SR ECMP-FEC optimization solution minimizes ECMP-FEC resource consumption during underlay programming for an SR-MPLS network. This feature supports sharing the same ECMP-FEC, regular FEC, and Egress Encapsulation DB (EEDB) entries for all /32 IPv4 Segment Routing prefixes with the same set of

next hops. ECMP-FEC optimization is triggered when all the out_labels associated with the ECMP paths for a given prefix have the same value. If this rule is not met, then the prefix is programmed with a dedicated ECMP-FEC. Other prefixes that meet the rule are candidates for optimization.

Segment Routing Label Edge Router (LER) ECMP-FEC Optimization enables ECMP-FEC optimization originally developed for Label Switched Router (LSR) nodes (MPLS P) to be enabled on LER (Layer 3 MPLS PE) routers.

For usage guidelines, limitations, and configuration options, see [Segment Routing ECMP-FEC Optimization](#).