



# L2VPN Services over Segment Routing for Traffic Engineering Policy

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Segment Routing (SR) is a flexible and scalable way of performing source routing. The source device selects a path and encodes it in the packet header as an ordered list of segments. Segments are identifiers for any type of instruction.

Segment routing for traffic engineering (SR-TE) takes place through a tunnel between a source and destination pair. SR-TE uses the concept of source routing, where the source calculates the path and encodes it in the packet header as a segment. In SR-TE preferred path, each segment is an end-to-end path from the source to the destination, and instructs the routers in the provider core network to follow the specified path instead of the shortest path calculated by the IGP. The destination is unaware of the presence of the tunnel.

The user can achieve better resilience and convergence for the network traffic, by transporting MPLS L2VPN services using segment routing, instead of MPLS LDP. Segment routing can be directly applied to the MPLS architecture without changing the forwarding plane. In a segment-routing network that uses the MPLS data plane, LDP or other signaling protocol is not required; instead label distribution is performed by IGP. Removing protocols from the network simplifies its operation and makes it more robust and stable by eliminating the need for protocol interaction. Segment routing utilizes the network bandwidth more effectively than traditional MPLS networks and offers lower latency.

Preferred tunnel path functionality allows you map pseudowires to specific traffic-engineering tunnel paths. Attachment circuits are cross-connected to specific SR traffic engineering tunnel interfaces instead of remote PE router IP addresses reachable using IGP or LDP. Using preferred tunnel path, the traffic engineering tunnel transports L2 or L3 traffic between the source and destination PE routers. A path is selected for an SR Policy when the path is valid and its preference is the best (highest value) among all the candidate paths of the SR Policy.

The following L2VPN services are supported over SR-TE policy:

- EVPN VPWS Preferred Path over SR-TE Policy
- L2VPN VPLS or VPWS Preferred Path over SR-TE Policy
- EVPN VPWS On Demand Next Hop with SR-TE
- [EVPN VPWS Preferred Path over SR-TE Policy, on page 2](#)
- [L2VPN VPLS or VPWS Preferred Path over SR-TE Policy, on page 16](#)
- [EVPN VPWS On-Demand Next Hop with SR-TE, on page 32](#)
- [Overview of Segment Routing , on page 47](#)
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- [Segment Routing Global Block](#) , on page 49

## EVPN VPWS Preferred Path over SR-TE Policy

EVPN VPWS Preferred Path over SR-TE Policy feature allows you to set the preferred path between the two end-points for EVPN VPWS pseudowire (PW) using SR-TE policy. SR policy allows you to choose the path on a per EVPN instance (EVI) basis. This feature is supported on bundle attachment circuit (AC), physical AC, and PWHE (PW-Ether interfaces) AC.

### Restrictions

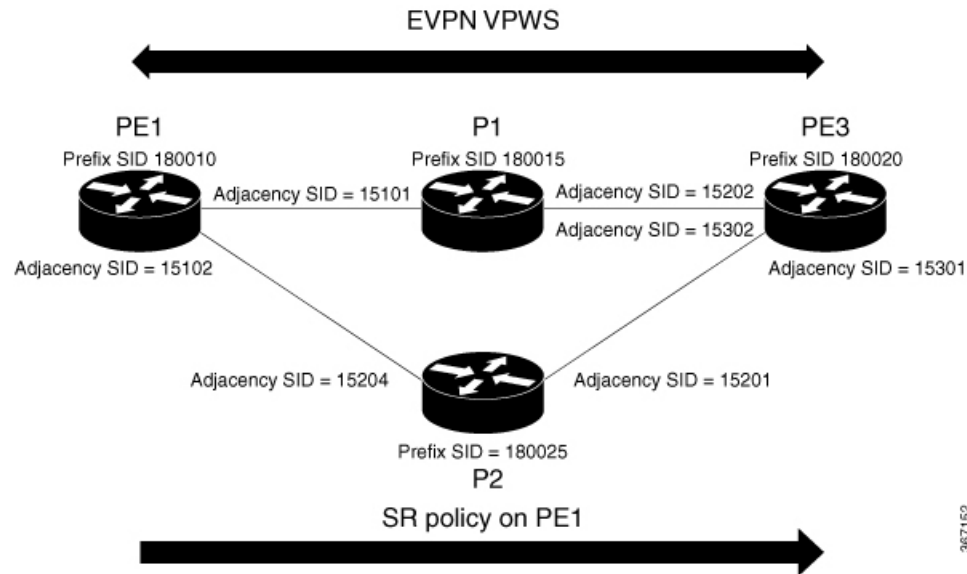
- If EVPN VPWS with On Demand Next Hop (ODN) is configured, and EVPN VPWS with preferred path is also configured for the same PW, then the preferred-path will take precedence.
- EVPN VPWS SR policy is not supported on EVPN VPWS dual homing.
- L2VPN services over PWHE with EVPN VPWS preferred-path over SR-TE policy is not supported.
- PWHE over SR-TE with Equal-cost multipath (ECMP) paths is not supported.
- EVPN validates if the route is for a single home next hop, otherwise it issues an error message about a dangling SR TE policy, and continue to set up EVPN-VPWS without it. EVPN relies on ESI value being zero to determine if this is a single home or not. If the AC is a Bundle-Ether interface running LACP then you need to manually configure the ESI value to zero to overwrite the auto-sense ESI as EVPN VPWS multihoming is not supported.

To disable EVPN dual homing, configure bundle-Ether AC with ESI value set to zero.

```
evpn
interface Bundle-Ether12
  ethernet-segment
    identifier type 0 00.00.00.00.00.00.00.00
/* Or globally */
Evpn
  ethernet-segment type 1 auto-generation-disable
```

## Topology

Figure 1: EVPN VPWS Preferred Path over SR-TE Policy



Consider a topology where PE1 and PE3 are the two EVPN VPWS PW end-points. Traffic is sent from PE1 to PE3 through SR in the core. Traffic from PE1 can be sent to PE3 either through P1 or P2 node. In this example, the EVPN VPWS preferred path over SR policy is configured to show the traffic flow from PE1 to PE3 using prefix-SID. Using adjacency-SID, you can steer traffic flow from PE1 to PE3 and specify whether it should pass through P1 or P2 node.

## Configure EVPN VPWS Preferred Path over SR-TE Policy

You must complete these tasks to ensure the successful configuration of EVPN VPWS Preferred Path over SR-TE Policy feature:

- Configure Prefix-SID on IGP — The following examples show how to configure prefix-SID in IS-IS.
- Configure Adjacency-SID on IGP — The following examples show how to configure Adjacency-SID in IS-IS.
- Configure segment-list
- Configure SR-TE policy
- Configure EVPN VPWS over SR-TE policy
- Configure VPWS pseudowire headend over SR-TE policy

### Configure Prefix-SID in IS-IS

Configure Prefix-SID on PE1, P1, P2, and PE3.

```
/* Configure Prefix-SID on PE1 */
```

```
Router# configure
```

```

Router(config)# segment-routing
Router(config-sr)# global-block 180000 200000
Router(config-sr)# exit
!
Router# configure
Route(config)# router isis core
Route(config-isis)# is-type level-2-only
Route(config-isis)# net 49.0002.0330.2000.0031.00
Route(config-isis)# nsr
Route(config-isis)# nsf ietf
Route(config-isis)# log adjacency changes
Route(config-isis)# address-family ipv4 unicast
Route(config-isis-af)# metric-style wide level 2
Route(config-isis-af)# mpls traffic-eng level-2-only
Route(config-isis-af)# mpls traffic-eng router-id 1.1.1.1
Route(config-isis-af)# segment-routing mpls sr-prefer
Route(config-isis-af)# segment-routing prefix-sid-map advertise-local
Route(config-isis-af)# exit
!
Route(config-isis)# interface loopback 0
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-af)# prefix-sid index 180010
Route(config-isis-af)# commit
Route(config-isis-af)# exit

/* Configure Prefix-SID on P1 */

Router# configure
Router(config)# segment-routing
Router(config-sr)# global-block 180000 200000
Router(config-sr)# exit
!
Router# configure
Router(config)# router isis core
Router(config-isis)# is-type level-2-only
Router(config-isis)# net 49.0002.0330.2000.0021.00
Router(config-isis)# nsr
Router(config-isis)# nsf ietf
Router(config-isis)# log adjacency changes
Router(config-isis)# address-family ipv4 unicast
Router(config-isis-af)# metric-style wide level 2
Router(config-isis-af)# mpls traffic-eng level-2-only
Router(config-isis-af)# mpls traffic-eng router-id loopback0
Router(config-isis-af)# segment-routing mpls sr-prefer
Router(config-isis-af)# segment-routing prefix-sid-map advertise-local
Router(config-isis-af)# exit
!
Router(config-isis)# interface loopback 0
Router(config-isis-if)# address-family ipv4 unicast
Router(config-isis-af)# prefix-sid index 180015
Router(config-isis-af)# commit
Router(config-isis-af)# exit

/* Configure Prefix-SID on P2 */

Router# configure
Router(config)# segment-routing
Router(config-sr)# global-block 180000 200000
Router(config-sr)# exit
!
Router# configure
Route(config)# router isis core
Route(config-isis)# is-type level-2-only

```

```

Route(config-isis)# net 49.0002.0330.2000.0022.00
Route(config-isis)# nsr
Route(config-isis)# nsf ietf
Route(config-isis)# log adjacency changes
Route(config-isis)# address-family ipv4 unicast
Route(config-isis-af)# metric-style wide level 2
Route(config-isis-af)# mpls traffic-eng level-2-only
Route(config-isis-af)# mpls traffic-eng router-id loopback0
Route(config-isis-af)# segment-routing mpls sr-prefer
Route(config-isis-af)# segment-routing prefix-sid-map advertise-local
Route(config-isis-af)# exit
!
Route(config-isis)# interface loopback 0
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-af)# prefix-sid index 180025
Route(config-isis-af)# commit
Route(config-isis-af)# exit

/* Configure Prefix-SID on PE3 */

Router# configure
Router(config)# segment-routing
Router(config-sr)# global-block 180000 200000
Router(config-sr)# exit
!
Router# configure
Route(config)# router isis core
Route(config-isis)# is-type level-2-only
Route(config-isis)# net 49.0002.0330.2000.3030.0030.0035.00
Route(config-isis)# address-family ipv4 unicast
Route(config-isis-af)# metric-style wide level 2
Route(config-isis-af)# mpls traffic-eng level-2-only
Route(config-isis-af)# mpls traffic-eng router-id loopback0
Route(config-isis-af)# segment-routing mpls sr-prefer
Route(config-isis-af)# segment-routing prefix-sid-map advertise-local
Route(config-isis-af)# exit
!
Route(config-isis)# interface loopback0
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-af)# prefix-sid index 180020
Route(config-isis-af)# commit
Route(config-isis-af)# exit

```

## Configure Adjacency-SID in IS-IS

Configure Adjacency-SID on PE1, P1, P2, and PE3.

```

/* Configure Adjacency-SID on PE1 */

Router# configure
Router(config)# segment-routing
Router(config-sr)# local-block 15000 15999
!
Router# configure
Route(config)# router isis core
Route(config-isis)# interface Bundle-Ether121
Route(config-isis-if)# circuit-type level-2-only
Route(config-isis-if)# point-to-point
Route(config-isis-if)# hello-padding disable
Route(config-isis-if)# address-family ipv4 unicast

```

```

Route(config-isis-if-af) # adjacency-sid absolute 15101
Route(config-isis-if-af) # exit
!
Router# configure
Route(config) # router isis core
Route(config-isis) # interface TenGigE0/0/1/6
Route(config-isis-if) # circuit-type level-2-only
Route(config-isis-if) # point-to-point
Route(config-isis-if) # hello-padding disable
Route(config-isis-if) # address-family ipv4 unicast
Route(config-isis-if-af) # adjacency-sid absolute 15102
Route(config-isis-if-af) # commit

/* Configure Adjacency-SID on P1 */

Router# configure
Router(config) # segment-routing
Router(config-sr) # local-block 15000 15999
!
Router# configure
Route(config) # router isis core
Route(config-isis) # interface Bundle-Ether121
Route(config-isis-if) # circuit-type level-2-only
Route(config-isis-if) # point-to-point
Route(config-isis-if) # hello-padding disable
Route(config-isis-if) # address-family ipv4 unicast
Route(config-isis-if-af) # metric 20
Route(config-isis-if-af) # adjacency-sid absolute 15200
Route(config-isis-if-af) # commit
!
Router# configure
Route(config) # router isis core
Route(config-isis) # interface TenGigE0/0/0/7
Route(config-isis-if) # circuit-type level-2-only
Route(config-isis-if) # point-to-point
Route(config-isis-if) # hello-padding disable
Route(config-isis-if) # address-family ipv4 unicast
Route(config-isis-if-af) # adjacency-sid absolute 15202
Route(config-isis-if-af) # commit
!

/* Configure Adjacency-SID on P2 */

Router# configure
Router(config) # segment-routing
Router(config-sr) # local-block 15000 15999
!
Router# configure
Route(config) # router isis core
Route(config-isis) # interface TenGigE0/0/0/7
Route(config-isis-if) # circuit-type level-2-only
Route(config-isis-if) # point-to-point
Route(config-isis-if) # hello-padding disable
Route(config-isis-if) # address-family ipv4 unicast
Route(config-isis-if-af) # metric 20
Route(config-isis-if-af) # adjacency-sid absolute 15201
Route(config-isis-if-af) # exit
!
Router# configure
Route(config) # router isis core
Route(config-isis) # interface TenGigE0/0/0/5
Route(config-isis-if) # circuit-type level-2-only
Route(config-isis-if) # point-to-point

```

```

Route(config-isis-if)# hello-padding disable
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-if-af)# metric 20
Route(config-isis-if-af)# adjacency-sid absolute 15204
Route(config-isis-if-af)# commit

/* Configure Adjacency-SID on PE3 */

Router# configure
Router(config)# segment-routing
Router(config-sr)# local-block 15000 15999
!
Router# configure
Route(config)# router isis core
Route(config-isis)# interface TenGigE0/0/0/1
Route(config-isis-if)# circuit-type level-2-only
Route(config-isis-if)# point-to-point
Route(config-isis-if)# hello-padding disable
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-if-af)# adjacency-sid absolute 15301
Route(config-isis-if-af)# exit
!
Router# configure
Route(config)# router isis core
Route(config-isis)# interface TenGigE0/0/0/2
Route(config-isis-if)# circuit-type level-2-only
Route(config-isis-if)# point-to-point
Route(config-isis-if)# hello-padding disable
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-if-af)# adjacency-sid absolute 15302
Route(config-isis-if-af)# commit

```

## Configure Segment-list

```

/* Configure Segment-list on PE1 using prefix-SID */

Router# configure
Router(config)# segment-routing
Router(config-sr)# global-block 180000 200000
Router(config-sr)# traffic-eng
Router(config-sr-te)# logging
Router(config-sr-te-log)# policy status
Router(config-sr-te-log)# exit
!
Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng
Router(config-sr-te)# segment-list name pref_sid_to_PE3
Router(config-sr-te-sl)# index 1 mpls label 180020 <-----using prefix-SID
Router(config-sr-te-sl)# exit

/* Configure Segment-list on PE1 using adjacency-SID */

Router# configure
Router(config)# segment-routing
Router(config-sr)# local-block 15000 15999
Router(config-sr)# traffic-eng
Router(config-sr-te)# logging
Router(config-sr-te-log)# policy status
Router(config-sr-te-log)# exit
!

```

```

Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng
Router(config-sr-te)# segment-list name pref_adj_sid_to_PE3
Router(config-sr-te-sl)# index 1 mpls label 15101 <-----using adjacency-SID
Router(config-sr-te-sl)# index 2 mpls label 15202 <-----using adjacency-SID
Router(config-sr-te-sl)# exit

```

## Configure SR-TE Policy

```

/* Configure SR-TE Policy */

Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng
Router(config-sr-te)# policy pref_sid_to_PE3
Router(config-sr-te-policy)# color 9001 end-point ipv4 20.20.20.20
Router(config-sr-te-policy)# candidate-paths
Router(config-sr-te-policy)# preference 10
Router(config-sr-te-pp-info)# explicit segment-list pref_sid_to_PE3
Router(config-sr-te-pp-info)# commit
Router(config-sr-te-pp-info)# exit
!
Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng
Router(config-sr-te)# policy pref_adj_sid_to_PE3
Router(config-sr-te-policy)# color 9001 end-point ipv4 20.20.20.20
Router(config-sr-te-policy)# candidate-paths
Router(config-sr-te-policy)# preference 200
Router(config-sr-te-pp-info)# explicit segment-list pref_adj_sid_to_PE3
Router(config-sr-te-pp-info)# commit
Router(config-sr-te-pp-info)# exit

/* You can configure multiple preferences for an SR policy. Among the configured preferences,
the largest number takes the highest precedence */

Router# configure
Router(config)# segment-routing
Router(config-sr)# global-block 180000 200000
Router(config-sr)# local-block 15000 15999
Router(config-sr)# traffic-eng
Router(config-sr-te)# policy 1013
Router(config-sr-te-policy)# color 1013 end-point ipv4 2.2.2.2
Router(config-sr-te-policy)# candidate-paths
Router(config-sr-te-policy)# preference 100
Router(config-sr-te-pp-info)# explicit segment-list PE1-P1_BE121
Router(config-sr-te-pp-info)# exit
!
Router(config-sr-te-policy)# preference 200
Router(config-sr-te-pp-info)# explicit segment-list PE1-PE3-P1-t0016
Router(config-sr-te-pp-info)# exit
!
Router(config-sr-te-policy)# preference 700 <-----largest number takes the precedence
Router(config-sr-te-pp-info)# explicit segment-list PE1-P1
Router(config-sr-te-pp-info)# commit
Router(config-sr-te-pp-info)# exit

```



## Configure EVPN VPWS over SR-TE Policy

```

Router# configure
Router(config)# l2vpn
Router(config-l2vpn)# pw-class 1001
Router(config-l2vpn-pwc)# encapsulation mpls
Router(config-l2vpn-pwc-mpls)# preferred-path sr-te policy pref_sid_to_PE3 fallback disable
Router(config-l2vpn-pwc-mpls)# commit
Router(config-l2vpn-pwc-mpls)# exit
!
Router(config)# l2vpn
Router(config-l2vpn)# xconnect group evpn_vpws
Router(config-l2vpn-xc)# p2p evpn_vpws_1001
Router(config-l2vpn-xc-p2p)# interface tengi0/1/0/1.1001
Router(config-l2vpn-xc-p2p)# neighbor evpn evi 1001 target 10001 source 20001
Router(config-l2vpn-xc-p2p-pw)# pw-class 1001
Router(config-l2vpn-xc-p2p-pw)# commit
Router(config-l2vpn-xc-p2p-pw)# exit

/* If Fallback Enable is configured, which is the default option, and if the SR-policy is
down, then EVPN VPWS will still continue to be UP using the regular IGP path, and not using
the SR-policy */
show l2vpn xconnect detail
EVPN: neighbor 20.20.20.20, PW ID: evi 1001, ac-id 10001, state is up ( established )
Preferred path Inactive : SR TE pref_sid_to_PE3, Statically configured, fallback enabled

Tunnel : Down
LSP: Up

/* If Fallback Disable is configured, and if the SR-policy is down, or if it misconfigured
in dual homed mode, then the L2VPN PW will be down */
show l2vpn xconnect detail
EVPN: neighbor 20.20.20.20, PW ID: evi 1001, ac-id 10001, state is down ( local ready )
Preferred path Active : SR TE pref_sid_to_PE3, Statically configured, fallback disabled
Tunnel : Down

```

## Configure VPWS Pseudowire Headend over SR-TE Policy

```

Router# configure
Router(config)# interface PW-Ether1
Router(config-if)# ipv4 address 10.1.1.1 255.255.255.0
Router(config-if)# attach generic-interface-list 1
Router(config-if)# exit
!
Router(config)# generic-interface-list 1
Router(config-gen-if-list)# interface Bundle-Ether1
Router(config-gen-if-list)# interface TenGigE0/1/0/6/1
Router(config-gen-if-list)# interface TenGigE0/1/0/6/2
Router(config-gen-if-list)# exit
!
Router(config)# l2vpn
Router(config-l2vpn)# pw-class pw1013
Router(config-l2vpn-pwc)# encapsulation mpls
Router(config-l2vpn-pwc-mpls)# transport-mode ethernet
Router(config-l2vpn-pwc-mpls)# preferred-path sr-te policy 1013 fallback disable
Router(config-l2vpn-pwc-mpls)# exit
!
Router(config)# l2vpn
Router(config-l2vpn)# Xconnect group evpn_vpws_pwhe

```

```

Router(config-l2vpn-xc)# p2p 1001
Router(config-l2vpn-xc-p2p)# interface pw-ether 1
Router(config-l2vpn-xc-p2p-pw)# neighbor evpn evi 1000 target 1000 source 1000
Router(config-l2vpn-xc-p2p-pw)# pw-class pw1013
Router(config-l2vpn-xc-p2p-pw)# commit

```

## Running Configuration

```

/* Configure Prefix-SID in ISIS */
P1:

configure
  segment-routing
    global-block 180000 200000
  !
router isis core
  is-type level-2-only
  net 49.0002.0330.2000.0031.00
  nsr
  nsf ietf
  log adjacency changes
  address-family ipv4 unicast
  metric-style wide level 2
  mpls traffic-eng level-2-only
  mpls traffic-eng router-id 1.1.1.1
  segment-routing mpls sr-prefer
  segment-routing prefix-sid-map advertise-local

interface Loopback0
  address-family ipv4 unicast
  prefix-sid index 180010

P1:

configure
  segment-routing
    global-block 180000 200000

router isis core
  is-type level-2-only
  net 49.0002.0330.2000.0021.00
  nsr
  nsf ietf
  log adjacency changes
  address-family ipv4 unicast
  metric-style wide level 2
  mpls traffic-eng level-2-only
  mpls traffic-eng router-id Loopback0
  segment-routing mpls sr-prefer
  segment-routing prefix-sid-map advertise-local

interface Loopback0
  address-family ipv4 unicast
  prefix-sid index 180015

P2:

configure
  segment-routing
    global-block 180000 200000

```

```

router isis core
 is-type level-2-only
 net 49.0002.0330.2000.0022.00
 nsr
 nsf ietf
 log adjacency changes
 address-family ipv4 unicast
  metric-style wide level 2
 mpls traffic-eng level-2-only
 mpls traffic-eng router-id Loopback0
 segment-routing mpls sr-prefer
 segment-routing prefix-sid-map advertise-local

```

```

interface Loopback0
 address-family ipv4 unicast
  prefix-sid index 180025

```

**PE3:**

```

configure
 segment-routing
  global-block 180000 200000

router isis core
 is-type level-2-only
 net 49.0002.0330.2000.3030.0030.0035.00
 address-family ipv4 unicast
  metric-style wide level 2
 mpls traffic-eng level-2-only
 mpls traffic-eng router-id Loopback0
 segment-routing mpls sr-prefer
 segment-routing prefix-sid-map advertise-local

interface Loopback0
 address-family ipv4 unicast
  prefix-sid index 180020

```

```
/* Configure Adjacency-SID in ISIS */
```

**PE1:**

```

configure
 segment-routing
  local-block 15000 15999
!

router isis core
!
interface Bundle-Ether121
 circuit-type level-2-only
 point-to-point
 hello-padding disable
 address-family ipv4 unicast
  adjacency-sid absolute 15101

interface TenGigE0/0/1/6
 circuit-type level-2-only
 point-to-point
 hello-padding disable
 address-family ipv4 unicast
  adjacency-sid absolute 15102

```

**P1:**

```

configure
  segment-routing
    local-block 15000 15999

router isis core
!
interface Bundle-Ether121
  circuit-type level-2-only
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
  metric 20
  adjacency-sid absolute 15200

interface TenGigE0/0/0/0/7
  circuit-type level-2-only
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
  metric 20
  adjacency-sid absolute 15202

```

**PE2:**

```

configure
  segment-routing
    local-block 15000 15999

router isis core
!
interface TenGigE0/0/0/0/5
  circuit-type level-2-only
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
  metric 20
  adjacency-sid absolute 15204

interface TenGigE0/0/0/0/7
  circuit-type level-2-only
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
  metric 20
  adjacency-sid absolute 15201

```

**PE3:**

```

configure
  segment-routing
    local-block 15000 15999

router isis core
!
interface TenGigE0/0/0/0/1
  circuit-type level-2-only
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
  adjacency-sid absolute 15301
!
!
interface TenGigE0/0/0/0/2
  circuit-type level-2-only

```

```

point-to-point
hello-padding disable
address-family ipv4 unicast
  adjacency-sid absolute 15302

/* Configure Segment-list */
PE1:

configure
segment-routing
  global-block 180000 200000
  traffic-eng
    logging
    policy status

segment-routing
traffic-eng
  segment-list name pref_sid_to_PE3
  index 1 mpls label 180020
  !
  !
configure
segment-routing
  local-block 15000 15999
  traffic-eng
    logging
    policy status

segment-routing
traffic-eng
  segment-list name pref_adj_sid_to_PE3
  index 1 mpls label 15101
  index 2 mpls label 15202
  !
  !

/* Configure SR-TE policy */

segment-routing
traffic-eng
  policy pref_sid_to_PE3
  color 9001 end-point ipv4 20.20.20.20
  candidate-paths
  preference 10
  explicit segment-list pref_sid_to_PE3
  !
  !
segment-routing
traffic-eng
  policy pref_adj_sid_to_PE3
  color 9001 end-point ipv4 20.20.20.20
  candidate-paths
  preference 200
  explicit segment-list pref_adj_sid_to_PE3
  !
  !

/* You can configure multiple preferences for an SR policy. Among the configured preferences,
the largest number takes the highest precedence */

segment-routing
traffic-eng
  policy 1013
  color 1013 end-point ipv4 2.2.2.2

```

```

candidate-paths
  preference 100
    explicit segment-list PE1-P1_BE121
    !
  preference 200
    explicit segment-list PE1-PE3-P1-t0016
    !
  preference 700
    explicit segment-list PE1-P1
    !

/* Configure EVPN VPWS over SR-TE policy */
PE1:
configure
  l2vpn
    pw-class 1001
      encapsulation mpls
      preferred-path sr-te policy pref_sid_to_PE3 fallback disable
  xconnect group evpn_vpws
    p2p evpn_vpws_1001
      interface tengi0/1/0/1.1001
      neighbor evpn evi 1001 target 10001 source 20001
      pw-class 1001
    !

/* Configure VPWS Pseudowire Headend SR-TE Policy */

interface PW-Ether1
  ipv4 address 10.1.1.1 255.255.255.0
  attach generic-interface-list 1

generic-interface-list 1
interface Bundle-Ether1
interface TenGigE0/1/0/6/1
interface TenGigE0/1/0/6/2

l2vpn
  pw-class pw1013
    encapsulation mpls
    transport-mode ethernet
    preferred-path sr-te policy 1013 fallback disable
  Xconnect group evpn_vpws_pwhe
    p2p 1001
      interface pw-ether 1
      neighbor evpn evi 1000 target 1000 source 1000
      pw-class pw1013

```

## Verify EVPN VPWS Preferred Path over SR-TE Policy Configuration

```

PE1#show segment-routing traffic-eng forwarding policy name pref_sid_to_PE3 detail
Policy          Segment      Outgoing    Outgoing      Next Hop      Bytes
Name           List         Label       Interface      Switched
-----
pref_sid_to_PE3
                                15102       TenGigE0/0/1/6    20.20.20.20    81950960
                                Label Stack (Top -> Bottom): { 15101, 15102 }
                                Path-id: 1, Weight: 0
                                Packets Switched: 787990
Local label: 34555

```

Packets/Bytes Switched: 1016545/105720680  
 (!): FRR pure backup

```
PE1#show mpls forwarding tunnels sr-policy name pref_sid_to_PE3
Tunnel      Outgoing   Outgoing   Next Hop      Bytes
Name        Label      Interface  Next Hop      Switched
-----
pref_sid_to_PE3 (SR) 15102 TenGigE0/0/1/6 20.20.20.20      836516512
```

```
PE1#show l2vpn xconnect group evpn_vpws xc-name evpn_vpws_1001 detail
Group evpn_vpws, XC evpn_vpws_1001, state is up; Interworking none
AC: Bundle-Ether12.1001, state is up
  Type VLAN; Num Ranges: 1
  Outer Tag: 1000
  Rewrite Tags: []
  VLAN ranges: [1, 1]
  MTU 1500; XC ID 0xc0000018; interworking none
  Statistics:
    packets: received 642304, sent 642244
    bytes: received 61661184, sent 61655424
    drops: illegal VLAN 0, illegal length 0
  EVPN: neighbor 20.20.20.20, PW ID: evi 1001, ac-id 10001, state is up ( established )
  XC ID 0xa0000007
  Encapsulation MPLS
  Source address 10.10.10.10
  Encap type Ethernet, control word enabled
  Sequencing not set
  Preferred path Active : SR TE pref_sid_to_PE3, Statically configured, fallback disabled
  Tunnel : Up
  Load Balance Hashing: src-dst-mac
```

```
PE1# show l2vpn xconnect group evpn_vpws_pwhe xc-name 3001 detail
Group evpn_vpws_pwhe, XC 3001, state is up; Interworking none
AC: PW-Ether3001, state is up
  Type PW-Ether
  Interface-list: GIL
  Internal label: 24022
  ...
  EVPN: neighbor 20.20.20.20, PW ID: evi 3001, ac-id 3001, state is up ( established )
  ...
  Preferred path Active : SR TE evpn_to_PE5_3001, Statically configured, fallback disabled
  Tunnel : Up
```

```
PE1# show mpls forwarding labels 24022 detail
Local  Outgoing   Prefix           Outgoing   Next Hop      Bytes
Label  Label      or ID            Interface  Next Hop      Switched
-----
24022  25022      PW-HE(PE3001)   evpn_to_PE5_point2point  0
Updated: Dec 18 12:52:50.764
PW HE VC type : 5
PW HE CW      : enabled
PW HE interface : PE3001
Outgoing Interface: evpn_to_PE5_3001 (ifhandle 0x0000fc20)
```

```
PE1# show l2vpn forwarding main-port pwhe location 0/2/CPU0
PWHE-MP Interface: PW-Ether3001
  ifhandle: 0x000101e0
  Generic Iflist ID: 1
  Internal_label: 24022
  Remote Label: 25022
  Control Word Enabled: Yes
```

```
Pseudowire Type:      5
Next Hop Tunnel IFH: 0xfc20
```

## Associated Commands

- adjacency-sid
- index
- prefix-sid
- router isis
- segment-routing

The applicable segment routing commands are described in the *Segment Routing Command Reference for Cisco ASR 9000 Series Routers*

## Related Topics

- [Overview of Segment Routing](#) , on page 47
- [How Segment Routing Works](#) , on page 48
- [Segment Routing Global Block](#) , on page 49

# L2VPN VPLS or VPWS Preferred Path over SR-TE Policy

L2VPN VPLS or VPWS Preferred Path over SR-TE Policy feature allows you to set the preferred path between the two end-points for L2VPN Virtual Private LAN Service (VPLS) or Virtual Private Wire Service (VPWS) using SR-TE policy.

This feature is supported on bundle attachment circuit (AC), physical AC, and PWHE AC.

### Restrictions

- When an SR policy is configured as the preferred path for a VPLS circuit, the traffic traverses through the SR policy path.

The PW counters are updated with statistics about packets transmitted and received.

When the SR policy configuration is deleted, the traffic session is still functional because the traffic transmission switches back to the normal LSP path between the PEs. There is no drop in the end-to-end traffic transmitted.

However, the packet statistics counters are reset and start from zero.

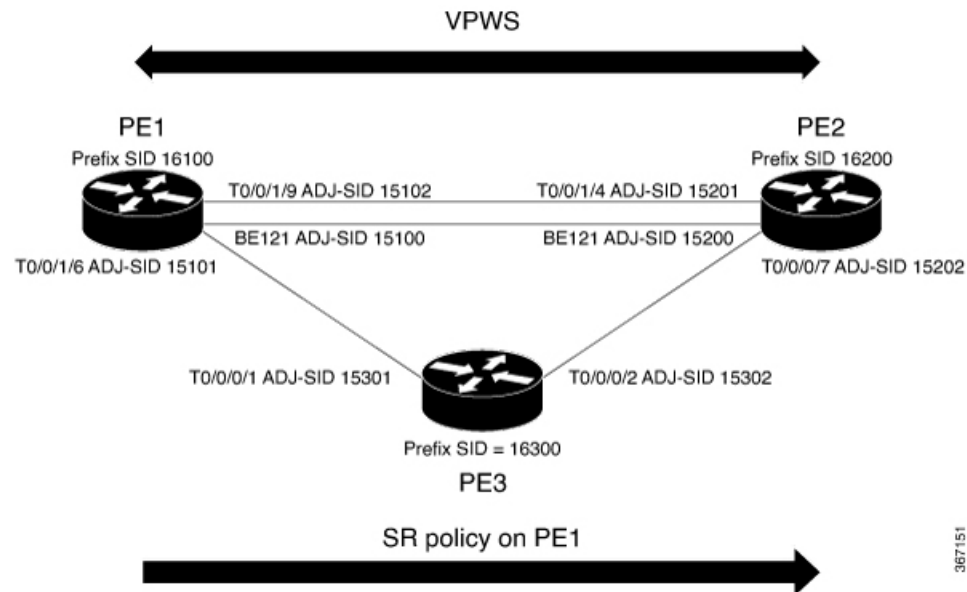
This is because, when the SR policy is deleted, the PW too gets deleted and the statistics information associated with the old PW is cleared. The counter restarts from zero when the new PW is created after the switch takes place.



## Configure L2VPN VPLS or VPWS Preferred Path over SR-TE Policy

Perform the following steps to configure L2VPN VPLS or VPWS Preferred Path over SR-TE Policy feature. The following figure is used as a reference to explain the configuration steps.

Figure 2: L2VPN VPWS and VPLS Preferred Path over SR-TE Policy



- Configure Prefix-SID on IGP — The following examples show how to configure prefix-SID in IS-IS.
- Configure Adjacency-SID on IGP — The following examples show how to configure Adjacency-SID in IS-IS.
- Configure segment-list
- Configure SR-TE policy
- Configure VPLS over SR-TE policy
- Configure VPWS over SR-TE policy
- Configure VPWS pseudowire headend over SR-TE policy

### Configure Prefix-SID in IS-IS

Configure Prefix-SID on PE1, PE2, and PE3.

```
/* Configure Prefix-SID on PE1 */

Router# configure
Route(config)# router isis core
Route(config-isis)# is-type level-2-only
Route(config-isis)# net 49.0002.0330.2000.0031.00
Route(config-isis)# nsr
Route(config-isis)# nsf ietf
Route(config-isis)# log adjacency changes
Route(config-isis)# address-family ipv4 unicast
```

```

Route(config-isis-af) # metric-style wide level 2
Route(config-isis-af) # mpls traffic-eng level-2-only
Route(config-isis-af) # mpls traffic-eng router-id 1.1.1.1
Route(config-isis-af) # segment-routing mpls sr-prefer
Route(config-isis-af) # segment-routing prefix-sid-map advertise-local
Route(config-isis-af) # exit
!
Route(config-isis) # interface loopback 0
Route(config-isis-if) # address-family ipv4 unicast
Route(config-isis-af) # prefix-sid index 16100
Route(config-isis-af) # commit
Route(config-isis-af) # exit

/* Configure Prefix-SID on PE2 */

Router# configure
Route(config) # router isis core
Route(config-isis) # is-type level-2-only
Route(config-isis) # net 49.0002.0330.2000.0021.00
Route(config-isis) # nsr
Route(config-isis) # nsf ietf
Route(config-isis) # log adjacency changes
Route(config-isis) # address-family ipv4 unicast
Route(config-isis-af) # metric-style wide level 2
Route(config-isis-af) # mpls traffic-eng level-2-only
Route(config-isis-af) # mpls traffic-eng router-id loopback0
Route(config-isis-af) # segment-routing mpls sr-prefer
Route(config-isis-af) # segment-routing prefix-sid-map advertise-local
Route(config-isis-af) # exit
!
Route(config-isis) # interface loopback 0
Route(config-isis-if) # address-family ipv4 unicast
Route(config-isis-af) # prefix-sid index 16200
Route(config-isis-af) # commit
Route(config-isis-af) # exit

/* Configure Prefix-SID on PE3 */

Router# configure
Route(config) # router isis core
Route(config-isis) # is-type level-2-only
Route(config-isis) # net 49.0002.0330.2000.3030.0030.0035.00
Route(config-isis) # address-family ipv4 unicast
Route(config-isis-af) # metric-style wide level 2
Route(config-isis-af) # mpls traffic-eng level-2-only
Route(config-isis-af) # mpls traffic-eng router-id loopback0
Route(config-isis-af) # segment-routing mpls sr-prefer
Route(config-isis-af) # segment-routing prefix-sid-map advertise-local
Route(config-isis-af) # exit
!
Route(config-isis) # interface loopback 0
Route(config-isis-if) # address-family ipv4 unicast
Route(config-isis-af) # prefix-sid index 16300
Route(config-isis-af) # commit
Route(config-isis-af) # exit

```

## Configure Adjacency-SID in IS-IS

Configure Adjacency-SID on PE1, PE2, and PE3.

```

/* Configure Adjacency-SID on PE1 */

Router# configure
Route(config)# router isis core
Route(config-isis)# interface Bundle-Ether121
Route(config-isis-if)# circuit-type level-2-only
Route(config-isis-if)# point-to-point
Route(config-isis-if)# hello-padding disable
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-if-af)# adjacency-sid absolute 15100
Route(config-isis-if-af)# exit
!
Router# configure
Route(config)# router isis core
Route(config-isis)# interface TenGigE0/0/1/6
Route(config-isis-if)# circuit-type level-2-only
Route(config-isis-if)# point-to-point
Route(config-isis-if)# hello-padding disable
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-if-af)# adjacency-sid absolute 15101
Route(config-isis-if-af)# exit
!
Router# configure
Route(config)# router isis core
Route(config-isis)# interface TenGigE0/0/1/9
Route(config-isis-if)# circuit-type level-2-only
Route(config-isis-if)# point-to-point
Route(config-isis-if)# hello-padding disable
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-if-af)# adjacency-sid absolute 15102
Route(config-isis-if-af)# commit

/* Configure Adjacency-SID on PE2 */

Router# configure
Route(config)# router isis core
Route(config-isis)# interface Bundle-Ether121
Route(config-isis-if)# circuit-type level-2-only
Route(config-isis-if)# point-to-point
Route(config-isis-if)# hello-padding disable
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-if-af)# adjacency-sid absolute 15200
Route(config-isis-if-af)# exit
!
Router# configure
Route(config)# router isis core
Route(config-isis)# interface TenGigET0/0/1/4
Route(config-isis-if)# circuit-type level-2-only
Route(config-isis-if)# point-to-point
Route(config-isis-if)# hello-padding disable
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-if-af)# adjacency-sid absolute 15201
Route(config-isis-if-af)# exit
!
Router# configure
Route(config)# router isis core
Route(config-isis)# interface TenGigE0/0/0/7
Route(config-isis-if)# circuit-type level-2-only
Route(config-isis-if)# point-to-point
Route(config-isis-if)# hello-padding disable
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-if-af)# adjacency-sid absolute 15202

```

```

Route(config-isis-if-af)# commit

/* Configure Adjacency-SID on PE3 */

Router# configure
Route(config)# router isis core
Route(config-isis)# interface TenGigE0/0/0/1
Route(config-isis-if)# circuit-type level-2-only
Route(config-isis-if)# point-to-point
Route(config-isis-if)# hello-padding disable
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-if-af)# adjacency-sid absolute 15301
Route(config-isis-if-af)# exit
!
Router# configure
Route(config)# router isis core
Route(config-isis)# interface TenGigE0/0/0/2
Route(config-isis-if)# circuit-type level-2-only
Route(config-isis-if)# point-to-point
Route(config-isis-if)# hello-padding disable
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-if-af)# adjacency-sid absolute 15302
Route(config-isis-if-af)# commit

```

## Configure Segment-list

Configure segment-list on PE1, PE2, and PE3.

```

/* Configure segment-list on PE1 */

Router# configure
Router(config)# segment-routing
Router(config-sr)# global-block 16000 23999
Router(config-sr)# local-block 15000 15999
Router(config-sr)# traffic-eng
Router(config-sr-te)# segment-list segment-list name PE1-PE2
Router(config-sr-te-sl)# index 1 mpls label 16200
Router(config-sr-te-sl)# exit
!
Router(config-sr-te)# segment-list segment-list name PE1-PE3
Router(config-sr-te-sl)# index 1 mpls label 16300
Router(config-sr-te-sl)# exit
!
Router(config-sr-te)# segment-list segment-list name PE1-PE2-PE3
Router(config-sr-te-sl)# index 1 mpls label 16200
Router(config-sr-te-sl)# index 2 mpls label 16300
Router(config-sr-te-sl)# exit
!
Router(config-sr-te)# segment-list segment-list name PE1-PE2_bad
Router(config-sr-te-sl)# index 1 mpls label 16900
Router(config-sr-te-sl)# exit
!
Router(config-sr-te)# segment-list segment-list name PE1-PE3-PE2
Router(config-sr-te-sl)# index 1 mpls label 16300
Router(config-sr-te-sl)# index 2 mpls label 16200
Router(config-sr-te-sl)# exit
!
Router(config-sr-te)# segment-list segment-list name PE1-PE2_BE121
Router(config-sr-te-sl)# index 1 mpls label 15100
Router(config-sr-te-sl)# exit

```

```

!
Router(config-sr-te)# segment-list segment-list name PE1-PE3-PE2_link
Router(config-sr-te-sl)# index 1 mpls label 15101
Router(config-sr-te-sl)# index 2 mpls label 15302
Router(config-sr-te-sl)# exit
!
Router(config-sr-te)# segment-list segment-list name PE1-PE3-PE2-t0016
Router(config-sr-te-sl)# index 1 mpls label 15101
Router(config-sr-te-sl)# index 2 mpls label 16200
Router(config-sr-te-sl)# commit

/* Configure segment-list on PE2 */

Router# configure
Router(config)# segment-routing
Router(config-sr)# global-block 16000 23999
Router(config-sr)# local-block 15000 15999
Router(config-sr)# traffic-eng
Router(config-sr-te)# segment-list segment-list name PE2-PE1
Router(config-sr-te-sl)# index 1 mpls label 16100
Router(config-sr-te-sl)# exit
!
Router(config-sr-te)# segment-list segment-list name PE2-PE3-PE1
Router(config-sr-te-sl)# index 1 mpls label 16300
Router(config-sr-te-sl)# index 2 mpls label 16100
Router(config-sr-te-sl)# commit

/* Configure segment-list on PE3 */

Router# configure
Router(config)# segment-routing
Router(config-sr)# global-block 16000 23999
Router(config-sr)# local-block 15000 15999
Router(config-sr)# traffic-eng
Router(config-sr-te)# segment-list segment-list name PE3-PE1
Router(config-sr-te-sl)# index 1 mpls label 16100
Router(config-sr-te-sl)# exit
!
Router(config-sr-te)# segment-list segment-list name PE3-PE2-PE1
Router(config-sr-te-sl)# index 1 mpls label 16200
Router(config-sr-te-sl)# index 2 mpls label 16100
Router(config-sr-te-sl)# commit

```

## Configure SR-TE Policy

```

/* Configure SR-TE policy */

Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng
Router(config-sr-te)# policy 100
Router(config-sr-te-policy)# color 1 end-point ipv4 2.2.2.2
Router(config-sr-te-policy)# candidate-paths
Router(config-sr-te-policy)# preference 400
Router(config-sr-te-pp-info)# explicit segment-list PE1-PE3-PE2
Router(config-sr-te-pp-info)# exit
!
Router(config-sr-te-policy)# preference 500 <-----largest number takes the
precedence

```

```

Router(config-sr-te-pp-info) # explicit segment-list PE1-PE2
Router(config-sr-te-pp-info) # commit
Router(config-sr-te-pp-info) # exit

Router# configure
Router(config) # segment-routing
Router(config-sr) # traffic-eng
Router(config-sr-te) # policy 1013
Router(config-sr-te-policy) # color 1013 end-point ipv4 2.2.2.2
Router(config-sr-te-policy) # candidate-paths
Router(config-sr-te-policy) # preference 100
Router(config-sr-te-pp-info) # explicit segment-list PE1-PE2_BE121
Router(config-sr-te-pp-info) # exit
!
Router(config-sr-te-policy) # preference 200
Router(config-sr-te-pp-info) # explicit segment-list PE1-PE3-PE2-t0016
Router(config-sr-te-pp-info) # exit
!
Router(config-sr-te-policy) # preference 500
Router(config-sr-te-pp-info) # explicit segment-list PE1-PE2
Router(config-sr-te-pp-info) # exit
!
Router(config-sr-te-policy) # preference 600
Router(config-sr-te-pp-info) # explicit segment-list PE1-PE3-PE2
Router(config-sr-te-pp-info) # exit
!
Router(config-sr-te-policy) # preference 700
Router(config-sr-te-pp-info) # explicit segment-list PE1-PE3-PE2_link
Router(config-sr-te-pp-info) # commit
!
Router# configure
Router(config) # segment-routing
Router(config-sr) # traffic-eng
Router(config-sr-te) # policy 1300
Router(config-sr-te-policy) # color 1300 end-point ipv4 3.3.3.3
Router(config-sr-te-policy) # candidate-paths
Router(config-sr-te-policy) # preference 100
Router(config-sr-te-pp-info) # explicit segment-list PE1-PE3
Router(config-sr-te-pp-info) # commit
!

```

## Configure VPLS over SR-TE Policy

```

Router# configure
Router(config) # l2vpn
Router(config-l2vpn) # pw-class pw100
Router(config-l2vpn-pwc) # encapsulation mpls
Router(config-l2vpn-pwc-mpls) # preferred-path sr-te policy 100
Router(config-l2vpn-pwc-mpls) # exit
!
Router(config-l2vpn) # pw-class pw1013
Router(config-l2vpn-pwc) # encapsulation mpls
Router(config-l2vpn-pwc-mpls) # preferred-path sr-te policy 1013 fallback disable
Router(config-l2vpn-pwc-mpls) # exit

/* The default is Fallback Enable. If the SR-policy is down, then L2VPN VPWS/VPLS will try
   to be UP using the regular IGP path, and not using the SR policy. If Fallback Disable is
   configured, the L2VPN PW will be down when the SR-policy is down. Preferred-path is the
   action of pinning down a PW to a SR TE policy */

```

```

Router(config)#l2vpn
Router(config-l2vpn)#bridge group bg1
Router(config-l2vpn-bg)#bridge-domain vpls501
Router(config-l2vpn-bg-bd)#interface Bundle-Ether41.501
Router(config-l2vpn-bg-bd-ac)#exit
!
Router(config-l2vpn-bg-bd)#interface TenGigE0/0/1/0.501
Router(config-l2vpn-bg-bd-ac)#split-horizon group
Router(config-l2vpn-bg-bd-ac)#exit
!
Router(config-l2vpn-bg-bd)#vfi vpls1
Router(config-l2vpn-bg-bd-vfi)#neighbor 2.2.2.2 pw-id 501
Router(config-l2vpn-bg-bd-vfi-pw)#pw-class pw100
Router(config-l2vpn-bg-bd-vfi-pw)#exit
!
Router(config-l2vpn-bg-bd-vfi)#neighbor 3.3.3.3 pw-id 501
Router(config-l2vpn-bg-bd-vfi-pw)#commit

```

## Configure VPWS over SR-TE Policy

```

Router# configure
Router(config)# l2vpn
Router(config-l2vpn)# pw-class pw1300
Router(config-l2vpn-pwc)# encapsulation mpls
Router(config-l2vpn-pwc-mpls)# load-balancing
Router(config-l2vpn-pwc-mpls-load-bal)# flow-label both
Router(config-l2vpn-pwc-mpls-load-bal)# exit
!
Router(config-l2vpn-pwc-mpls)# preferred-path sr-te policy 1300 fallback disable
Router(config-l2vpn-pwc-mpls)# exit
!
Router(config)# l2vpn
Router(config-l2vpn)# xconnect group xcon1
Router(config-l2vpn-xc)# p2p vplw1002
Router(config-l2vpn-xc-p2p)# interface TenGigE0/0/1/1.1002
Router(config-l2vpn-xc-p2p)# neighbor 3.3.3.3 pw-id 1002
Router(config-l2vpn-xc-p2p-pw)# pw-class pw1300
Router(config-l2vpn-xc-p2p-pw)# commit
Router(config-l2vpn-xc-p2p-pw)# exit

```

## Configure VPWS Pseudowire Headend over SR-TE Policy

```

Router# configure
Router(config)# interface PW-Ether1
Router(config-if)# ipv4 address 10.1.1.1 255.255.255.0
Router(config-if)# attach generic-interface-list 1
Router(config-if)# exit
!
Router(config)# generic-interface-list 1
Router(config-gen-if-list)# interface Bundle-Ether1
Router(config-gen-if-list)# interface TenGigE0/1/0/6/1
Router(config-gen-if-list)# interface TenGigE0/1/0/6/2
Router(config-gen-if-list)# exit
!
Router(config)# l2vpn
Router(config-l2vpn)# pw-class pw1013
Router(config-l2vpn-pwc)# encapsulation mpls
Router(config-l2vpn-pwc-mpls)# transport-mode ethernet

```

```

Router(config-l2vpn-pwc-mps)# preferred-path sr-te policy 1013 fallback disable
Router(config-l2vpn-pwc-mps)# exit
!
Router(config)# l2vpn
Router(config-l2vpn)# xconnect group xg2
Router(config-l2vpn-xc)# p2p pwhe10001
Router(config-l2vpn-xc-p2p)# interface PW-Ether10001
Router(config-l2vpn-xc-p2p-pw)# neighbor ipv4 2.2.2.2 pw-id 10001
Router(config-l2vpn-xc-p2p-pw)# pw-class pw1013
Router(config-l2vpn-xc-p2p-pw)# commit

```

## Running Configuration

```

/* Configure prefix-SID */
PE1:
router isis core
 is-type level-2-only
 net 49.0002.0330.2000.0031.00
 nsr
 nsf ietf
 log adjacency changes
 address-family ipv4 unicast
  metric-style wide level 2
  mpls traffic-eng level-2-only
  mpls traffic-eng router-id 1.1.1.1
 segment-routing mpls sr-prefer
 segment-routing prefix-sid-map advertise-local

interface Loopback0
 address-family ipv4 unicast
  prefix-sid index 16100

PE2:
router isis core
 is-type level-2-only
 net 49.0002.0330.2000.0021.00
 nsr
 nsf ietf
 log adjacency changes
 address-family ipv4 unicast
  metric-style wide level 2
  mpls traffic-eng level-2-only
  mpls traffic-eng router-id Loopback0
 segment-routing mpls sr-prefer
 segment-routing prefix-sid-map advertise-local

interface Loopback0
 address-family ipv4 unicast
  prefix-sid index 16200

PE3:
router isis core
 is-type level-2-only
 net 49.0002.0330.2000.3030.0030.0035.00
 address-family ipv4 unicast
  metric-style wide level 2
  mpls traffic-eng level-2-only
  mpls traffic-eng router-id Loopback0
 segment-routing mpls sr-prefer
 segment-routing prefix-sid-map advertise-local

```



```
interface Loopback0
  address-family ipv4 unicast
  prefix-sid index 16300

/* Configure Adjacency-SID */
PE1:
router isis core
!
interface Bundle-Ether121
  circuit-type level-2-only
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
  adjacency-sid absolute 15100
!
interface TenGigE0/0/1/6
  circuit-type level-2-only
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
  adjacency-sid absolute 15101
!
interface TenGigE0/0/1/9
  circuit-type level-2-only
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
  adjacency-sid absolute 15102

PE2
router isis core
!
interface Bundle-Ether121
  circuit-type level-2-only
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
  adjacency-sid absolute 15200

interface TenGigE0/0/0/0/4
  circuit-type level-2-only
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
  adjacency-sid absolute 15201

interface TenGigE0/0/0/0/7
  circuit-type level-2-only
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
  adjacency-sid absolute 15202

PE3:
router isis core
!
interface TenGigE0/0/0/1
  circuit-type level-2-only
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
  adjacency-sid absolute 15301
!
```

```

interface TenGigE0/0/0/2
  circuit-type level-2-only
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
    adjacency-sid absolute 15302

/* Configure segment-list */
PE1:
segment-routing
global-block 16000 23999
local-block 15000 15999
traffic-eng
segment-list name PE1-PE2
  index 1 mpls label 16200
!
segment-list name PE1-PE3
  index 1 mpls label 16300
!
segment-list name PE1-PE2-PE3
  index 1 mpls label 16200
  index 2 mpls label 16300
!
segment-list name PE1-PE2_bad
  index 1 mpls label 16900
!
segment-list name PE1-PE3-PE2
  index 1 mpls label 16300
  index 2 mpls label 16200
!
segment-list name PE1-PE2_BE121
  index 1 mpls label 15100
!
segment-list name PE1-PE3-PE2_link
  index 1 mpls label 15101
  index 2 mpls label 15302
!

segment-list name PE1-PE3-PE2-t0016
  index 1 mpls label 15101
  index 2 mpls label 16200

PE2:
segment-routing
global-block 16000 23999
local-block 15000 15999
traffic-eng
segment-list name PE2-PE1
  index 1 mpls label 16100
!
segment-list name PE2-PE3-PE1
  index 1 mpls label 16300
  index 2 mpls label 16100

PE3:
segment-routing
global-block 16000 23999
local-block 15000 15999
traffic-eng
segment-list name PE3-PE1
  index 1 mpls label 16100
!
segment-list name PE3-PE2-PE1
  index 1 mpls label 16200

```

```

    index 2 mpls label 16100

/* Configure SR-TE policy */

segment-routing
traffic-eng
policy 100
color 1 end-point ipv4 2.2.2.2
candidate-paths
preference 400
    explicit segment-list PE1-PE3-PE2
    !
preference 500
    explicit segment-list PE1-PE2

policy 1013
color 1013 end-point ipv4 2.2.2.2
candidate-paths
preference 100
    explicit segment-list PE1-PE2_BE121
    !
preference 200
    explicit segment-list PE1-PE3-PE2-t0016
    !
preference 500
    explicit segment-list PE1-PE2
    !
preference 600
    explicit segment-list PE1-PE3-PE2
    !
preference 700
    explicit segment-list PE1-PE3-PE2_link
    !

policy 1300
color 1300 end-point ipv4 3.3.3.3
candidate-paths
preference 100
    explicit segment-list PE1-PE3
    !

/* Configure VPLS over SR-TE policy
l2vpn
pw-class pw100
    encapsulation mpls
    preferred-path sr-te policy 100
pw-class pw1013
    encapsulation mpls
    preferred-path sr-te policy 1013 fallback disable
l2vpn
bridge group bg1
    bridge-domain vpls501
    interface Bundle-Ether41.501
    !
    interface TenGigE0/0/1/0.501
    split-horizon group
    !
    vfi vpls1
    neighbor 2.2.2.2 pw-id 501
    pw-class pw100
    !
    neighbor 3.3.3.3 pw-id 501

/*Configure VPWS over SR-TE policy
l2vpn

```

```

pw-class pw1013
  encapsulation mpls
  load-balancing
  flow-label both
  preferred-path sr-te policy 1013 fallback disable

Xconnect group xcon1
  p2p vplw1002
  interface TenGigE0/0/1/1.1002
  neighbor 3.3.3.3 pw-id 1002
  pw-class pw1013

/* Configure VPWS Pseudowire Headend SR-TE Policy */

interface PW-Ether1
  ipv4 address 10.1.1.1 255.255.255.0
  attach generic-interface-list 1

generic-interface-list 1
  interface Bundle-Ether1
  interface TenGigE0/1/0/6/1
  interface TenGigE0/1/0/6/2

l2vpn
  pw-class pw1300
  encapsulation mpls
  transport-mode ethernet
  preferred-path sr-te policy 1300 [fallback disable]

l2vpn
  xconnect group xg2
  p2p pwhe10001
  interface PW-Ether10001
  neighbor ipv4 2.2.2.2 pw-id 10001
  pw-class pw1300

```

## Verify L2VPN VPLS or VPWS Preferred Path over SR-TE Policy Configuration

```

/* The prefix-sid and Adjacency-sid must be in the SR topology */

PE1#show segment-routing traffic-eng ipv4 topology | inc Prefix
Thu Feb 1 20:28:43.343 EST
Prefix SID:
  Prefix 1.1.1.1, label 16100 (regular)
Prefix SID:
  Prefix 3.3.3.3, label 16300 (regular)
Prefix SID:
  Prefix 2.2.2.2, label 16200 (regular)

PE1#show segment-routing traffic-eng ipv4 topology | inc Adj SID
Thu Feb 1 20:30:25.760 EST
Adj SID: 61025 (unprotected) 15102 (unprotected)
Adj SID: 61023 (unprotected) 15101 (unprotected)
Adj SID: 65051 (unprotected) 15100 (unprotected)
Adj SID: 41516 (unprotected) 15301 (unprotected)
Adj SID: 41519 (unprotected) 15302 (unprotected)
Adj SID: 46660 (unprotected) 15201 (unprotected)
Adj SID: 24003 (unprotected) 15202 (unprotected)
Adj SID: 46675 (unprotected) 15200 (unprotected)

```

```
PE1#show segment-routing traffic-eng policy name 100
```

```
Thu Feb 1 23:16:58.368 EST
```

```
SR-TE policy database
```

```
-----
```

```
Name: 100 (Color: 1, End-point: 2.2.2.2)
```

```
Status:
```

```
Admin: up Operational: up for 05:44:25 (since Feb 1 17:32:34.434)
```

```
Candidate-paths:
```

```
Preference 500:
```

```
Explicit: segment-list PE1-PE2 (active)
```

```
Weight: 0, Metric Type: IGP
```

```
16200 [Prefix-SID, 2.2.2.2]
```

```
Preference 400:
```

```
Explicit: segment-list PE1-PE3-PE2 (inactive)
```

```
Inactive Reason: unresolved first label
```

```
Weight: 0, Metric Type: IGP
```

```
Attributes:
```

```
Binding SID: 27498
```

```
Allocation mode: dynamic
```

```
State: Programmed
```

```
Policy selected: yes
```

```
Forward Class: 0
```

```
PE1#show segment-routing traffic-eng policy name 1013
```

```
Thu Feb 1 21:20:57.439 EST
```

```
SR-TE policy database
```

```
-----
```

```
Name: 1013 (Color: 1013, End-point: 2.2.2.2)
```

```
Status:
```

```
Admin: up Operational: up for 00:06:36 (since Feb 1 21:14:22.057)
```

```
Candidate-paths:
```

```
Preference 700:
```

```
Explicit: segment-list PE1-PE3-PE2_link (active)
```

```
Weight: 0, Metric Type: IGP
```

```
15101 [Adjacency-SID, 13.1.1.1 - 13.1.1.2]
```

```
15302
```

```
Preference 600:
```

```
Explicit: segment-list PE1-PE3-PE2 (inactive)
```

```
Inactive Reason:
```

```
Weight: 0, Metric Type: IGP
```

```
Preference 500:
```

```
Explicit: segment-list PE1-PE2 (inactive)
```

```
Inactive Reason:
```

```
Weight: 0, Metric Type: IGP
```

```
Preference 200:
```

```
Explicit: segment-list PE1-PE3-PE2-t0016 (inactive)
```

```
Inactive Reason: unresolved first label
```

```
Weight: 0, Metric Type: IGP
```

```
Preference 100:
```

```
Explicit: segment-list PE1-PE2_BE121 (inactive)
```

```
Inactive Reason: unresolved first label
```

```
Weight: 0, Metric Type: IGP
```

```
Attributes:
```

```
Binding SID: 27525
```

```
Allocation mode: dynamic
```

```
State: Programmed
```

```
Policy selected: yes
```

```
Forward Class: 0
```

```
PE1#show segment-routing traffic-eng forwarding policy name 100
```

## Verify L2VPN VPLS or VPWS Preferred Path over SR-TE Policy Configuration

```
Thu Feb 1 23:19:28.951 EST
Policy          Segment      Outgoing   Outgoing      Next Hop      Bytes
Name           List         Label      Interface     Interface     Switched
-----
100            PE1-PE2     Pop        Te0/0/1/9    12.1.9.2      0
                Pop        BE121     121.1.0.2    0
```

## PE1#show segment-routing traffic-eng forwarding policy name 1013 detail

```
Thu Feb 1 21:22:46.069 EST
Policy          Segment      Outgoing   Outgoing      Next Hop      Bytes
Name           List         Label      Interface     Interface     Switched
-----
1013          PE1-PE3-PE2_link
                15302      Te0/0/1/6    13.1.1.2      0
                Label Stack (Top -> Bottom): { 15302 }
                Path-id: 1, Weight: 0
                Packets Switched: 0
Local label: 24005
Packets/Bytes Switched: 0/0
(!): FRR pure backup
```

## PE1#show mpls forwarding tunnels sr-policy name 1013

```
Thu Feb 1 21:23:22.743 EST
Tunnel          Outgoing   Outgoing      Next Hop      Bytes
Name           Label      Interface     Interface     Switched
-----
1013          (SR) 15302   Te0/0/1/6    13.1.1.2      0
```

## PE1#show l2vpn bridge-domain bd-name vpls501 detail

```
Sat Feb 3 11:27:35.655 EST
Legend: pp = Partially Programmed.
Bridge group: bg1, bridge-domain: vpls501, id: 250, state: up, ShgId: 0, MSTi: 0
.....
List of VFIs:
  VFI vpls1 (up)
    PW: neighbor 2.2.2.2, PW ID 501, state is up ( established )
    PW class pw100, XC ID 0xa00020d5
    Encapsulation MPLS, protocol LDP
    Source address 1.1.1.1
    PW type Ethernet, control word disabled, interworking none
    Sequencing not set
    Preferred path Active : SR TE 100, Statically configured, fallback disabled
    Tunnel : Up
    PW Status TLV in use
      MPLS          Local          Remote
      -----
      Label         41042         24010
      Group ID     0xfa         0x1
      Interface    vpls1        vpls1
      MTU          1500         1500
      Control word disabled
      PW type      Ethernet     Ethernet
      VCCV CV type 0x2         0x2
                  (LSP ping verification)   (LSP ping verification)
      VCCV CC type 0x6         0x6
                  (router alert label)   (router alert label)
                  (TTL expiry)         (TTL expiry)
      -----
Incoming Status (PW Status TLV):
  Status code: 0x0 (Up) in Notification message
  MIB cpwVcIndex: 2684362965
  Create time: 02/02/2018 16:20:59 (19:06:37 ago)
```

```
PE1# show l2vpn bridge-domain bd-name pwhe1 detail
```

Legend: pp = Partially Programmed.

Bridge group: bg3, bridge-domain: pwhe1, id: 3448, state: up, ShgId: 0, MSTi: 0

.....

List of ACs:

AC: PW-Ether1.1, state is up

List of Access PWs:

List of VFIs:

VFI pwhe1 (up)

PW: neighbor 2.2.2.2, PW ID 600001, state is up ( established )

PW class pw1000, XC ID 0xa0004401

Encapsulation MPLS, protocol LDP

Source address 1.1.1.1

PW type Ethernet, control word disabled, interworking none

Sequencing not set

Preferred path Active : SR TE 1000, Statically configured, fallback disabled

Tunnel : Up

PW Status TLV in use

| MPLS         | Local                                       | Remote                                      |
|--------------|---|---|
| Label        | 43292                                       | 35464                                       |
| Group ID     | 0xd78                                       | 0xd79                                       |
| Interface    | pwhe1                                       | pwhe1                                       |
| MTU          | 1500  | 1500  |
| Control word | disabled                                    | disabled                                    |
| PW type      | Ethernet                                    | Ethernet                                    |
| VCCV CV type | 0x2<br>(LSP ping verification)              | 0x2<br>(LSP ping verification)              |
| VCCV CC type | 0x6<br>(router alert label)<br>(TTL expiry) | 0x6<br>(router alert label)<br>(TTL expiry) |

```
PE1# show l2vpn xconnect group xg2 xc-name pwhe10001 detail
```

Group xg2, XC pwhe10001, state is up; Interworking none

AC: PW-Ether10001, state is up

Type PW-Ether

Interface-list: pwhe2

Replicate status:

Te0/0/1/9: success

BE121: success

Hu0/1/0/3: success

MTU 1500; interworking none

Internal label: 33018

.....

PW: neighbor 2.2.2.2, PW ID 10001, state is up ( established )

PW class pw1013, XC ID 0xa0000007

Encapsulation MPLS, protocol LDP

Source address 1.1.1.1

PW type Ethernet, control word disabled, interworking none

PW backup disable delay 0 sec

Sequencing not set

Preferred path Active : SR TE 1013, Statically configured, fallback disabled

Tunnel : Up

PW Status TLV in use

| MPLS      | Local         | Remote                 |
|-----------|---------------|------------------------|
| Label     | 55510         | 25363                  |
| Group ID  | 0x203f1e0     | 0x880                  |
| Interface | PW-Ether10001 | TenGigE0/0/0/0/6.10001 |

```

MTU          1500
Control word disabled

```

```

1500
disabled

```

## Associated Commands

- adjacency-sid
- index
- prefix-sid
- router isis
- segment-routing

The applicable segment routing commands are described in the *Segment Routing Command Reference for Cisco ASR 9000 Series Routers*

## Related Topics

- [Overview of Segment Routing](#) , on page 47
- [How Segment Routing Works](#) , on page 48
- [Segment Routing Global Block](#) , on page 49

# EVPN VPWS On-Demand Next Hop with SR-TE

The EVPN VPWS On-Demand Next Hop with SR-TE feature enables you to fetch the best path to send traffic from the source to destination in a point-to-point service using IOS XR Traffic Controller (XTC). On-Demand Next Hop (ODN) with SR-TE is supported on EVPN Virtual Private Wire Service (VPWS) and VPWS with pseudowire headend (PWHE).

When redistributing routing information across domains, provisioning of multi-domain services (Layer2 VPN and Layer 3 VPN) poses complexity and scalability issues. ODN with SR-TE feature delegates computation of an end-to-end Label Switched Path (LSP) to a path computation element (PCE). This PCE includes constraints and policies without any redistribution. It then installs the reapplied multi-domain LSP for the duration of the service into the local forwarding information base(FIB).

ODN uses BGP dynamic SR-TE capabilities and adds the path to the PCE. The PCE has the ability to find and download the end-to-end path based on the requirements. ODN triggers an SR-TE auto-tunnel based on the defined BGP policy. The PCE learns real-time topologies through BGP and/or IGP.

### IOS XR Traffic Controller (XTC)

The path computation element (PCE) describes a set of procedures by which a path computation client (PCC) reports and delegates control of head-end tunnels sourced from the PCC to a PCE peer. The PCE peer requests the PCC to update and modify parameters of LSPs it controls. It also enables a PCC to allow the PCE to initiate computations and to perform network-wide orchestration.



### Restrictions

- Maximum number of auto-provisioned TE policies is 1000.
- L2VPN services over PWHE with EVPN VPWS On-Demand Next Hop with SR-TE is not supported.
- PWHE over SR-TE with ECMP paths is not supported.
- SR-ODN is not supported with EVPN VPWS dual-homing.

EVPN validates if the route is for a single home next hop, otherwise it issues an error message about a dangling SR-TE policy, and continue to setup EVPN-VPWS without it. EVPN relies on ESI value being zero to determine if this is a single home or not. If the AC is a Bundle-Ether interface running LACP then you need to manually configure the ESI value to zero to overwrite the auto-sense ESI as EVPN VPWS multihoming is not supported.

To disable EVPN dual homing, configure bundle-Ether AC with ESI value set to zero.

```
evpn
interface Bundle-Ether12
ethernet-segment
identifier type 0 00.00.00.00.00.00.00.00
/* Or globally */
evpn
ethernet-segment type 1 auto-generation-disable
```

## Configure EVPN VPWS On Demand Next Hop with SR-TE

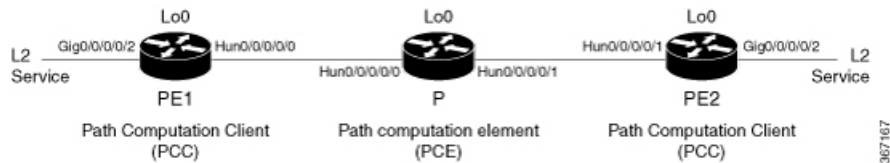
Perform the following steps to configure EVPN VPWS On Demand Next Hop with SR-TE. The following figure is used as a reference to explain the configuration steps:

- Configure Prefix-SID in ISIS
- Configure SR-TE
- Configure PCE and PCC
- Configure SR color
- Configure EVPN route policy
- Configure BGP
- Configure EVPN VPWS
- Configure VPWS with pseudowire headend

### Topology

Consider a topology where EVPN VPWS is configured on PE1 and PE2. Traffic is sent from PE1 to PE2 using SR-TE in the core. The PCE, which is configured on the P router, calculates the best path from PE1 to PE2. Path computation client (PCC) is configured on PE1 and PE2.

Figure 3: EVPN VPWS On Demand Next Hop with SR-TE



## Configuration Example

### Configure Prefix-SID in ISIS

Configure Prefix-SID in ISIS and topology-independent loop-free alternate path (TI-LFA) in the core such that each router uses a unique segment identifier associated with the prefix.

```

/* Configure Prefix-SID in ISIS and TI-LFA on PE1 */

Router# configure
Route(config)# router isis ring
Route(config-isis)# is-type level-2-only
Route(config-isis)# net 49.0001.1921.6800.1001.00
Route(config-isis)# segment-routing global-block 30100 39100
Route(config-isis)# nsr
Route(config-isis)# distribute link-state
Route(config-isis)# nsf cisco
Route(config-isis)# address-family ipv4 unicast
Route(config-isis-af)# metric-style wide
Route(config-isis-af)# mpls traffic-eng level-1
Route(config-isis-af)# mpls traffic-eng router-id loopback0
Route(config-isis-af)# segment-routing mpls
Route(config-isis-af)# exit
!
Route(config-isis)# interface loopback0
Route(config-isis-if)# address-family ipv4 unicast
Route(config-isis-af)# prefix-sid index 30101
Route(config-isis-af)# exit
!
Route(config-isis)# interface HundredGigE0/0/0/0
Route(config-isis-if)# circuit-type level-1
Route(config-isis-if)# point-to-point
Route(config-isis-if)# hello-padding disable
Route(config-isis-if)# fast-reroute per-prefix
Route(config-isis-if-af)# fast-reroute per-prefix ti-lfa
Route(config-isis-if-af)# commit

/*Configure Prefix-SID in ISIS and TI-LFA on P router */

Router# configure
Route(config)# router isis ring
Route(config-isis)# net 49.0001.1921.6800.1002.00
Route(config-isis)# segment-routing global-block 30100 39100
Route(config-isis)# nsr
Route(config-isis)# distribute link-state
Route(config-isis)# nsf cisco
Route(config-isis)# address-family ipv4 unicast
Route(config-isis-af)# metric-style wide
Route(config-isis-af)# mpls traffic-eng level-1
Route(config-isis-af)# mpls traffic-eng router-id loopback0
Route(config-isis-af)# segment-routing mpls

```

```

Route(config-isis-af) # exit
!
Route(config-isis) # interface loopback0
Route(config-isis-if) # address-family ipv4 unicast
Route(config-isis-af) # prefix-sid index 30102
Route(config-isis-af) # exit
!
Route(config-isis) # interface HundredGigE0/0/0/0
Route(config-isis-if) # circuit-type level-1
Route(config-isis-if) # point-to-point
Route(config-isis-if) # hello-padding disable
Route(config-isis-if) # fast-reroute per-prefix
Route(config-isis-if-af) # fast-reroute per-prefix ti-lfa
Route(config-isis-if-af) # exit
!
Route(config-isis) # interface HundredGigE0/0/0/1
Route(config-isis-if) # circuit-type level-1
Route(config-isis-if) # point-to-point
Route(config-isis-if) # hello-padding disable
Route(config-isis-if) # fast-reroute per-prefix
Route(config-isis-if-af) # fast-reroute per-prefix ti-lfa
Route(config-isis-if-af) # commit

/* Configure Prefix-SID in ISIS and TI-LFA on PE2 */

Router# configure
Route(config) # router isis ring
Route(config-isis) # net 49.0001.1921.6800.1003.00
Route(config-isis) # segment-routing global-block 30100 39100
Route(config-isis) # nsr
Route(config-isis) # distribute link-state
Route(config-isis) # nsf cisco
Route(config-isis) # address-family ipv4 unicast
Route(config-isis-af) # metric-style wide
Route(config-isis-af) # mpls traffic-eng level-1
Route(config-isis-af) # mpls traffic-eng router-id loopback0
Route(config-isis-af) # segment-routing mpls
Route(config-isis-af) # exit
!
Route(config-isis) # interface loopback0
Route(config-isis-if) # address-family ipv4 unicast
Route(config-isis-af) # prefix-sid index 30103
Route(config-isis-af) # exit
!
Route(config-isis) # interface HundredGigE0/0/0/1
Route(config-isis-if) # circuit-type level-1
Route(config-isis-if) # point-to-point
Route(config-isis-if) # hello-padding disable
Route(config-isis-if) # fast-reroute per-prefix
Route(config-isis-if-af) # fast-reroute per-prefix ti-lfa
Route(config-isis-if-af) # commit

```

## Configure SR-TE

Configure SR-TE for P and PE routers.

```

/Configure SR-TE on PE1 */

Router# configure
Router(config) # segment-routing
Router(config-sr) # traffic-eng

```

```

Router(config-sr-te)# on-demand color 1
Router(config-sr-te-color)# dynamic
Router(config-sr-te-color-dyn-mpls)# pce
Router(config-sr-te-color-dyn-mpls-pce)# exit
!
Router(config-sr-te)# on-demand color 2
Router(config-sr-te-color)# dynamic
Router(config-sr-te-color-dyn-mpls)# pce
Router(config-sr-te-color-dyn-mpls-pce)# exit
!
Router(config-sr-te)# on-demand color 3
Router(config-sr-te-color)# dynamic
Router(config-sr-te-color-dyn-mpls)# pce
Router(config-sr-te-color-dyn-mpls-pce)# commit

/*Configure SR-TE on P router */
Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng
Router(config-sr-te)# commit

/Configure SR-TE on PE2 */

Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng
Router(config-sr-te)# on-demand color 11
Router(config-sr-te-color)# dynamic
Router(config-sr-te-color-dyn-mpls)# pce
Router(config-sr-te-color-dyn-mpls-pce)# exit
!
Router(config-sr-te)# on-demand color 12
Router(config-sr-te-color)# dynamic
Router(config-sr-te-color-dyn-mpls)# pce
Router(config-sr-te-color-dyn-mpls-pce)# exit
!
Router(config-sr-te)# on-demand color 13
Router(config-sr-te-color)# dynamic
Router(config-sr-te-color-dyn-mpls)# pce
Router(config-sr-te-color-dyn-mpls-pce)# commit

```

## Configure PCE and PCC

Configure PCE on P router, and PCC on PE1 and PE2. Optionally, you can configure multiple PCEs as well.

```

/* Configure PCC on PE1 */

Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng
Router(config-sr-te)# pcc
Router(config-sr-te-pcc)# source-address ipv4 205.1.0.1
Router(config-sr-te-pcc)# pce address ipv4 205.2.0.2
Router(config-sr-te-pcc)# commit

/* Configure PCE on P router */

Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng

```

```

Router(config-sr-te)# exit
Router(config)# pce
Router(config-pce)# address ipv4 205.2.0.2
Router(config-pce)# commit

/* Configure PCC on PE2 */

Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng
Router(config-sr-te)# pcc
Router(config-sr-te-pcc)# source-address ipv4 205.3.0.3
Router(config-sr-te-pcc)# pce address ipv4 205.2.0.2
Router(config-sr-te-pcc)# commit

```

## Configure SR Color

Configure SR colors on PE routers.

```

/* Define SR color on PE1 */

Router# configure
Router(config)# extcommunity-set opaque color1
Router(config-ext)# 1
Router(config-ext)# end-set
!
Router(config)# extcommunity-set opaque color2
Router(config-ext)# 2
Router(config-ext)# end-set
!
Router(config)# extcommunity-set opaque color3
Router(config-ext)# 3
Router(config-ext)# end-set
!
/* Define SR color on PE2 */

Router# configure
Router(config)# extcommunity-set opaque color11
Router(config-ext)# 11
Router(config-ext)# end-set
!
Router(config)# extcommunity-set opaque color12
Router(config-ext)# 12
Router(config-ext)# end-set
!
Router(config)# extcommunity-set opaque color13
Router(config-ext)# 13
Router(config-ext)# end-set
!

```

## Configure EVPN Route Policy

Configure EVPN route policy on PE1 and PE2. This example shows how to define the route policy language and track the EVPN route. The "rd" refers to the address of the PE and acts as Ethernet virtual interconnect for the L2 service.

```

/* Configure EVPN route policy on PE1 */

Router# configure

```

```

Router(config)# route-policy evpn_odn_policy
Router(config-rpl)# if rd in (205.3.0.3:2) then
Router(config-rpl-if)# set extcommunity color color1
Router(config-rpl-if)# set next-hop 205.3.0.3
Router(config-rpl-if)# elseif rd in (205.3.0.3:3) then
Router(config-rpl-elseif)# set extcommunity color color2
Router(config-rpl-elseif)# set next-hop 205.3.0.3
Router(config-rpl-elseif)# elseif rd in (205.3.0.3:4) then
Router(config-rpl-elseif)# set extcommunity color color3
Router(config-rpl-elseif)# set next-hop 205.3.0.3
Router(config-rpl-elseif)# endif
Router(config-rpl)# pass
Router(config-rpl)# end-policy

/* Configure EVPN route policy on PE2 */

Router# configure
Router(config)# route-policy evpn_odn_policy
Router(config-rpl)# if rd in (205.1.0.1:2) then
Router(config-rpl-if)# set extcommunity color color11
Router(config-rpl-if)# set next-hop 205.1.0.1
Router(config-rpl-if)# elseif rd in (205.1.0.1:3) then
Router(config-rpl-elseif)# set extcommunity color color12
Router(config-rpl-elseif)# set next-hop 205.1.0.1
Router(config-rpl-elseif)# elseif rd in (205.1.0.1:4) then
Router(config-rpl-elseif)# set extcommunity color color13
Router(config-rpl-elseif)# set next-hop 205.1.0.1
Router(config-rpl-elseif)# endif
Router(config-rpl)# pass
Router(config-rpl)# end-policy

```

## Configure BGP

Configure BGP on PE1 and PE2.

```

/* Configure BGP on PE1 */

Router# configure
Router(config)# router bgp 100
Router(config-bgp)# bgp router-id 205.1.0.1
Router(config-bgp)# bgp graceful-restart
Router(config-bgp)# address-family l2vpn evpn
Router(config-bgp-af)# exit
!
Router(config-bgp)# neighbor 205.3.0.3
Router(config-bgp-nbr)# remote-as 100
Router(config-bgp-nbr)# update-source loopback 0
Router(config-bgp-nbr)# address-family l2vpn evpn
Router(config-bgp-nbr-af)# route-policy evpn_odn_policy in
Router(config-rpl)# commit

/* Configure BGP on PE2 */

Router# configure
Router(config)# router bgp 100
Router(config-bgp)# bgp router-id 205.3.0.3
Router(config-bgp)# bgp graceful-restart
Router(config-bgp)# address-family l2vpn evpn
Router(config-bgp-af)# exit
!

```

```

Router(config-bgp) # neighbor 205.1.0.1
Router(config-bgp-nbr) # remote-as 100
Router(config-bgp-nbr) # update-source loopback 0
Router(config-bgp-nbr) # address-family l2vpn evpn
Router(config-bgp-nbr-af) # route-policy evpn_odn_policy in
Router(config-rpl) # commit

```

## Configure EVPN VPWS

Configure EVPN VPWS on PE1 and PE2.

```

/* Configure EVPN VPWS on PE1 */

Router# configure
Router(config)# interface GigE0/0/0/2.2 l2transport
Router(config-subif) # encapsulation dot1q 1
Router# exit
!
Router(config)# l2vpn
Router(config-l2vpn) # xconnect group evpn_vpws
Router(config-l2vpn-xc) # p2p e1_10
Router(config-l2vpn-xc-p2p) # interface GigE0/0/0/2.2
Router(config-l2vpn-xc-p2p) # neighbor evpn evi 2 target 10 source 10
Router(config-l2vpn-xc-p2p) #commit

/* Configure EVPN VPWS on PE2 */

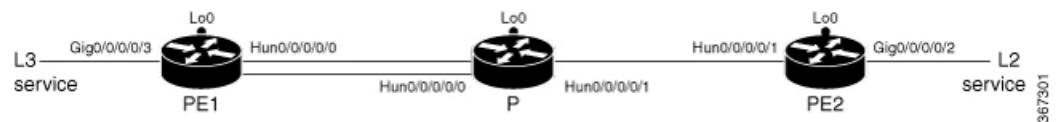
Router# configure
Router(config)# interface GigE0/0/0/2.4 l2transport
Router(config-subif) # encapsulation dot1q 1
Router# exit
!
Router(config)# l2vpn
Router(config-l2vpn) # xconnect group evpn_vpws
Router(config-l2vpn-xc) # p2p e3_30
Router(config-l2vpn-xc-p2p) # interface GigE0/0/0/2.4
Router(config-l2vpn-xc-p2p) # neighbor evpn evi 2 target 10 source 10
Router(config-l2vpn-xc-p2p) #commit

```

## Configure VPWS with Pseudowire Headend

Configure VPWS with pseudowire headend. The L3 services are used on the customer side with PWHE.

**Figure 4: VPWS with Pseudowire Headend**



```

Router# configure
Router(config)# generic-interface-list ifl
Router(config-gen-if-list) # interface HundredGigE0/0/0/0
Router(config-gen-if-list) # exit
!
Router(config)# interface PW-Ether18
Router(config-if) # attach generic-interface-list ifl

```

```

Router(config-gen-if-list)# exit
!
Router# configure
Router(config)# interface PW-Ether18.4
Router(config-if)# ipv4 address 123.123.123.1 255.255.255.0
Router(config-if)# encapsulation dot1q 4
Router(config-if)# exit
!
Router(config)# l2vpn
Router(config-l2vpn)# xconnect group evpn_vpws
Router(config-l2vpn-xc)# p2p e3_30
Router(config-l2vpn-xc-p2p-pw)# interface PW-Ether18
Router(config-l2vpn-xc-p2p-pw)# neighbor evpn evi 4 target 30 source 30
Router(config-l2vpn-xc-p2p-pw)# exit
!
Router# configure
Router(config)# interface GigE0/0/0/2.4 l2transport
Router(config-if)# encapsulation dot1q 4
Router(config-if)# exit
!
Router(config)# l2vpn
Router(config-l2vpn)# xconnect group evpn_vpws
Router(config-l2vpn-xc)# p2p e3_30
Router(config-l2vpn-xc-p2p)# interface GigE0/0/0/2.4
Router(config-l2vpn-xc-p2p-pw)# neighbor evpn evi 4 target 30 source 30
Router(config-l2vpn-xc-p2p-pw)# commit

```

## Running Configuration

```
/* Configure Prefix-SID in ISIS and TI-LFA */
```

**PE1:**

```

configure
router isis ring
net 49.0001.1921.6800.1001.00
segment-routing global-block 30100 39100
nsr
distribute link-state
nsf cisco
address-family ipv4 unicast
metric-style wide
mpls traffic-eng level-1
mpls traffic-eng router-id Loopback0
segment-routing mpls
!
interface Loopback0
address-family ipv4 unicast
prefix-sid index 30101
!
!
interface HundredGigE0/0/0/0
circuit-type level-1
point-to-point
hello-padding disable
address-family ipv4 unicast
fast-reroute per-prefix
fast-reroute per-prefix ti-lfa
!
!

```



**P:**

```

configure
router isis ring
  net 49.0001.1921.6800.1002.00
  segment-routing global-block 30100 39100
  nsr
  distribute link-state
  nsf cisco
  address-family ipv4 unicast
    metric-style wide
  mpls traffic-eng level-1
  mpls traffic-eng router-id Loopback0
  segment-routing mpls
!
interface Loopback0
  address-family ipv4 unicast
    prefix-sid index 30102
  !
!
interface HundredGigE0/0/0/0
  circuit-type level-1
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
    fast-reroute per-prefix
    fast-reroute per-prefix ti-lfa
  !
!
interface HundredGigE0/0/0/1
  circuit-type level-1
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
    fast-reroute per-prefix
    fast-reroute per-prefix ti-lfa
  !

```

**PE2:**

```

configure
router isis ring
  net 49.0001.1921.6800.1003.00
  segment-routing global-block 30100 39100
  nsr
  distribute link-state
  nsf cisco
  address-family ipv4 unicast
    metric-style wide
  mpls traffic-eng level-1
  mpls traffic-eng router-id Loopback0
  segment-routing mpls
!
interface Loopback0
  address-family ipv4 unicast
    prefix-sid index 30103
  !
!
interface HundredGigE0/0/0/1
  circuit-type level-1
  point-to-point
  hello-padding disable
  address-family ipv4 unicast
    fast-reroute per-prefix

```

```

    fast-reroute per-prefix ti-lfa
    !
    !

/* Configure SR-TE */

PE1:

configure
segment-routing
traffic-eng
on-demand color 1
dynamic
pce
!
!
on-demand color 2
dynamic
pce
!
!
on-demand color 3
dynamic
pce
!
P:

configure
segment-routing
traffic-eng
!

PE2:

configure
segment-routing
traffic-eng
on-demand color 11
dynamic
pce
!
!
on-demand color 12
dynamic
pce
!
!
on-demand color 13
dynamic
pce
!

/* Configure PCE and PCC */

PE1:

configure
segment-routing
traffic-eng
pcc
source-address ipv4 205.1.0.1

```

```
        pce address ipv4 205.2.0.2
        !
P:

configure
  segment-routing
  traffic-eng
  pce
  address ipv4 205.2.0.2
  !

PE2:

configure
  segment-routing
  traffic-eng
  pcc
  source-address ipv4 205.3.0.3
  pce address ipv4 205.2.0.2
  !

/* Configure SR Color */

PE1:

configure
  extcommunity-set opaque color1
  1
end-set
!
  extcommunity-set opaque color2
  2
end-set
!
  extcommunity-set opaque color3
  3
end-set
!

PE2:

configure
  extcommunity-set opaque color11
  11
end-set
!
  extcommunity-set opaque color12
  12
end-set
!
  extcommunity-set opaque color13
  13
end-set
!

/* Configure EVPN route policy */

PE1:

configure
  route-policy evpn_odn_policy
  if rd in (205.3.0.3:2) then
    set extcommunity color color1
```

```

        set next-hop 205.3.0.3
    elseif rd in (205.3.0.3:3) then
        set extcommunity color color2
        set next-hop 205.3.0.3
    elseif rd in (205.3.0.3:4) then
        set extcommunity color color3
        set next-hop 205.3.0.3
    endif
pass
end-policy

```

**PE2:**

```

configure
route-policy evpn_odn_policy
if rd in (205.1.0.1:2) then
    set extcommunity color color11
    set next-hop 205.1.0.1
elseif rd in (205.1.0.1:3) then
    set extcommunity color color12
    set next-hop 205.1.0.1
elseif rd in (205.1.0.1:4) then
    set extcommunity color color13
    set next-hop 205.1.0.1
endif
pass
end-policy

```

```
/* Configure BGP */
```

**PE1:**

```

configure
router bgp 100
    bgp router-id 205.1.0.1
    bgp graceful-restart
    address-family l2vpn evpn
    !
neighbor 205.3.0.3
    remote-as 100
    update-source Loopback0
    address-family l2vpn evpn
        route-policy evpn_odn_policy in
    !

```

**PE2:**

```

configure
router bgp 100
    bgp router-id 205.3.0.3
    bgp graceful-restart
    address-family l2vpn evpn
    !
neighbor 205.1.0.1
    remote-as 100
    update-source Loopback0
    address-family l2vpn evpn
        route-policy evpn_odn_policy in
    !

```

```
/* Configure EVPN VPWS */
```

**PE1:**

```

configure
 interface GigE0/0/0/2.2 l2transport
  encapsulation dot1q 1
 !
l2vpn
 xconnect group evpn_vpws
  p2p e1_10
  interface GigE0/0/0/2.2
  neighbor evpn evi 2 target 10 source 10
 !
 !

PE2:

configure
 interface GigE0/0/0/2.4 l2transport
  encapsulation dot1q 1
 !
l2vpn
 xconnect group evpn_vpws
  p2p e3_30
  interface GigE0/0/0/2.4
  neighbor evpn evi 2 target 10 source 10
 !
 !
 !

/* Configure VPWS with Pseudowire Headend */

generic-interface-list if1
 interface HundredGigE0/0/0/0
 !
interface PW-Ether18
 attach generic-interface-list if1
 !
interface PW-Ether18.4
 ipv4 address 123.123.123.1 255.255.255.0
 encapsulation dot1q 4
 !
l2vpn
 xconnect group evpn_vpws
  p2p e3_30
  interface PW-Ether18
  neighbor evpn evi 4 target 30 source 30
 !
interface GigE0/0/0/2.4 l2transport
 encapsulation dot1q 4
 !
l2vpn
 xconnect group evpn_vpws
  p2p e3_30
  interface GigE0/0/0/2.4
  neighbor evpn evi 4 target 30 source 30
 !

```

### Verify EVPN VPWS On Demand Next Hop with SR-TE Configuration

Verify if SR-TE policy is auto-provisioned for each L2 service configured on EVPN ODN.

```

PE1# show segment-routing traffic-eng policy

```

SR-TE policy database

-----

Name: **bgp\_AP\_1 (Color: 1, End-point: 205.3.0.3)**

Status:

**Admin: up Operational: up** for 07:16:59 (since Oct 3 16:47:04.541)

Candidate-paths:

Preference 100:

Dynamic (pce 205.2.0.2) (active)

Weight: 0

30103 [Prefix-SID, 205.3.0.3]

Attributes:

Binding SID: 68007

Allocation mode: dynamic

State: Programmed

Policy selected: yes

Forward Class: 0

Distinguisher: 0

Auto-policy info:

Creator: BGP

IPv6 caps enable: no

PE1#show l2vpn xconnect group evpn\_vpws xc-name evpn\_vpws\_1001 detail

Group evpn\_vpws, XC evpn\_vpws\_1001, state is up; Interworking none

AC: Bundle-Ether12.1001, state is up

Type VLAN; Num Ranges: 1

Outer Tag: 1000

Rewrite Tags: []

VLAN ranges: [1, 1]

MTU 1500; XC ID 0xc0000018; interworking none

Statistics:

packets: received 642304, sent 642244

bytes: received 61661184, sent 61655424

drops: illegal VLAN 0, illegal length 0

EVPN: neighbor 20.20.20.20, PW ID: evi 1001, ac-id 10001, state is up ( established )

XC ID 0xa0000007

Encapsulation MPLS

Source address 10.10.10.10

Encap type Ethernet, control word enabled

Sequencing not set

Preferred path Active : SR TE pref\_sid\_to\_PE3, On-Demand, fallback enabled

Tunnel : Up

Load Balance Hashing: src-dst-mac

PE1#show bgp l2vpn evpn route-type 1

BGP router identifier 205.1.0.1, local AS number 100

BGP generic scan interval 60 secs

Non-stop routing is enabled

BGP table state: Active

Table ID: 0x0 RD version: 0

BGP main routing table version 36

BGP NSR Initial initsync version 25 (Reached)

BGP NSR/ISSU Sync-Group versions 36/0

BGP scan interval 60 secs

Status codes: s suppressed, d damped, h history, \* valid, > best

i - internal, r RIB-failure, S stale, N Nexthop-discard

Origin codes: i - IGP, e - EGP, ? - incomplete

Network Next Hop Metric LocPrf Weight Path

Route Distinguisher: 205.1.0.1:2 (default for vrf VPWS:2)

\*>i[1][0000.0000.0000.0000.0000][1]/120

205.3.0.3 T:bgp\_AP\_1

100 0 i

```
PE1# show evpn evi ead detail

EVI Ethernet Segment Id EtherTag Nexthop Label SRTE IFH
-----
-----
2 0000.0000.0000.0000.0000 1 205.3.0.3 24000 0x5a0
Source: Remote, MPLS
```

### Associated Commands

- adjacency-sid
- index
- prefix-sid
- router isis
- segment-routing

The applicable segment routing commands are described in the *Segment Routing Command Reference for Cisco ASR 9000 Series Routers*

### Related Topics

- [Overview of Segment Routing](#) , on page 47
- [How Segment Routing Works](#) , on page 48
- [Segment Routing Global Block](#) , on page 49

## Overview of Segment Routing

Segment Routing (SR) is a flexible, scalable way of doing source routing. The source chooses a path and encodes it in the packet header as an ordered list of segments. Segments are identifier for any type of instruction. Each segment is identified by the segment ID (SID) consisting of a flat unsigned 32-bit integer. Segment instruction can be:

- Go to node N using the shortest path
- Go to node N over the shortest path to node M and then follow links Layer 1, Layer 2, and Layer 3
- Apply service S

With segment routing, the network no longer needs to maintain a per-application and per-flow state. Instead, it obeys the forwarding instructions provided in the packet.

Segment Routing relies on a small number of extensions to Cisco Intermediate System-to-Intermediate System (IS-IS) and Open Shortest Path First (OSPF) protocols. It can operate with an MPLS (Multiprotocol Label Switching) or an IPv6 data plane, and it integrates with the rich multi service capabilities of MPLS, including Layer 3 VPN (L3VPN), Virtual Private Wire Service (VPWS), Virtual Private LAN Service (VPLS), and Ethernet VPN (EVPN).

Segment routing can be directly applied to the Multiprotocol Label Switching (MPLS) architecture with no change in the forwarding plane. Segment routing utilizes the network bandwidth more effectively than traditional MPLS networks and offers lower latency. A segment is encoded as an MPLS label. An ordered

list of segments is encoded as a stack of labels. The segment to process is on the top of the stack. The related label is popped from the stack, after the completion of a segment.

Segment Routing provides automatic traffic protection without any topological restrictions. The network protects traffic against link and node failures without requiring additional signaling in the network. Existing IP fast re-route (FRR) technology, in combination with the explicit routing capabilities in Segment Routing guarantees full protection coverage with optimum backup paths. Traffic protection does not impose any additional signaling requirements.

## How Segment Routing Works

A router in a Segment Routing network is capable of selecting any path to forward traffic, whether it is explicit or Interior Gateway Protocol (IGP) shortest path. Segments represent subpaths that a router can combine to form a complete route to a network destination. Each segment has an identifier (Segment Identifier) that is distributed throughout the network using new IGP extensions. The extensions are equally applicable to IPv4 and IPv6 control planes. Unlike the case for traditional MPLS networks, routers in a Segment Router network do not require Label Distribution Protocol (LDP) and Resource Reservation Protocol - Traffic Engineering (RSVP-TE) to allocate or signal their segment identifiers and program their forwarding information.

There are two ways to configure segment routing:

- SR-TE policy under "segment-routing traffic-eng" sub-mode
- TE tunnel with SR option under "mpls traffic-eng" sub-mode



### Note

However, you can configure the above mentioned L2VPN and EVPN services using only "segment-routing traffic-eng" sub-mode.

Each router (node) and each link (adjacency) has an associated segment identifier (SID). Node segment identifiers are globally unique and represent the shortest path to a router as determined by the IGP. The network administrator allocates a node ID to each router from a reserved block. On the other hand, an adjacency segment ID is locally significant and represents a specific adjacency, such as egress interface, to a neighboring router. Routers automatically generate adjacency identifiers outside of the reserved block of node IDs. In an MPLS network, a segment identifier is encoded as an MPLS label stack entry. Segment IDs direct the data along a specified path. There are two kinds of segment IDs:

- Prefix SID: A segment ID that contains an IP address prefix calculated by an IGP in the service provider core network. Prefix SIDs are globally unique. A prefix segment represents the shortest path (as computed by IGP) to reach a specific prefix; a node segment is a special prefix segment that is bound to the loopback address of a node. It is advertised as an index into the node specific SR Global Block or SRGB.
- Adjacency SID: A segment ID that contains an advertising router's adjacency to a neighbor. An adjacency SID is a link between two routers. Since the adjacency SID is relative to a specific router, it is locally unique.

A node segment can be a multi-hop path while an adjacency segment is a one-hop path.



## Segment Routing Global Block

Segment Routing Global Block (SRGB) is the range of labels reserved for segment routing. SRGB is local property of an segment routing node. In MPLS, architecture, SRGB is the set of local labels reserved for global segments. In segment routing, each node can be configured with a different SRGB value and hence the absolute SID value associated to an IGP Prefix Segment can change from node to node.

The SRGB default value is 16000 to 23999. The SRGB can be configured as follows:

```
Router(config)# router isis 1
Router(config-isis)#segment-routing global-block 45000 55000
```

