# Configure SR-TE Policies

This module provides information about segment routing for traffic engineering (SR-TE) policies, how to configure SR-TE policies, and how to steer traffic into an SR-TE policy.

## SR-TE Policy Overview

Segment routing for traffic engineering (SR-TE) uses a “policy” to steer traffic through the network. An SR-TE policy path is expressed as a list of segments that specifies the path, called a segment ID (SID) list. Each segment is an end-to-end path from the source to the destination, and instructs the routers in the network to follow the specified path instead of following the shortest path calculated by the IGP. If a packet is steered into an SR-TE policy, the SID list is pushed on the packet by the head-end. The rest of the network executes the instructions embedded in the SID list.

An SR-TE policy is identified as an ordered list (head-end, color, end-point):

- Head-end – Where the SR-TE policy is instantiated
- Color – A numerical value that distinguishes between two or more policies to the same node pairs (Head-end – End point)
- End-point – The destination of the SR-TE policy

Every SR-TE policy has a color value. Every policy between the same node pairs requires a unique color value.

An SR-TE policy uses one or more candidate paths. A candidate path is a single segment list (SID-list) or a set of weighted SID-lists (for weighted equal cost multi-path [WECMP]). A candidate path is either dynamic or explicit. See *SR-TE Policy Path Types* section for more information.

## Usage Guidelines and Limitations

Observe the following guidelines and limitations for the platform.

- Before configuring SR-TE policies, use the **distribute link-state** command under IS-IS or OSPF to distribute the link-state database to external services.
- SR-TE is supported on Cisco CRS-X 400-Gbps line cards (MSC400/FP400/LSP400)
- SR-TE is not supported on Cisco CRS-1 (40-Gbps) and CRS-3 (140-Gbps) line cards
- SR-TE is not supported when mixing line cards of different generations
- GRE tunnel as primary interface for an SR policy is not supported.
- GRE tunnel as backup interface for an SR policy with TI-LFA protection is not supported.
- Head-end computed inter-domain SR policy with Flex Algo constraint and IGP redistribution is not supported.

## Instantiation of an SR Policy

An SR policy is instantiated, or implemented, at the head-end router.

The following sections provide details on the SR policy instantiation methods:

- Manually Provisioned SR Policy, on page 2

### Manually Provisioned SR Policy

Manually provisioned SR policies are configured on the head-end router. These policies can use dynamic paths or explicit paths. See the SR-TE Policy Path Types, on page 2 section for information on manually provisioning an SR policy using dynamic or explicit paths.

## SR-TE Policy Path Types

A **dynamic** path is based on an optimization objective and a set of constraints. The head-end computes a solution, resulting in a SID-list or a set of SID-lists. When the topology changes, a new path is computed. If the head-end does not have enough information about the topology, the head-end might delegate the computation to a Segment Routing Path Computation Element (SR-PCE). For information on configuring SR-PCE, see *Configure Segment Routing Path Computation Element* chapter.

An **explicit** path is a specified SID-list or set of SID-lists.

An SR-TE policy initiates a single (selected) path in RIB/FIB. This is the preferred valid candidate path.

A candidate path has the following characteristics:

- It has a preference – If two policies have same {color, endpoint} but different preferences, the policy with the highest preference is selected.

- It is associated with a single binding SID (BSID) – A BSID conflict occurs when there are different SR policies with the same BSID. In this case, the policy that is installed first gets the BSID and is selected.
- It is valid if it is usable.

A path is selected when the path is valid and its preference is the best among all candidate paths for that policy.

**Note** The protocol of the source is not relevant in the path selection logic.

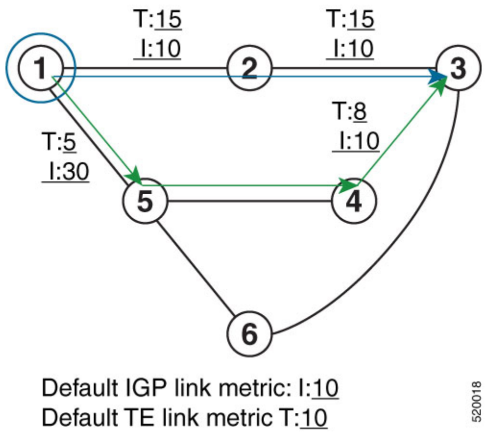
## Dynamic Paths

### Optimization Objectives

Optimization objectives allow the head-end router to compute a SID-list that expresses the shortest dynamic path according to the selected metric type:

- IGP metric — Refer to the "Implementing IS-IS" and "Implementing OSPF" chapters in the *Routing Configuration Guide for Series Routers*.
- TE metric — See the Configure Interface TE Metrics, on page 3 section for information about configuring TE metrics.

This example shows a dynamic path from head-end router 1 to end-point router 3 that minimizes IGP or TE metric:



- The blue path uses the minimum IGP metric: Min-Metric (1 → 3, IGP) = SID-list <16003>; cumulative IGP metric: 20
- The green path uses the minimum TE metric: Min-Metric (1 → 3, TE) = SID-list <16005, 16004, 16003>; cumulative TE metric: 23

#### Configure Interface TE Metrics

Use the **metric** *value* command in SR-TE interface submode to configure the TE metric for interfaces. The *value* range is from 0 to 2147483647.

```
Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng
Router(config-sr-te)# interface type interface-path-id
Router(config-sr-te-if)# metric value
```

### Configuring TE Metric: Example

The following configuration example shows how to set the TE metric for various interfaces:

```
segment-routing
 traffic-eng
  interface TenGigE0/0/0/0
   metric 100
  !
  interface TenGigE0/0/0/1
   metric 1000
  !
  interface TenGigE0/0/2/0
   metric 50
  !
 !
end
```

## Constraints

Constraints allow the head-end router to compute a dynamic path according to the selected metric type:

- Affinity — You can apply a color or name to links or interfaces by assigning affinity bit-maps to them. You can then specify an affinity (or relationship) between an SR policy path and link colors. SR-TE computes a path that includes or excludes links that have specific colors,or combinations of colors. See the Named Interface Link Admin Groups and SR-TE Affinity Maps, on page 4 section for information on named interface link admin groups and SR-TE Affinity Maps.
- Disjoint — SR-TE computes a path that is disjoint from another path in the same disjoint-group. Disjoint paths do not share network resources. Path disjointness may be required for paths between the same pair of nodes, between different pairs of nodes, or a combination (only same head-end or only same end-point).
- Flexible Algorithm — Flexible Algorithm allows for user-defined algorithms where the IGP computes paths based on a user-defined combination of metric type and constraint.

### Named Interface Link Admin Groups and SR-TE Affinity Maps

Named Interface Link Admin Groups and SR-TE Affinity Maps provide a simplified and more flexible means of configuring link attributes and path affinities to compute paths for SR-TE policies.

In the traditional TE scheme, links are configured with attribute-flags that are flooded with TE link-state parameters using Interior Gateway Protocols (IGPs), such as Open Shortest Path First (OSPF).

Named Interface Link Admin Groups and SR-TE Affinity Maps let you assign, or map, up to color names for affinity and attribute-flag attributes instead of 32-bit hexadecimal numbers. After mappings are defined, the attributes can be referred to by the corresponding color name in the CLI. Furthermore, you can define constraints using *include-any*, *include-all*, and *exclude-any* arguments, where each statement can contain up to 10 colors.

**Note** You can configure affinity constraints using attribute flags or the Flexible Name Based Policy Constraints scheme; however, when configurations for both schemes exist, only the configuration pertaining to the new scheme is applied.

### *Configure Named Interface Link Admin Groups and SR-TE Affinity Maps*

Use the **affinity name** *NAME* command in SR-TE interface submode to assign affinity to interfaces. Configure this on routers with interfaces that have an associated admin group attribute.

```
Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng
Router(config-sr-te)# interface TenGigE0/0/1/2
Router(config-sr-if)# affinity
Router(config-sr-if-affinity)# name RED
```

Use the **affinity-map name** *NAME* **bit-position** *bit-position* command in SR-TE sub-mode to define affinity maps. The *bit-position* range is from 0 to 255.

Configure affinity maps on the following routers:

- Routers with interfaces that have an associated admin group attribute.
- Routers that act as SR-TE head-ends for SR policies that include affinity constraints.

```
Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng
Router(config-sr-te)# affinity-map
Router(config-sr-te-affinity-map)# name RED bit-position 23
```

### Configuring Link Admin Group: Example

The following example shows how to assign affinity to interfaces and to define affinity maps. This configuration is applicable to any router (SR-TE head-end or transit node) with colored interfaces.

```
segment-routing
 traffic-eng
  interface TenGigE0/0/1/1
   affinity
    name CROSS
    name RED
   !
  !
  interface TenGigE0/0/1/2
   affinity
    name RED
   !
  !
  interface TenGigE0/0/2/0
   affinity
    name BLUE
   !
  !
  affinity-map
   name RED bit-position 23
   name BLUE bit-position 24
   name CROSS bit-position 25
  !
end
```

## Configure SR Policy with Dynamic Path

To configure a SR-TE policy with a dynamic path, optimization objectives, and affinity constraints, complete the following configurations:

1. Define the optimization objectives. See the Optimization Objectives, on page 3 section.
2. Define the constraints. See the Constraints, on page 4 section.
3. Create the policy.

### Behaviors and Limitations

### Examples

The following example shows a configuration of an SR policy at an SR-TE head-end router. The policy has a dynamic path with optimization objectives and affinity constraints computed by the head-end router.

```
segment-routing
 traffic-eng
  policy foo
   color 100 end-point ipv4 1.1.1.2
   candidate-paths
    preference 100
     dynamic
      metric
       type te
      !
     !
     constraints
      affinity
       exclude-any
        name RED
       !
      !
     !
    !
   !
  !
```

The following example shows a configuration of an SR policy at an SR-TE head-end router. The policy has a dynamic path with optimization objectives and affinity constraints computed by the SR-PCE.

```
segment-routing
 traffic-eng
  policy baa
   color 101 end-point ipv4 1.1.1.2
   candidate-paths
    preference 100
     dynamic
      pcep
      !
      metric
       type te
      !
     !
     constraints
```

```
          affinity
           exclude-any
            name BLUE
           !
          !
         !
        !
       !
      !
```

# Explicit Paths

## Configure SR-TE Policy with Explicit Path

To configure an SR-TE policy with an explicit path, complete the following configurations:

1. Create the segment lists.
2. Create the SR-TE policy.

### Behaviors and Limitations

A segment list can use IP addresses or MPLS labels, or a combination of both.

- The IP address can be link or a Loopback address.
- Once you enter an MPLS label, you cannot enter an IP address.

When configuring an explicit path using IP addresses of links along the path, the SR-TE process selects either the protected or the unprotected Adj-SID of the link, depending on the order in which the Adj-SIDs were received.

### Configure Local SR-TE Policy Using Explicit Paths

Create a segment list with IP addresses:

```
Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng
Router(config-sr-te)# segment-list name SIDLIST1
Router(config-sr-te-sl)# index 10 address ipv4 1.1.1.2
Router(config-sr-te-sl)# index 20 address ipv4 1.1.1.3
Router(config-sr-te-sl)# index 30 address ipv4 1.1.1.4
Router(config-sr-te-sl)# exit
```

Create a segment list with MPLS labels:

```
Router(config-sr-te)# segment-list name SIDLIST2
Router(config-sr-te-sl)# index 10 mpls label 16002
Router(config-sr-te-sl)# index 20 mpls label 16003
Router(config-sr-te-sl)# index 30 mpls label 16004
Router(config-sr-te-sl)# exit
```

Create a segment list with invalid MPLS label:

```
Router(config-sr-te)# segment-list name SIDLIST4
Router(config-sr-te-sl)# index 10 mpls label 16009
Router(config-sr-te-sl)# index 20 mpls label 16003
Router(config-sr-te-sl)# index 30 mpls label 16004
Router(config-sr-te-sl)# exit
```

Create a segment list with IP addresses and MPLS labels:

```
Router(config-sr-te)# segment-list name SIDLIST3
Router(config-sr-te-sl)# index 10 address ipv4 1.1.1.2
Router(config-sr-te-sl)# index 20 mpls label 16003
Router(config-sr-te-sl)# index 30 mpls label 16004
Router(config-sr-te-sl)# exit
```

Create the SR-TE policy:

```
Router(config-sr-te)# policy POLICY2
Router(config-sr-te-policy)# color 20 end-point ipv4 1.1.1.4
Router(config-sr-te-policy)# candidate-paths
Router(config-sr-te-policy-path)# preference 100
Router(config-sr-te-policy-path-pref)# explicit segment-list SIDLIST2
Router(config-sr-te-pp-info)# exit
Router(config-sr-te-policy-path-pref)# exit
Router(config-sr-te-policy-path)# preference 200
Router(config-sr-te-policy-path-pref)# explicit segment-list SIDLIST1
Router(config-sr-te-pp-info)# exit
Router(config-sr-te-policy-path-pref)# explicit segment-list SIDLIST4
Router(config-sr-te-pp-info)# exit
Router(config-sr-te-policy-path-pref)# exit
```

### Running Configuration

```
Router# show running-configuration
segment-routing
 traffic-eng
  segment-list SIDLIST1
   index 10 address ipv4 1.1.1.2
   index 20 address ipv4 1.1.1.3
   index 30 address ipv4 1.1.1.4
  !
  segment-list SIDLIST2
   index 10 mpls label 16002
   index 20 mpls label 16003
   index 30 mpls label 16004
  !
  segment-list SIDLIST3
   index 10 address ipv4 1.1.1.2
   index 20 mpls label 16003
   index 30 mpls label 16004
  !
  segment-list SIDLIST4
   index 10 mpls label 16009
   index 20 mpls label 16003
   index 30 mpls label 16004
  !
  policy POLICY1
   color 10 end-point ipv4 1.1.1.4
   candidate-paths
    preference 100
     explicit segment-list SIDLIST1
     !
    !
   !
  !
  policy POLICY2
   color 20 end-point ipv4 1.1.1.4
```

```
    candidate-paths
     preference 100
      explicit segment-list SIDLIST1
      !
     !
     preference 200
      explicit segment-list SIDLIST2
      !
      explicit segment-list SIDLIST4
      !
     !
    !
   !
   policy POLICY3
    color 30 end-point ipv4 1.1.1.4
    candidate-paths
     preference 100
      explicit segment-list SIDLIST3
      !
     !
    !
   !
 !
 !
```

### Verification

Verify the SR-TE policy configuration using:

```
Router# show segment-routing traffic-eng policy name srte_c_20_ep_1.1.1.4

SR-TE policy database
---------------------

Color: 20, End-point: 1.1.1.4
  Name: srte_c_20_ep_1.1.1.4
  Status:
    Admin: up  Operational: up for 00:00:15 (since Jul 14 00:53:10.615)
  Candidate-paths:
    Preference: 200 (configuration) (active)
      Name: POLICY2
      Requested BSID: dynamic
        Protection Type: protected-preferred
        Maximum SID Depth: 8
      Explicit: segment-list SIDLIST2 (active)
        Weight: 1, Metric Type: TE
          16002
          16003
          16004
    Attributes:
    Binding SID: 51301
   Forward Class: Not Configured
    Steering labeled-services disabled: no
    Steering BGP disabled: no
    IPv6 caps enable: yes
    Invalidation drop enabled: no
```

## Configuring Explicit Path with Affinity Constraint Validation

To fully configure SR-TE flexible name-based policy constraints, you must complete these high-level tasks in order:

1. Assign Color Names to Numeric Values
2. Associate Affinity-Names with SR-TE Links
3. Associate Affinity Constraints for SR-TE Policies

```
/* Enter the global configuration mode and assign color names to numeric values
Router# configure
Router(config)# segment-routing
Router(config-sr)# traffic-eng
Router(config-sr-te)# affinity-map
Router(config-sr-te-affinity-map)# blue bit-position 0
Router(config-sr-te-affinity-map)# green bit-position 1
Router(config-sr-te-affinity-map)# red bit-position 2
Router(config-sr-te-affinity-map)# exit



/* Associate affinity-names with SR-TE links
Router(config-sr-te)# interface Gi0/0/0/0
Router(config-sr-te-if)# affinity
Router(config-sr-te-if-affinity)# blue
Router(config-sr-te-if-affinity)# exit
Router(config-sr-te-if)# exit
Router(config-sr-te)# interface Gi0/0/0/1
Router(config-sr-te-if)# affinity
Router(config-sr-te-if-affinity)# blue
Router(config-sr-te-if-affinity)# green
Router(config-sr-te-if-affinity)# exit
Router(config-sr-te-if)# exit
Router(config-sr-te)#



/* Associate affinity constraints for SR-TE policies
Router(config-sr-te)# segment-list name SIDLIST1
Router(config-sr-te-sl)# index 10 address ipv4 1.1.1.2
Router(config-sr-te-sl)# index 20 address ipv4 2.2.2.23
Router(config-sr-te-sl)# index 30 address ipv4 1.1.1.4
Router(config-sr-te-sl)# exit
Router(config-sr-te)# segment-list name SIDLIST2
Router(config-sr-te-sl)# index 10 address ipv4 1.1.1.2
Router(config-sr-te-sl)# index 30 address ipv4 1.1.1.4
Router(config-sr-te-sl)# exit
Router(config-sr-te)# segment-list name SIDLIST3
Router(config-sr-te-sl)# index 10 address ipv4 1.1.1.5
Router(config-sr-te-sl)# index 30 address ipv4 1.1.1.4
Router(config-sr-te-sl)# exit

Router(config-sr-te)# policy POLICY1
Router(config-sr-te-policy)# color 20 end-point ipv4 1.1.1.4
Router(config-sr-te-policy)# binding-sid mpls 1000
Router(config-sr-te-policy)# candidate-paths
Router(config-sr-te-policy-path)# preference 200
Router(config-sr-te-policy-path-pref)# constraints affinity exclude-any red
Router(config-sr-te-policy-path-pref)# explicit segment-list SIDLIST1
Router(config-sr-te-pp-info)# exit
Router(config-sr-te-policy-path-pref)# explicit segment-list SIDLIST2
Router(config-sr-te-pp-info)# exit
Router(config-sr-te-policy-path-pref)# exit
Router(config-sr-te-policy-path)# preference 100
Router(config-sr-te-policy-path-pref)# explicit segment-list SIDLIST3
```

### Running Configuration

```
Router# show running-configuration
segment-routing
 traffic-eng

  interface GigabitEthernet0/0/0/0
   affinity
    blue
   !
  !
  interface GigabitEthernet0/0/0/1
   affinity
    blue
    green
   !
  !


  segment-list name SIDLIST1
   index 10 address ipv4 1.1.1.2
   index 20 address ipv4 2.2.2.23
   index 30 address ipv4 1.1.1.4
  !
  segment-list name SIDLIST2
   index 10 address ipv4 1.1.1.2
   index 30 address ipv4 1.1.1.4
  !
  segment-list name SIDLIST3
   index 10 address ipv4 1.1.1.5
   index 30 address ipv4 1.1.1.4
  !
  policy POLICY1
   binding-sid mpls 1000
   color 20 end-point ipv4 1.1.1.4
   candidate-paths
    preference 100
     explicit segment-list SIDLIST3
     !
    !
    preference 200
     explicit segment-list SIDLIST1
     !
     explicit segment-list SIDLIST2
     !
     constraints
      affinity
       exclude-any
        red
       !
      !
     !
    !
   !
  !
  affinity-map
   blue bit-position 0
   green bit-position 1
   red bit-position 2
  !
 !
```

```
!
```

# Protocols

## Path Computation Element Protocol

The path computation element protocol (PCEP) describes a set of procedures by which a path computation client (PCC) can report and delegate control of head-end label switched paths (LSPs) sourced from the PCC to a PCE peer. The PCE can request the PCC to update and modify parameters of LSPs it controls. The stateful model also enables a PCC to allow the PCE to initiate computations allowing the PCE to perform network-wide orchestration.

## BGP SR-TE

BGP may be used to distribute SR Policy candidate paths to an SR-TE head-end. Dedicated BGP SAFI and NLRI have been defined to advertise a candidate path of an SR Policy. The advertisement of Segment Routing policies in BGP is documented in the IETF drafthttps://datatracker.ietf.org/doc/draft-ietf-idr-segment-routing-te-policy/

SR policies with IPv4 and IPv6 end-points can be advertised over BGPv4 or BGPv6 sessions between the SR-TE controller and the SR-TE headend.

The Cisco IOS-XR implementation supports the following combinations:

- IPv4 SR policy advertised over BGPv4 session
- IPv6 SR policy advertised over BGPv4 session
- IPv6 SR policy advertised over BGPv6 session

### Configure BGP SR Policy Address Family at SR-TE Head-End

Perform this task to configure BGP SR policy address family at SR-TE head-end:

#### SUMMARY STEPS

1. **configure**
2. **router bgp** *as-number*
3. **bgp router-id** *ip-address*
4. **address-family** {**ipv4** | **ipv6**} **sr-policy**
5. **exit**
6. **neighbor** *ip-address*
7. **remote-as** *as-number*
8. **address-family** {**ipv4** | **ipv6**} **sr-policy**
9. **route-policy** *route-policy-name* {**in** | **out**}

## DETAILED STEPS

| | Command or Action | Purpose |
|---|---|---|
| **Step 1** | **configure** | |
| **Step 2** | **router bgp** *as-number*<br>**Example:**<br>`RP/0/RSP0/CPU0:router(config)# router bgp 65000` | Specifies the BGP AS number and enters the BGP configuration mode, allowing you to configure the BGP routing process. |
| **Step 3** | **bgp router-id** *ip-address*<br>**Example:**<br>`RP/0/RSP0/CPU0:router(config-bgp)# bgp router-id 1.1.1.1` | Configures the local router with a specified router ID. |
| **Step 4** | **address-family** {**ipv4** \| **ipv6**} **sr-policy**<br>**Example:**<br>`RP/0/RSP0/CPU0:router(config-bgp)# address-family ipv4 sr-policy` | Specifies either the IPv4 or IPv6 address family and enters address family configuration submode. |
| **Step 5** | **exit** | |
| **Step 6** | **neighbor** *ip-address*<br>**Example:**<br>`RP/0/RSP0/CPU0:router(config-bgp)# neighbor 10.10.0.1` | Places the router in neighbor configuration mode for BGP routing and configures the neighbor IP address as a BGP peer. |
| **Step 7** | **remote-as** *as-number*<br>**Example:**<br>`RP/0/RSP0/CPU0:router(config-bgp-nbr)# remote-as 1` | Creates a neighbor and assigns a remote autonomous system number to it. |
| **Step 8** | **address-family** {**ipv4** \| **ipv6**} **sr-policy**<br>**Example:**<br>`RP/0/RSP0/CPU0:router(config-bgp-nbr)# address-family ipv4 sr-policy` | Specifies either the IPv4 or IPv6 address family and enters address family configuration submode. |
| **Step 9** | **route-policy** *route-policy-name* {**in** \| **out**}<br>**Example:**<br>`RP/0/RSP0/CPU0:router(config-bgp-nbr-af)#` | Applies the specified policy to IPv4 or IPv6 unicast routes. |

| | Command or Action | Purpose |
|---|---|---|
| | `route-policy pass out` | |

### Example: BGP SR-TE with BGPv4 Neighbor to BGP SR-TE Controller

The following configuration shows the an SR-TE head-end with a BGPv4 session towards a BGP SR-TE controller. This BGP session is used to signal both IPv4 and IPv6 SR policies.

```
router bgp 65000
bgp router-id 1.1.1.1
 !
 address-family ipv4 sr-policy
 !
 address-family ipv6 sr-policy
 !
 neighbor 10.1.3.1
  remote-as 10
  description *** eBGP session to BGP SRTE controller ***
  address-family ipv4 sr-policy
   route-policy pass in
   route-policy pass out
  !
  address-family ipv6 sr-policy
   route-policy pass in
   route-policy pass out
  !
 !
!
```

### Example: BGP SR-TE with BGPv6 Neighbor to BGP SR-TE Controller

The following configuration shows an SR-TE head-end with a BGPv6 session towards a BGP SR-TE controller. This BGP session is used to signal IPv6 SR policies.

```
router bgp 65000
bgp router-id 1.1.1.1
 address-family ipv6 sr-policy
 !
 neighbor 3001::10:1:3:1
  remote-as 10
  description *** eBGP session to BGP SRTE controller ***
  address-family ipv6 sr-policy
   route-policy pass in
   route-policy pass out
  !
 !
!
```

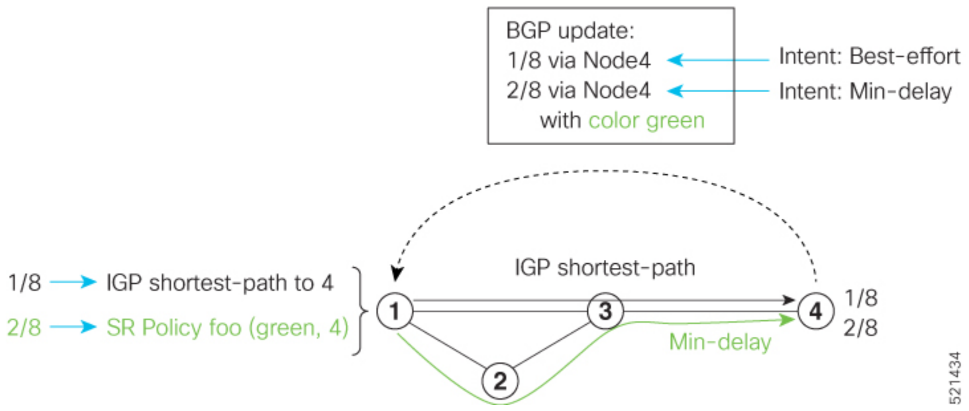
# Traffic Steering

## Automated Steering

Automated steering (AS) allows service traffic to be automatically steered onto the required transport SLA path programmed by an SR policy.

With AS, BGP automatically steers traffic onto an SR Policy based on the next-hop and color of a BGP service route. The color of a BGP service route is specified by a color extended community attribute. This color is used as a transport SLA indicator, such as min-delay or min-cost.

When the next-hop and color of a BGP service route matches the end-point and color of an SR Policy, BGP automatically installs the route resolving onto the BSID of the matching SR Policy. Recall that an SR Policy on a head-end is uniquely identified by an end-point and color.



When a BGP route has multiple extended-color communities, each with a valid SR Policy, the BGP process installs the route on the SR Policy giving preference to the color with the highest numerical value.

The granularity of AS behaviors can be applied at multiple levels, for example:

- At a service level—When traffic destined to all prefixes in a given service is associated to the same transport path type. All prefixes share the same color.
- At a destination/prefix level—When traffic destined to a prefix in a given service is associated to a specific transport path type. Each prefix could be assigned a different color.
- At a flow level—When flows destined to the same prefix are associated with different transport path types

AS behaviors apply regardless of the instantiation method of the SR policy, including:

- On-demand SR policy
- Manually provisioned SR policy
- PCE-initiated SR policy

## Using Binding Segments

The binding segment is a local segment identifying an SR-TE policy. Each SR-TE policy is associated with a binding segment ID (BSID). The BSID is a local label that is automatically allocated for each SR-TE policy when the SR-TE policy is instantiated.

BSID can be used to steer traffic into the SR-TE policy and across domain borders, creating seamless end-to-end inter-domain SR-TE policies. Each domain controls its local SR-TE policies; local SR-TE policies can be validated and rerouted if needed, independent from the remote domain's head-end. Using binding segments isolates the head-end from topology changes in the remote domain.

Packets received with a BSID as top label are steered into the SR-TE policy associated with the BSID. When the BSID label is popped, the SR-TE policy's SID list is pushed.

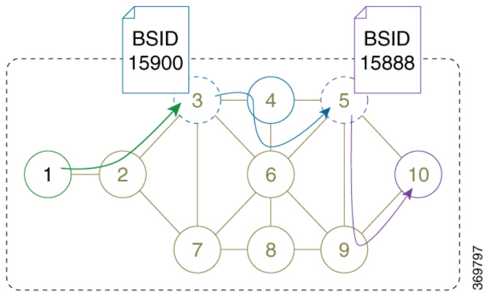
BSID can be used in the following cases:

- Multi-Domain (inter-domain, inter-autonomous system)—BSIDs can be used to steer traffic across domain borders, creating seamless end-to-end inter-domain SR-TE policies.
- Large-Scale within a single domain—The head-end can use hierarchical SR-TE policies by nesting the end-to-end (edge-to-edge) SR-TE policy within another layer of SR-TE policies (aggregation-to-aggregation). The SR-TE policies are nested within another layer of policies using the BSIDs, resulting in seamless end-to-end SR-TE policies.
- Label stack compression—If the label-stack size required for an SR-TE policy exceeds the platform capability, the SR-TE policy can be seamlessly stitched to, or nested within, other SR-TE policies using a binding segment.
- BGP SR-TE Dynamic—The head-end steers the packet into a BGP-based FIB entry whose next hop is a binding-SID.

## Stitching SR-TE Polices Using Binding SID: Example

In this example, three SR-TE policies are stitched together to form a seamless end-to-end path from node 1 to node 10. The path is a chain of SR-TE policies stitched together using the binding-SIDs of intermediate policies, providing a seamless end-to-end path.

***Figure 1: Stitching SR-TE Polices Using Binding SID***



**Step 1** On node 5, do the following:

a) Define an SR-TE policy with an explicit path configured using the loopback interface IP addresses of node 9 and node 10.

b) Define an explicit binding-SID (**mpls label 15888**) allocated from SRLB for the SR-TE policy.

**Example:**

**Node 5**

```
segment-routing
 traffic-eng
  segment-list PATH-9_10
   index 10 address ipv4 1.1.1.9
   index 20 address ipv4 1.1.1.10
  !
  policy foo
   binding-sid mpls 15888
   color 777 end-point ipv4 1.1.1.10
```

```
     candidate-paths
      preference 100
       explicit segment-list PATH5-9_10
        !
       !
      !
     !
    !
   !

RP/0/RSP0/CPU0:Node-5# show segment-routing traffic-eng policy color 777

SR-TE policy database
---------------------

Color: 777, End-point: 1.1.1.10
  Name: srte_c_777_ep_1.1.1.10
  Status:
    Admin: up  Operational: up for 00:00:52 (since Aug 19 07:40:12.662)
  Candidate-paths:
    Preference: 100 (configuration) (active)
      Name: foo
      Requested BSID: 15888
      PCC info:
        Symbolic name: cfg_foo_discr_100
        PLSP-ID: 70
      Explicit: segment-list PATH-9_10 (valid)
        Weight: 1, Metric Type: TE
          16009 [Prefix-SID, 1.1.1.9]
          16010 [Prefix-SID, 1.1.1.10]
  Attributes:
    Binding SID: 15888 (SRLB)
    Forward Class: 0
    Steering BGP disabled: no
    IPv6 caps enable: yes
```

**Step 2** On node 3, do the following:

a) Define an SR-TE policy with an explicit path configured using the following:

- Loopback interface IP address of node 4
- Interface IP address of link between node 4 and node 6
- Loopback interface IP address of node 5
- Binding-SID of the SR-TE policy defined in Step 1 (**mpls label 15888**)

  **Note** This last segment allows the stitching of these policies.

b) Define an explicit binding-SID (**mpls label 15900**) allocated from SRLB for the SR-TE policy.

**Example:**

**Node 3**

```
segment-routing
 traffic-eng
  segment-list PATH-4_4-6_5_BSID
   index 10 address ipv4 1.1.1.4
   index 20 address ipv4 10.4.6.6
   index 30 address ipv4 1.1.1.5
   index 40 mpls label 15888
  !
  policy baa
   binding-sid mpls 15900
   color 777 end-point ipv4 1.1.1.5
   candidate-paths
    preference 100
     explicit segment-list PATH-4_4-6_5_BSID
     !
    !
   !
  !
 !
!

RP/0/RSP0/CPU0:Node-3# show segment-routing traffic-eng policy color 777

SR-TE policy database
---------------------

Color: 777, End-point: 1.1.1.5
  Name: srte_c_777_ep_1.1.1.5
  Status:
    Admin: up  Operational: up for 00:00:32 (since Aug 19 07:40:32.662)
  Candidate-paths:
    Preference: 100 (configuration) (active)
      Name: baa
      Requested BSID: 15900
      PCC info:
        Symbolic name: cfg_baa_discr_100
        PLSP-ID: 70
      Explicit: segment-list PATH-4_4-6_5_BSID (valid)
        Weight: 1, Metric Type: TE
          16004 [Prefix-SID, 1.1.1.4]
          80005 [Adjacency-SID, 10.4.6.4 - 10.4.6.6]
          16005 [Prefix-SID, 1.1.1.5]
          15888
  Attributes:
    Binding SID: 15900 (SRLB)
    Forward Class: 0
    Steering BGP disabled: no
    IPv6 caps enable: yes
```

**Step 3** On node 1, define an SR-TE policy with an explicit path configured using the loopback interface IP address of node 3 and the binding-SID of the SR-TE policy defined in step 2 (**mpls label 15900**). This last segment allows the stitching of these policies.

**Example:**

**Node 1**

```
segment-routing
 traffic-eng
  segment-list PATH-3_BSID
   index 10 address ipv4 1.1.1.3
   index 20 mpls label 15900
  !
  policy bar
   color 777 end-point ipv4 1.1.1.3
   candidate-paths
    preference 100
     explicit segment-list PATH-3_BSID
     !
    !
   !
```

```
    !
  !
!

RP/0/RSP0/CPU0:Node-1# show segment-routing traffic-eng policy color 777

SR-TE policy database
---------------------

Color: 777, End-point: 1.1.1.3
  Name: srte_c_777_ep_1.1.1.3
  Status:
    Admin: up  Operational: up for 00:00:12 (since Aug 19 07:40:52.662)
  Candidate-paths:
    Preference: 100 (configuration) (active)
      Name: bar
      Requested BSID: dynamic
      PCC info:
        Symbolic name: cfg_bar_discr_100
        PLSP-ID: 70
      Explicit: segment-list PATH-3_BSID (valid)
        Weight: 1, Metric Type: TE
          16003 [Prefix-SID, 1.1.1.3]
          15900
  Attributes:
    Binding SID: 80021
    Forward Class: 0
    Steering BGP disabled: no
    IPv6 caps enable: yes
```

## L2VPN Preferred Path

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.

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.

Refer to the EVPN VPWS Preferred Path over SR-TE Policy and L2VPN VPLS or VPWS Preferred Path over SR-TE Policy sections in the "L2VPN Services over Segment Routing for Traffic Engineering Policy" chapter of the *L2VPN and Ethernet Services Configuration Guide*.