



ZebOS-XP®

Network Platform

Version 1.4

Extended Performance

**Segment Routing
Configuration Guide**

December 2015

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Contents

| | |
|---|----|
| Preface | v |
| Audience | v |
| Conventions | v |
| Contents | v |
| Related Documents | v |
| Support | v |
| Comments | vi |
| CHAPTER 1 Overview | 7 |
| Segment Routing Global Block | 7 |
| Segment Identifiers | 7 |
| Forwarding Example with SIDs | 7 |
| CHAPTER 2 Configuring Segment Routing | 9 |
| Configure OSPF Intra-Area Segment Routing | 9 |
| Configure Static Segment Routing | 20 |
| Index | 23 |

Preface

This guide describes how to configure segment routing in ZebOS-XP.

Audience

This guide is intended for network administrators and other engineering professionals who configure segment routing.

Conventions

Table P-1 shows the conventions used in this guide.

Table P-1: Conventions

| Convention | Description |
|------------------------------|---|
| <i>Italics</i> | Emphasized terms; titles of books |
| Note: | Special instructions, suggestions, or warnings |
| <code>monospaced type</code> | Code elements such as commands, functions, parameters, files, and directories |

Contents

This guide contains these chapters:

- [Chapter 1, Overview](#)
- [Chapter 2, Configuring Segment Routing](#)

Related Documents

Use this guide with these command references for details about the commands used in the configurations.

- *Segment Routing Command Reference*
- *Network Services Module Command Reference*

Note: All ZebOS-XP technical manuals are available to licensed customers at http://www.ipinfusion.com/support/document_list.

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CHAPTER 1 Overview

Source routing is a technique where the sender of a packet can partially or completely specify the route that a packet should take through the network. Segment routing is a form of source routing where nodes and links are represented as segments. The path that a particular packet needs to traverse is represented by one or more segments. The list of segments is inserted into the packet itself and each segment in the path represents a particular node or an adjacency through which the packet needs to pass. The ZebOS-XP implementation of segment routing is based on draft-ietf-spring-segment-routing-02.

ZebOS-XP uses prefix segments which forward a packet along the shortest path to reach the prefix. Prefix segments are global and all the nodes in the segment routing domain advertise the forwarding entry for the prefix segment. When a prefix is for a loopback interface that identifies a node, it is called a node segment.

Segment routing does not require any additional control plane protocol and is implemented by extending an existing interior gateway protocol (IGP) such as OSPF. Segment routing replaces MPLS control plane protocols such as LDP or RSVP.

In ZebOS-XP, MPLS clients such as LDP and RSVP create FEC-to-NHLFE and Incoming Label Map (FTN/ILM) entries by signaling within the MPLS domain. After this, the entries are installed into the MPLS RIB hosted by NSM.

The segment routing framework reuses the existing MPLS framework with OSPF acting as an MPLS client. OSPF with segment routing extensions exchanges the segment information within the segment routing domain. These segments are converted to MPLS FTN/ILM entries using a library. After this, the entries are installed into the same MPLS RIB hosted by NSM.

In segment routing, the path states are maintained only at the ingress node and the path to follow is pushed into the packet itself. The transit and egress nodes do not maintain state for each path traversing through them. The configuration overhead is less than traditional MPLS.

Segment Routing Global Block

The Segment Routing Global Block (SRGB) is a local property of a segment routing node. In the context of MPLS, it is a set of “local labels” for global segments. ZebOS-XP uses the same local label range (1024000-1048319) for all the segment routing nodes for SRGB.

Segment Identifiers

Segments are identified by a Segment Identifier (SID) which is an unsigned 32-bit integer. Because the MPLS data plane is used, the segments are identified by a 20-bit integer, leaving the 12 left-most bits of the SID unused. A SID has an absolute value (label) allocated for the segment. Because the SRGB is the same across the entire domain, all nodes identify the segment with the same absolute value.

Forwarding Example with SIDs

Figure 1-1 shows an example of forwarding a packet using a prefix SID.

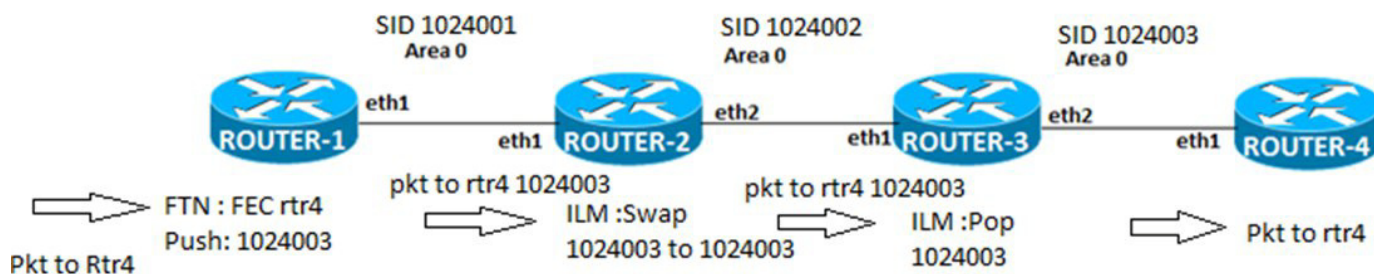


Figure 1-1: Forwarding example

Router-4 is connected to Router-3 and is identified by the prefix SID 1024003 configured on the Router-3 `eth2` interface which is advertised to the entire network. All nodes install an MPLS forwarding entry (FTN/ILM) for this node prefix between Router-3 and Router-4.

After the packet enters the segment routing domain, it follows these steps:

1. Router-1 pushes the label/SID 1024003 on the packet
2. Router-2 swaps with the same label/SID 1024003
3. Router-3 performs penultimate hop popping for the label/SID 1024003 which identifies the next node as Router-4
4. The packet arrives at Router-4

CHAPTER 2 Configuring Segment Routing

This chapter shows how to configure segment routing.

Configure OSPF Intra-Area Segment Routing

The segment routing capabilities of a router are advertised to other routers through the Router Information opaque LSA.

SIDs are advertised through the Extended Prefix opaque LSA which supports multiple Extended Prefix TLVs containing subTLVs to carry the prefix and corresponding SID information.

These advertised SIDs are installed in the RIB based on the OSPF routes. These segments are also converted to MPLS labels and installed in the FTN/ILM and forwarding tables.

Topology

Figure 2-1 shows the configuration required to enable OSPF segment routing at a global level and configure a prefix SID at the interface level.

You can configure a prefix SID on any router directly attached to that network prefix. In most cases configuring only one router is sufficient. If a prefix SID with the same prefix is configured on different routers, IP Infusion Inc. recommends that all SID values be the same.

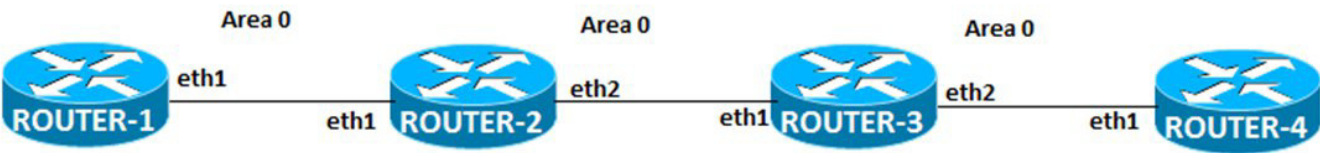


Figure 2-1: OSPF Segment Routing Topology

R1

| | |
|---------------------------------------|---|
| R1#configure terminal | Enter configure mode. |
| R1 (config)#int eth1 | Enter interface mode. |
| R1 (config-if)#ip address 10.1.1.1/24 | Configure the IP address of the interface. |
| R1 (config-if)#exit | Exit interface mode. |
| R1 (config)#router ospf 1 | Configure the routing process and specify the Process ID (1). |
| R1 (config-router)#router-id 1.1.1.1 | Configure router-id for the process. |

| | |
|---|--|
| R1(config-router)#network 10.1.1.0/24 area 0 | Define the interface (10.1.1.0/24) and associate the area ID (0) with the interface (area ID 0 specifies the backbone area). |
| R1(config-router)#end | Exit router mode. |
| R1#configure terminal | Enter configure mode. |
| R1(config)#segment-routing mpls ospf | Enable MPLS-based segment routing for OSPF. |
| R1(config)#int eth1 | Enter interface mode. |
| R1(config-if)#prefix-sid value 1024001 | Set the prefix SID value. |
| R1(config-if)#exit | Exit interface mode. |

R2

| | |
|---|--|
| R2#configure terminal | Enter configure mode. |
| R2(config)#int eth1 | Enter interface mode. |
| R2(config-if)#ip address 10.1.1.2/24 | Configure the IP address of the interface. |
| R2(config-if)#exit | Exit interface mode. |
| R2(config)#int eth2 | Enter interface mode. |
| R2(config-if)#ip address 20.1.1.1/24 | Configure the IP address of the interface. |
| R2(config-if)#exit | Exit interface mode. |
| R2(config)#router ospf 1 | Configure the routing process and specify the Process ID (1). |
| R2(config-router)#router-id 2.2.2.2 | Configure router-id for the process. |
| R2(config-router)#network 10.1.1.0/24 area 0 | Define the interface (10.1.1.0/24) and associate the area ID (0) with the interface (area ID 0 specifies the backbone area). |
| R2(config-router)#network 20.1.1.0/24 area 0 | Define the interface (20.1.1.0/24) and associate the area ID (0) with the interface (area ID 0 specifies the backbone area). |
| R2(config-router)#end | Exit router mode. |
| R2#configure terminal | Enter configure mode. |
| R2(config)#segment-routing mpls ospf | Enable MPLS-based segment routing for OSPF. |
| R2(config)#int eth2 | Enter interface mode. |
| R2(config-if)#prefix-sid value 1024002 | Set the prefix SID value. |
| R2(config-if)#exit | Exit interface mode. |
| R2(config)#exit | Exit configure mode. |

R3

| | |
|--------------------------------------|--|
| R3#configure terminal | Enter configure mode. |
| R3(config)#int eth1 | Enter interface mode. |
| R3(config-if)#ip address 20.1.1.2/24 | Configure the IP address of the interface. |
| R3(config-if)#exit | Exit interface mode. |
| R3(config)#int eth2 | Enter interface mode. |
| R3(config-if)#ip address 30.1.1.1/24 | Configure the IP address of the interface. |
| R3(config-if)#exit | Exit interface mode. |

| | |
|---|--|
| R3(config)#router ospf 1 | Configure the routing process and specify the Process ID (1). |
| R3(config-router)#router-id 3.3.3.3 | Configure router-id for the process. |
| R3(config-router)#network 20.1.1.0/24 area 0 | Define the interface (20.1.1.0/24) and associate the area ID (0) with the interface (area ID 0 specifies the backbone area). |
| R3(config-router)#network 30.1.1.0/24 area 0 | Define the interface (30.1.1.0/24) and associate the area ID (0) with the interface (area ID 0 specifies the backbone area). |
| R3(config-router)#end | Exit router mode. |
| R3#configure terminal | Enter configure mode. |
| R3(config)#segment-routing mpls ospf | Enable MPLS-based segment routing for OSPF. |
| R3(config)#int eth2 | Enter interface mode. |
| R3(config-if)#prefix-sid value 1024003 | Set the prefix SID value. |
| R3(config-if)#exit | Exit interface mode. |
| R3(config)#exit | Exit configure mode. |

R4

| | |
|---|--|
| R4#configure terminal | Enter configure mode. |
| R4(config)#int eth1 | Enter interface mode. |
| R4(config-if)#ip address 30.1.1.2/24 | Configure the IP address of the interface. |
| R4(config-if)#exit | Exit interface mode. |
| R4(config)#router ospf 1 | Configure the routing process and specify the Process ID (1). |
| R4(config-router)#network 30.1.1.0/24 area 0 | Define the interface (30.1.1.0/24) and associate the area ID (0) with the interface (area ID 0 specifies the backbone area). |
| R4(config-router)#end | Exit router mode. |
| R4#configure terminal | Enter configure mode. |
| R4(config)#segment-routing mpls ospf | Enable MPLS-based segment routing for OSPF. |
| R4(config)#exit | Exit configure mode. |

Validation

Validation 1

Verify OSPF neighborship between all 4 routers.

R1:

```
#show ip ospf neighbor
Total number of full neighbors: 1
OSPF process 1 VRF(default):
Neighbor ID      Pri   State           Dead Time   Address        Interface
Instance ID
2.2.2.2          1    Full/DR         00:00:39   10.1.1.2       eth1           0
#
```

R2:

```
#sh ip ospf neighbor
```

Total number of full neighbors: 2

OSPF process 1 VRF(default):

| Neighbor ID Instance ID | Pri | State | Dead Time | Address | Interface | |
|----------------------------|-----|-------------|-----------|----------|-----------|---|
| 1.1.1.1 | 1 | Full/Backup | 00:00:36 | 10.1.1.1 | eth1 | 0 |
| 3.3.3.3 | 1 | Full/DR | 00:00:36 | 20.1.1.2 | eth2 | 0 |
| # | | | | | | |

R3:

#sh ip ospf neighbor

Total number of full neighbors: 2

OSPF process 1 VRF(default):

| Neighbor ID Instance ID | Pri | State | Dead Time | Address | Interface | |
|----------------------------|-----|-------------|-----------|----------|-----------|---|
| 2.2.2.2 | 1 | Full/Backup | 00:00:39 | 20.1.1.1 | eth1 | 0 |
| 4.4.4.4 | 1 | Full/DR | 00:00:40 | 30.1.1.2 | eth2 | 0 |
| # | | | | | | |

Validation 2

Verify that segment routing is enabled and that prefix SIDs are announced to other routers via OSPF opaque LSAs.

Verify that labels are in the MPLS forwarding table and that prefix SIDs are installed. Verify the same in FTN and ILM tables.

R1:

#sh mpls forwarding-table

Codes: > - selected FTN, p - stale FTN, B - BGP FTN, K - CLI FTN,
L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
U - unknown FTN, T - MPLS-TP Map FTN, O - SR-OSPF FTN,
i - SR-ISIS FTN, k - SR-CLI FTN

| Code Nexthop | FEC | FTN-ID | Tunnel-id | Pri | LSP-Type | Out-Label | Out-Intf |
|-----------------|-------------|--------|-----------|-----|-------------|-----------|----------|
| O 10.1.1.2 | 20.1.1.0/24 | 1 | 0 | Yes | LSP_DEFAULT | 3 | eth1 |
| O 10.1.1.2 | 30.1.1.0/24 | 2 | 0 | Yes | LSP_DEFAULT | 1024003 | eth1 |
| # | | | | | | | |

R2:

#sh mpls forwarding-table

Codes: > - selected FTN, p - stale FTN, B - BGP FTN, K - CLI FTN,
L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
U - unknown FTN, T - MPLS-TP Map FTN, O - SR-OSPF FTN,
i - SR-ISIS FTN, k - SR-CLI FTN

| Code Nexthop | FEC | FTN-ID | Tunnel-id | Pri | LSP-Type | Out-Label | Out-Intf |
|-----------------|-------------|--------|-----------|-----|-------------|-----------|----------|
| O 20.1.1.2 | 30.1.1.0/24 | 1 | 0 | Yes | LSP_DEFAULT | 3 | eth2 |
| # | | | | | | | |

R3:

```
#sh mpls forwarding-table
```

```
Codes: > - selected FTN, p - stale FTN, B - BGP FTN, K - CLI FTN,
        L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
        U - unknown FTN, T - MPLS-TP Map FTN, O - SR-OSPF FTN,
        i - SR-ISIS FTN, k - SR-CLI FTN
```

| Code | FEC | FTN-ID | Tunnel-id | Pri | LSP-Type | Out-Label | Out-Intf |
|-------------------|-------------|--------|-----------|-----|-------------|-----------|----------|
| O | 10.1.1.0/24 | 1 | 0 | Yes | LSP_DEFAULT | 3 | eth1 |
| Nextthop 20.1.1.1 | | | | | | | |
| # | | | | | | | |

R4:

```
#sh mpls forwarding-table
```

```
Codes: > - selected FTN, p - stale FTN, B - BGP FTN, K - CLI FTN,
        L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
        U - unknown FTN, T - MPLS-TP Map FTN, O - SR-OSPF FTN,
        i - SR-ISIS FTN, k - SR-CLI FTN
```

| Code | FEC | FTN-ID | Tunnel-id | Pri | LSP-Type | Out-Label | Out-Intf |
|-------------------|-------------|--------|-----------|-----|-------------|-----------|----------|
| O | 10.1.1.0/24 | 1 | 0 | Yes | LSP_DEFAULT | 1024001 | eth1 |
| Nextthop 30.1.1.1 | | | | | | | |
| O | 20.1.1.0/24 | 2 | 0 | Yes | LSP_DEFAULT | 3 | eth1 |
| Nextthop 30.1.1.1 | | | | | | | |
| # | | | | | | | |

In the forwarding tables above, the configured prefix SIDs are in the Out-Label column which is expected and is global across the topology. The swap happens in between nodes with this prefix SID and there is no local labelling.

For the entries to be selected, configure label switching on the OSPF-enabled interfaces using the `label-switching` command.

```
(config)#int eth1
(config-if)#label-switching
(config-if)#end
#
```

Also verify the ILM and FTN tables. R1 is an edge node which does not have an ILM table, only an FTN table.

```
#sh mpls ilm-table
```

```
#sh mpls ftn-table
```

```
Primary FTN entry with FEC: 20.1.1.0/24, id: 1, row status: Active
Owner: OSPF-SR, Action-type: Redirect to Tunnel, Exp-bits: 0x0, Incoming DSCP: none
Tunnel id: 0, Protected LSP id: 0, QoS Resource id: 0, Description: N/A
Matched bytes:0, pkts:0, TX bytes:0, Pushed pkts:0
Cross connect ix: 1, in intf: - in label: 0 out-segment ix: 1
Owner: OSPF-SR, Persistent: No, Admin Status: Up, Oper Status: Up
Out-segment with ix: 1, owner: OSPF-SR, out intf: eth1, out label: 3
Nextthop addr: 10.1.1.2 cross connect ix: 1, op code: Push
```

```
Primary FTN entry with FEC: 30.1.1.0/24, id: 2, row status: Active
Owner: OSPF-SR, Action-type: Redirect to Tunnel, Exp-bits: 0x0, Incoming DSCP: none
Tunnel id: 0, Protected LSP id: 0, QoS Resource id: 0, Description: N/A
```

```
Matched bytes:0, pkts:0, TX bytes:0, Pushed pkts:0
Cross connect ix: 2, in intf: - in label: 0 out-segment ix: 2
Owner: OSPF-SR, Persistent: No, Admin Status: Up, Oper Status: Up
Out-segment with ix: 2, owner: OSPF-SR, out intf: eth1, out label: 1024003
Nexthop addr: 10.1.1.2          cross connect ix: 2, op code: Push
#
```

Validation 3

Verify whether a device is an edge node or core node. The same output shows the prefix SID, who is advertising, and whether it is a loopback interface.

```
#sh ip ospf segment-routing prefix-sid
```

```
-----
Prefix(or FEC)      :20.1.1.0/24
Segment             :Global
Advertisement Router :2.2.2.2
SID Value           :1024002
Next-Hop Route      :10.1.1.2
Next-Hop If_Index   :3
PHP Route Prefix    :Yes
Loop-back Prefix    :No
-----
```

```
-----
Prefix(or FEC)      :30.1.1.0/24
Segment             :Global
Advertisement Router :3.3.3.3
SID Value           :1024003
Next-Hop Route      :10.1.1.2
Next-Hop If_Index   :3
PHP Route Prefix    :No
Loop-back Prefix    :No
-----
```

```
-----
This Segment Node   :EDGE
-----
#
```

The command output below displays the details of routers configured with segment routing.

```
#sh ip ospf segment-routing capability
```

```
-----
Advertisement Router Capability :1.1.1.1
Algorithm                      :0
Total SID'S Supported          :24320
SID Range List Count           :1
SID's Range                    :1024000 - 1048319
-----
```

```
-----
Advertisement Router Capability :2.2.2.2
Algorithm                      :0
Total SID'S Supported          :24320
SID Range List Count           :1
SID's Range                    :1024000 - 1048319
-----
```

```
-----
Advertisement Router Capability :3.3.3.3
-----
```

```

Algorithm                               :0
Total SID'S Supported                   :24320
SID Range List Count                   :1
SID's Range                            :1024000 - 1048319
-----

```

```

Advertisement Router Capability          :4.4.4.4
Algorithm                               :0
Total SID'S Supported                   :24320
SID Range List Count                   :1
SID's Range                            :1024000 - 1048319
-----

```

```
#
```

The command below displays the database details where a prefix SID is advertised through opaque LSAs.

```
#sh ip ospf database opaque-area 7.0.0.1
      OSPF Router with ID (1.1.1.1) (Process ID 1 VRF default)
```

```

      Area-Local Opaque-LSA (Area 0.0.0.0)

```

```

LS age: 1002
Options: 0x22 (-|-|DC|-|-|-|E|-)
LS Type: Area-Local Opaque-LSA
Link State ID: 7.0.0.1 (Area-Local Opaque-Type/ID)
Opaque Type: 7
Opaque ID: 1
Advertising Router: 1.1.1.1
LS Seq Number: 80000002
Checksum: 0x0a12
Length: 44

```

```

Route Type: 1
Prefix Length: 24
AF: 0
Flags: 0
Address Prefix: 10.1.1.0
Flags: 8
MT-ID: 0
Algorithm: 0
SID: 1024001

```

```

LS age: 1106
Options: 0x22 (-|-|DC|-|-|-|E|-)
LS Type: Area-Local Opaque-LSA
Link State ID: 7.0.0.1 (Area-Local Opaque-Type/ID)
Opaque Type: 7
Opaque ID: 1
Advertising Router: 2.2.2.2
LS Seq Number: 80000002
Checksum: 0x7498
Length: 44

```

```
Route Type: 1
Prefix Length: 24
AF: 0
Flags: 0
Address Prefix: 20.1.1.0
  Flags: 8
  MT-ID: 0
  Algorithm: 0
  SID: 1024002
```

```
LS age: 1338
Options: 0x22 (-|-|DC|-|-|-|E|-)
LS Type: Area-Local Opaque-LSA
Link State ID: 7.0.0.1 (Area-Local Opaque-Type/ID)
Opaque Type: 7
Opaque ID: 1
Advertising Router: 3.3.3.3
LS Seq Number: 80000002
Checksum: 0xdelf
Length: 44
```

```
Route Type: 1
Prefix Length: 24
AF: 0
Flags: 0
Address Prefix: 30.1.1.0
  Flags: 8
  MT-ID: 0
  Algorithm: 0
  SID: 1024003
```

#

R2:

```
#sh mpls ilm-table
```

```
Codes: > - selected ILM, p - stale ILM, K - CLI ILM, T - MPLS-TP
```

| Code | FEC ILM-ID | In-Label | Out-Label | In-Intf | Out-Intf | Nexthop |
|-------------|-------------|----------|-----------|---------|----------|---------------|
| LSP-Type | | | | | | |
| > | 30.1.1.0/24 | 1 | 1024003 | 3 | N/A | eth2 20.1.1.2 |
| LSP_DEFAULT | | | | | | |

```
#sh mpls ftn-table
```

```
Primary FTN entry with FEC: 30.1.1.0/24, id: 1, row status: Active
```

```
Owner: OSPF-SR, Action-type: Redirect to Tunnel, Exp-bits: 0x0, Incoming DSCP: none
```

```
Tunnel id: 0, Protected LSP id: 0, QoS Resource id: 0, Description: N/A
```

```
Matched bytes:0, pkts:0, TX bytes:0, Pushed pkts:0
```

```
Cross connect ix: 1, in intf: - in label: 0 out-segment ix: 1
```

```
Owner: OSPF-SR, Persistent: No, Admin Status: Up, Oper Status: Up
```

```
Out-segment with ix: 1, owner: OSPF-SR, out intf: eth2, out label: 3
```

```
Nexthop addr: 20.1.1.2 cross connect ix: 1, op code: Push
```



```
#sh ip ospf segment-routing prefix-sid
```

```
-----
Prefix(or FEC)      :30.1.1.0/24
Segment             :Global
Advertisement Router :3.3.3.3
SID Value           :1024003
Next-Hop Route      :20.1.1.2
Next-Hop If_Index   :4
PHP Route Prefix    :Yes
Loop-back Prefix    :No
-----
```

```
This Segment Node   :CORE
-----
```

```
#sh ip ospf segment-routing capability
```

```
-----
Advertisement Router Capability :1.1.1.1
Algorithm                      :0
Total SID'S Supported         :24320
SID Range List Count          :1
SID's Range                   :1024000 - 1048319
-----
```

```
Advertisement Router Capability :2.2.2.2
Algorithm                      :0
Total SID'S Supported         :24320
SID Range List Count          :1
SID's Range                   :1024000 - 1048319
-----
```

```
Advertisement Router Capability :3.3.3.3
Algorithm                      :0
Total SID'S Supported         :24320
SID Range List Count          :1
SID's Range                   :1024000 - 1048319
-----
```

```
Advertisement Router Capability :4.4.4.4
Algorithm                      :0
Total SID'S Supported         :24320
SID Range List Count          :1
SID's Range                   :1024000 - 1048319
-----
```

```
#
```

R3:

```
#sh mpls ilm-table
```

```
Codes: > - selected ILM, p - stale ILM, K - CLI ILM, T - MPLS-TP
```

| Code | FEC | ILM-ID | In-Label | Out-Label | In-Intf | Out-Intf | Nexthop |
|-------------|-------------|--------|----------|-----------|---------|----------|----------|
| LSP-Type | | | | | | | |
| > | 10.1.1.0/24 | | 1 | 1024001 | 3 | N/A eth1 | 20.1.1.1 |
| LSP_DEFAULT | | | | | | | |

```
#sh mpls ftn-table
```

```
Primary FTN entry with FEC: 10.1.1.0/24, id: 1, row status: Active
```

Configuring Segment Routing

```
Owner: OSPF-SR, Action-type: Redirect to Tunnel, Exp-bits: 0x0, Incoming DSCP: none
Tunnel id: 0, Protected LSP id: 0, QoS Resource id: 0, Description: N/A
Matched bytes:0, pkts:0, TX bytes:0, Pushed pkts:0
Cross connect ix: 1, in intf: - in label: 0 out-segment ix: 1
Owner: OSPF-SR, Persistent: No, Admin Status: Up, Oper Status: Up
Out-segment with ix: 1, owner: OSPF-SR, out intf: eth1, out label: 3
Nexthop addr: 20.1.1.1 cross connect ix: 1, op code: Push
#
#sh ip ospf segment-routing prefix-sid
-----
Prefix(or FEC)      :10.1.1.0/24
Segment             :Global
Advertisement Router :1.1.1.1
SID Value           :1024001
Next-Hop Route      :20.1.1.1
Next-Hop If_Index   :3
PHP Route Prefix    :Yes
Loop-back Prefix    :No
-----
This Segment Node   :CORE
-----
#sh ip ospf segment-routing capability
-----
Advertisement Router Capability :1.1.1.1
Algorithm                 :0
Total SID'S Supported       :24320
SID Range List Count       :1
SID's Range                :1024000 - 1048319
-----
Advertisement Router Capability :2.2.2.2
Algorithm                 :0
Total SID'S Supported       :24320
SID Range List Count       :1
SID's Range                :1024000 - 1048319
-----
Advertisement Router Capability :3.3.3.3
Algorithm                 :0
Total SID'S Supported       :24320
SID Range List Count       :1
SID's Range                :1024000 - 1048319
-----
Advertisement Router Capability :4.4.4.4
Algorithm                 :0
Total SID'S Supported       :24320
SID Range List Count       :1
SID's Range                :1024000 - 1048319
-----
#
```

R4:

```
#sh mpls ilm-table
#sh mpls ftn-table
Primary FTN entry with FEC: 10.1.1.0/24, id: 1, row status: Active
Owner: OSPF-SR, Action-type: Redirect to Tunnel, Exp-bits: 0x0, Incoming DSCP: none
Tunnel id: 0, Protected LSP id: 0, QoS Resource id: 0, Description: N/A
Matched bytes:0, pkts:0, TX bytes:0, Pushed pkts:0
Cross connect ix: 1, in intf: - in label: 0 out-segment ix: 1
Owner: OSPF-SR, Persistent: No, Admin Status: Up, Oper Status: Up
Out-segment with ix: 1, owner: OSPF-SR, out intf: eth1, out label: 1024001
Nexthop addr: 30.1.1.1 cross connect ix: 1, op code: Push

Primary FTN entry with FEC: 20.1.1.0/24, id: 2, row status: Active
Owner: OSPF-SR, Action-type: Redirect to Tunnel, Exp-bits: 0x0, Incoming DSCP: none
Tunnel id: 0, Protected LSP id: 0, QoS Resource id: 0, Description: N/A
Matched bytes:0, pkts:0, TX bytes:0, Pushed pkts:0
Cross connect ix: 2, in intf: - in label: 0 out-segment ix: 2
Owner: OSPF-SR, Persistent: No, Admin Status: Up, Oper Status: Up
Out-segment with ix: 2, owner: OSPF-SR, out intf: eth1, out label: 3
Nexthop addr: 30.1.1.1 cross connect ix: 2, op code: Push
#
#sh ip ospf segment-routing prefix-sid
-----
Prefix(or FEC)      :10.1.1.0/24
Segment             :Global
Advertisement Router :1.1.1.1
SID Value           :1024001
Next-Hop Route      :30.1.1.1
Next-Hop If_Index   :3
PHP Route Prefix    :No
Loop-back Prefix    :No
-----
Prefix(or FEC)      :20.1.1.0/24
Segment             :Global
Advertisement Router :2.2.2.2
SID Value           :1024002
Next-Hop Route      :30.1.1.1
Next-Hop If_Index   :3
PHP Route Prefix    :Yes
Loop-back Prefix    :No
-----
This Segment Node   :EDGE
-----
#
#sh ip ospf segment-routing capability
-----
Advertisement Router Capability :1.1.1.1
Algorithm              :0
Total SID'S Supported  :24320
SID Range List Count   :1
```

```
SID's Range :1024000 - 1048319
```

```
-----  
Advertisement Router Capability :2.2.2.2  
Algorithm :0  
Total SID'S Supported :24320  
SID Range List Count :1  
SID's Range :1024000 - 1048319  
-----
```

```
Advertisement Router Capability :3.3.3.3  
Algorithm :0  
Total SID'S Supported :24320  
SID Range List Count :1  
SID's Range :1024000 - 1048319  
-----
```

```
Advertisement Router Capability :4.4.4.4  
Algorithm :0  
Total SID'S Supported :24320  
SID Range List Count :1  
SID's Range :1024000 - 1048319  
-----
```

```
#
```

The command below on R1 displays who is advertising the prefix SID.

```
#show ip ospf segment-routing announce-list
```

```
-----  
Area 0.0.0.0
```

```
Instance 1
```

```
-----  
Prefix:10.1.1.0/24
```

```
Origin Adv-Router:1.1.1.1
```

```
Route-Type:1  
-----
```

Configure Static Segment Routing

This section shows how to configure static segment routing.

The RIB segment routing module is used for static configuration of prefix SID values.

You can manually configure a prefix SID using static segment routing commands or from routes learned from any IGP protocol. The segment routing framework converts static prefix SIDs into MPLS labels and installs them in the FTN/ILM tables.

R1

| | |
|--------------------------------------|--|
| R1#configure terminal | Enter configure mode. |
| R1(config)#int eth1 | Enter interface mode. |
| R1(config-if)#ip address 10.1.1.1/24 | Configure the IP address of the interface. |
| R1(config-if)#exit | Exit interface mode. |

| | |
|--|--|
| R1#configure terminal | Enter configure mode. |
| R1(config)#segment-routing mpls | Enable MPLS-based segment routing. |
| R1(config)#segment-routing-static 20.1.1.0/24 10.1.1.2 eth1 1024001 | Configure the prefix SID for the static route with the nexthop address and outgoing interface. |
| R1(config)#exit | Exit configure mode. |

Validation

Verify that the MPLS forwarding table has the static entry.

```
#sh mpls forwarding-table
```

```
Codes: > - selected FTN, p - stale FTN, B - BGP FTN, K - CLI FTN,
        L - LDP FTN, R - RSVP-TE FTN, S - SNMP FTN, I - IGP-Shortcut,
        U - unknown FTN, T - MPLS-TP Map FTN, O - SR-OSPF FTN,
        i - SR-ISIS FTN, k - SR-CLI FTN
```

| Code | FEC | FTN-ID | Tunnel-id | Pri | LSP-Type | Out-Label | Out-Intf |
|---------|-------------------------|--------|-----------|-----|-------------|-----------|----------|
| Nexthop | | | | | | | |
| k> | 20.1.1.0/24 10.1.1.2 | 1 | 0 | Yes | LSP_DEFAULT | 1024001 | eth1 |

```
#sh mpls ilm-table
```

```
Codes: > - selected ILM, p - stale ILM, K - CLI ILM, T - MPLS-TP
```

| Code | FEC | ILM-ID | In-Label | Out-Label | In-Intf | Out-Intf | Nexthop |
|----------|----------------------------|--------|----------|-----------|---------|----------|----------|
| LSP-Type | | | | | | | |
| K> | 20.1.1.0/24 LSP_DEFAULT | 1 | 1024001 | 1024001 | N/A | eth1 | 10.1.1.2 |

```
#sh mpls ftn-table
```

```
Primary FTN entry with FEC: 20.1.1.0/24, id: 1, row status: Active
Owner: CLI-SR, Action-type: Redirect to Tunnel, Exp-bits: 0x0, Incoming DSCP: none
Tunnel id: 0, Protected LSP id: 0, QoS Resource id: 0, Description: N/A
Matched bytes:0, pkts:0, TX bytes:0, Pushed pkts:0
Cross connect ix: 1, in intf: - in label: 0 out-segment ix: 1
Owner: CLI-SR, Persistent: No, Admin Status: Up, Oper Status: Up
Out-segment with ix: 1, owner: CLI-SR, out intf: eth1, out label: 1024001
Nexthop addr: 10.1.1.2 cross connect ix: 1, op code: Push
```

```
#
```


Index

E

Extended Prefix opaque LSA 9

F

FTN/ILM 7, 9, 20

I

IGP 7, 20

L

label 7

label range 7

LDP 7

M

MPLS 7

O

OSPF 7, 9

P

prefix segments 7

prefix SID 9, 20

R

RIB 9

Router Information opaque LSA 9

RSVP 7

S

segment routing 7

SID 7

source routing 7

SRGB 7

static segment routing 20

