



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.

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About SR-TE Policies

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 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.

There are two types of SR-TE policies: dynamic and explicit.

Local Dynamic SR-TE Policy

When you configure local dynamic SR-TE, the head-end locally calculates the path to the destination address. Dynamic path calculation results in a list of interface IP addresses that traffic engineering (TE) maps to adj-SID labels. Routes are learned by way of forwarding adjacencies over the TE tunnel.

Explicit SR-TE Policy

An explicit path is a list of IP addresses or labels, each representing a node or link in the explicit path. This feature is enabled through the **explicit-path** command that allows you to create an explicit path and enter a configuration submode for specifying the path.

How to Configure SR-TE Policies

This section contains the following procedures:

- [Configure Local Dynamic SR-TE Policy, on page 2](#)

- [Configure Explicit SR-TE Policy, on page 3](#)

Configure Local Dynamic SR-TE Policy

This task explains how to configure a local dynamic SR-TE policy.

SUMMARY STEPS

1. **configure**
2. **interface tunnel-te** *tunnel-id*
3. **ipv4 unnumbered** *type interface-path-id*
4. **ipv6 enable**
5. **destination** *ip-address*
6. **path-option** *preference-priority* **dynamic segment-routing**
7. **path-protection**
8. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	interface tunnel-te <i>tunnel-id</i> Example: RP/0/RP0/CPU0:router(config)# interface tunnel-te22	Configures the tunnel interface.
Step 3	ipv4 unnumbered <i>type interface-path-id</i> Example: RP/0/RP0/CPU0:router(config-if)# ipv4 unnumbered loopback0	Assigns a source address so that forwarding can be performed on the new tunnel. Loopback is commonly used as the interface type.
Step 4	ipv6 enable Example: RP/0/RP0/CPU0:router(config-if)# ipv6 enable	Enables IPv6 over the IPv4 tunnel. Note IPv6 over IPv4 tunnel is supported with CRS-FP-X next generation line cards.
Step 5	destination <i>ip-address</i> Example:	Assigns a destination address on the new tunnel.

	Command or Action	Purpose
	RP/0/RP0/CPU0:router(config-if)# destination 192.168.0.2	
Step 6	path-option preference-priority dynamic segment-routing Example: RP/0/RP0/CPU0:router(config-if)# path-option 1 dynamic segment-routing	Sets the path option to dynamic and assigns the path ID.
Step 7	path-protection Example: RP/0/RP0/CPU0:router(config-if)# path-protection	Enables path protection on the tunnel-te interface.
Step 8	commit	

This completes the configuration of the dynamic SR-TE policy.

Configure Explicit SR-TE Policy

This task explains how to configure an explicit SR-TE policy.

SUMMARY STEPS

1. **configure**
2. **explicit-path name path-name**
3. **index index {next-address ip-address | next-label label}**
4. **exit**
5. **interface tunnel-te tunnel-id**
6. **ipv4 unnumbered type interface-path-id**
7. **ipv6 enable**
8. **destination ip-address [verbatim]**
9. **path-option preference-priority explicit name path-name segment-routing**
10. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.

	Command or Action	Purpose
Step 2	explicit-path name <i>path-name</i> Example: <pre>RP/0/RP0/CPU0:router(config)# explicit-path name r1r6_exp</pre>	Enters a name for the explicit path and enters the explicit path configuration mode.
Step 3	index <i>index</i> { next-address <i>ip-address</i> next-label <i>label</i> } Example: <pre>RP/0/RP0/CPU0:router(config-expl-path)# index 1 next-label 16001 RP/0/RP0/CPU0:router(config-expl-path)# index 2 next-label 16006</pre>	Specifies a label or an address in an explicit path of a tunnel. Note <ul style="list-style-type: none"> You can include multiple addresses, labels, or both. However, you cannot configure addresses after you have configured labels. Once you start configuring labels, you need to continue with labels. Each entry must have a unique index. If the first hop is specified as next-label, that label must be an Adj-SID of the head-end or a prefix-SID label value known by the head-end.
Step 4	exit	
Step 5	interface tunnel-te <i>tunnel-id</i> Example: <pre>RP/0/RP0/CPU0:router(config)# interface tunnel-te22</pre>	Configures the tunnel interface.
Step 6	ipv4 unnumbered <i>type interface-path-id</i> Example: <pre>RP/0/RP0/CPU0:router(config-if)# ipv4 unnumbered loopback0</pre>	Assigns a source address so that forwarding can be performed on the new tunnel. Loopback is commonly used as the interface type.
Step 7	ipv6 enable Example: <pre>RP/0/RP0/CPU0:router(config-if)# ipv6 enable</pre>	Enables IPv6 over the IPv4 tunnel. Note IPv6 over IPv4 tunnel is supported with CRS-FP-X next generation line cards.
Step 8	destination <i>ip-address</i> [verbatim] Example: <pre>RP/0/RP0/CPU0:router(config-if)# destination 192.168.0.2</pre>	Assigns a destination address on the new tunnel. Typically, the tunnel destination must have a match in the routing information base (RIB). For inter-area or inter-domain policies to destinations that are otherwise not

	Command or Action	Purpose
		reachable, use the verbatim option to disable the RIB verification on a tunnel destination.
Step 9	<p>path-option <i>preference-priority</i> explicit name <i>path-name</i> segment-routing</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# path-option 1 explicit name rlr6_exp segment-routing</pre>	Specifies the explicit path name and assigns the path ID.
Step 10	commit	

This completes the configuration of the explicit SR-TE policy.

Steering Traffic into an SR-TE Policy

This section describes the following traffic steering methods:

Static Routes

Static routes can use the segment routing tunnel as a next-hop interface. Both IPv4 and IPv6 prefixes can be routed through the tunnel.

A static route to a destination with a prefix-SID removes the IGP-installed SR-forwarding entry of that prefix.

Autoroute Announce

The SR-TE policy can be advertised into an IGP as a next hop by configuring the autoroute announce statement on the source router. The IGP then installs routes in the Routing Information Base (RIB) for shortest paths that involve the tunnel destination. Autoroute announcement of IPv4 prefixes can be carried through either OSPF or IS-IS. Autoroute announcement of IPv6 prefixes can be carried only through IS-IS.

Autoroute Destination

Autoroute destination allows you to automatically route traffic through a segment routing tunnel instead of manually configuring static routes. Multiple autoroute destination addresses can be added in the routing information base (RIB) per tunnel.

Static routes are always added with zero cost metric, which can result in traffic that is mapped on multiple tunnels to always load-balance due to ECMP. This load-balancing may be undesirable when some of those tunnels have sub-optimal paths. With autoroute destination, only the tunnel whose IGP cost to its endpoint is lowest will be considered for carrying traffic.

- **Interaction Between Static Routes and Autoroute Destination**

If there is a manually configured static route to the same destination as a tunnel with autoroute destination enabled, traffic for that destination is load-shared between the static route and the tunnel with autoroute destination enabled.

- **Interaction Between Autoroute Announce and Autoroute Destination**

For intra-area tunnels, if a tunnel is configured with both autoroute announce and autoroute destination, the tunnel is announced to the RIB by both the IGP and the static process. RIBs prefer static routes, not IGP routes, so the autoroute destination features takes precedence over autoroute announce.

Configure Static Routes

This task explains how to configure a static route.

SUMMARY STEPS

1. **configure**
2. **interface tunnel-te** *tunnel-id*
3. **ipv4 unnumbered** *type interface-path-id*
4. **ipv6 enable**
5. **destination** *ip-address*
6. **path-option** *preference-priority* **dynamic segment-routing**
7. **exit**
8. **router static**
9. **address-family ipv4 unicast**
10. *prefix mask interface-type interface-instance*
11. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	interface tunnel-te <i>tunnel-id</i> Example: RP/0/RP0/CPU0:router(config)# interface tunnel-te22	Configures the tunnel interface.
Step 3	ipv4 unnumbered <i>type interface-path-id</i> Example: RP/0/RP0/CPU0:router(config-if)# ipv4 unnumbered loopback0	Assigns a source address so that forwarding can be performed on the new tunnel. Loopback is commonly used as the interface type.
Step 4	ipv6 enable Example:	Enables IPv6 over the IPv4 tunnel. Note IPv6 over IPv4 tunnel is supported with CRS-FP-X next generation line cards.

	Command or Action	Purpose
	<pre>RP/0/RP0/CPU0:router(config-if)# ipv6 enable</pre>	
Step 5	<p>destination <i>ip-address</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# destination 192.168.0.2</pre>	Assigns a destination address on the new tunnel.
Step 6	<p>path-option <i>preference-priority</i> dynamic segment-routing</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-if)# path-option 1 dynamic segment-routing</pre>	Sets the path option to dynamic and assigns the path ID.
Step 7	exit	
Step 8	<p>router static</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config)# router static</pre>	Configures the static route and enters static configuration mode.
Step 9	<p>address-family ipv4 unicast</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-static)# address-family ipv4 unicast</pre>	Enters address family mode.
Step 10	<p><i>prefix mask interface-type interface-instance</i></p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-static-af)# 192.168.0.2/32 tunnel-te22</pre>	Specifies the destination prefix is directly reachable through the tunnel interface.
Step 11	commit	

This completes the configuration of the static route.

Configure Autoroute Announce

This task explains how to configure autoroute announce to steer traffic through the SR-TE policy.

SUMMARY STEPS

1. **configure**
2. **interface tunnel-te** *tunnel-id*
3. **ipv4 unnumbered** *type interface-path-id*
4. **ipv6 enable**
5. **autoroute announce**
6. **destination** *ip-address*
7. **path-option** *preference-priority* **dynamic segment-routing**
8. **path-protection**
9. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	interface tunnel-te <i>tunnel-id</i> Example: RP/0/RP0/CPU0:router(config)# interface tunnel-te22	Configures the tunnel interface.
Step 3	ipv4 unnumbered <i>type interface-path-id</i> Example: RP/0/RP0/CPU0:router(config-if)# ipv4 unnumbered loopback0	Assigns a source address so that forwarding can be performed on the new tunnel. Loopback is commonly used as the interface type.
Step 4	ipv6 enable Example: RP/0/RP0/CPU0:router(config-if)# ipv6 enable	Enables IPv6 over the IPv4 tunnel. Note IPv6 over IPv4 tunnel is supported with CRS-FP-X next generation line cards.
Step 5	autoroute announce Example: RP/0/RP0/CPU0:router(config-if)# autoroute announce	Enables messages that notify the neighbor nodes about the routes that are forwarding.
Step 6	destination <i>ip-address</i> Example:	Assigns a destination address on the new tunnel.

	Command or Action	Purpose
	RP/0/RP0/CPU0:router(config-if)# destination 192.168.0.2	
Step 7	path-option <i>preference-priority</i> dynamic segment-routing Example: RP/0/RP0/CPU0:router(config-if)# path-option 1 dynamic segment-routing	Sets the path option to dynamic and assigns the path ID.
Step 8	path-protection Example: RP/0/RP0/CPU0:router(config-if)# path-protection	Enables path protection on the tunnel-te interface.
Step 9	commit	

Configure Autoroute Destination

This task explains how to configure autoroute destination to steer traffic through the SR-TE policy.

SUMMARY STEPS

1. **configure**
2. **interface tunnel-te *tunnel-id***
3. **ipv4 unnumbered *type interface-path-id***
4. **ipv6 enable**
5. **autoroute destination *destination-ip-address***
6. **destination *ip-address***
7. **path-option *preference-priority* dynamic segment-routing**
8. **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	interface tunnel-te <i>tunnel-id</i> Example: RP/0/RP0/CPU0:router(config)# interface tunnel-te22	Configures the tunnel interface.

	Command or Action	Purpose
Step 3	ipv4 unnumbered <i>type interface-path-id</i> Example: <pre>RP/0/RP0/CPU0:router(config-if)# ipv4 unnumbered loopback0</pre>	Assigns a source address so that forwarding can be performed on the new tunnel. Loopback is commonly used as the interface type.
Step 4	ipv6 enable Example: <pre>RP/0/RP0/CPU0:router(config-if)# ipv6 enable</pre>	Enables IPv6 over the IPv4 tunnel. Note IPv6 over IPv4 tunnel is supported with CRS-FP-X next generation line cards.
Step 5	autoroute destination <i>destination-ip-address</i> Example: <pre>RP/0/RP0/CPU0:router(config-if)# autoroute destination 192.168.0.1 RP/0/RP0/CPU0:router(config-if)# autoroute destination 192.168.0.2 (the default route) RP/0/RP0/CPU0:router(config-if)# autoroute destination 192.168.0.3 RP/0/RP0/CPU0:router(config-if)# autoroute destination 192.168.0.4</pre>	(Optional) Adds a route (destination-ip-address) in the RIB with the tunnel as outgoing interface to the tunnel destination.
Step 6	destination <i>ip-address</i> Example: <pre>RP/0/RP0/CPU0:router(config-if)# destination 192.168.0.2</pre>	Assigns a destination address on the new tunnel.
Step 7	path-option <i>preference-priority</i> dynamic segment-routing Example: <pre>RP/0/RP0/CPU0:router(config-if)# path-option 1 dynamic segment-routing</pre>	Sets the path option to dynamic and assigns the path ID.
Step 8	commit	

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.

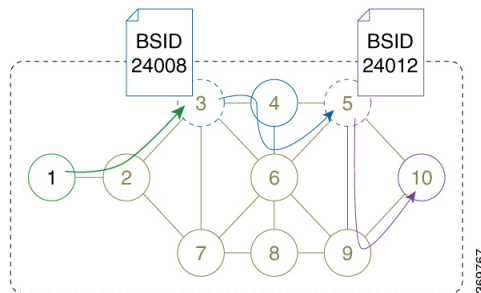
BSID can be used in the following cases:

- 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 Policies Using Binding SID: Example

In this intra-domain example, three SR-TE policies are stitched together to form a seamless end-to-end path from node 1 to node 10.

Figure 1: Intra-Domain Topology



Step 1

Configure an SR-TE policy on node 5 to node 10 via node 9. Node 5 automatically allocates a binding-SID (24012) for the SR-TE policy.

Example:

```
RP/0/0/CPU0:xrvr-5(config)# explicit-path name PATH5-9_10
RP/0/0/CPU0:xrvr-5(config-expl-path)# index 10 next-address strict ipv4 unicast 192.168.59.9
RP/0/0/CPU0:xrvr-5(config-expl-path)# index 20 next-address strict ipv4 unicast 10.1.1.10
RP/0/0/CPU0:xrvr-5(config-expl-path)# exit

RP/0/0/CPU0:xrvr-5(config)# interface tunnel-tel
RP/0/0/CPU0:xrvr-5(config-if)# ipv4 unnumbered Loopback0
```

```
RP/0/0/CPU0:xrivr-5(config-if)# destination 10.1.1.10
RP/0/0/CPU0:xrivr-5(config-if)# path-option 1 explicit name PATH5-9_10 segment-routing
RP/0/0/CPU0:xrivr-5(config-if)# commit

RP/0/0/CPU0:xrivr-5# show mpls traffic-eng tunnels 1 detail
Name: tunnel-tel Destination: 10.1.1.10 Ifhandle:0x680
  Signalled-Name: xrivr-5_t1
  Status:
    Admin: up Oper: up Path: valid Signalling: connected
    path option 1, (Segment-Routing) type dynamic (Basis for Setup, path weight 10)
<...>
  Binding SID: 24012
<...>
  Segment-Routing Path Info (IS-IS 1 level-2)
    Segment0[Link]: 192.168.59.5 - 192.168.59.9, Label: 24007
    Segment1[Node]: 10.1.1.10, Label: 16010
```

Step 2 Configure an SR-TE policy on node 3 to node 5 via node 4 and Link4-6, and push the binding-SID of the SR-TE policy at node 5 (24012) to stitch to the SR-TE policy on node 5. Node 3 automatically allocates a binding-SID (24008) for this SR-TE policy.

Example:

```
RP/0/0/CPU0:xrivr-3(config)# explicit-path name PATH4_4-6_5_BSID
RP/0/0/CPU0:xrivr-3(config-expl-path)# index 10 next-address strict ipv4 unicast 10.1.1.4
RP/0/0/CPU0:xrivr-3(config-expl-path)# index 20 next-address strict ipv4 unicast 192.168.46.6
RP/0/0/CPU0:xrivr-3(config-expl-path)# index 30 next-address strict ipv4 unicast 10.1.1.5
RP/0/0/CPU0:xrivr-3(config-expl-path)# index 40 next-label 24012
RP/0/0/CPU0:xrivr-3(config-expl-path)# exit

RP/0/0/CPU0:xrivr-3(config)# interface tunnel-tel
RP/0/0/CPU0:xrivr-3(config-if)# ipv4 unnumbered Loopback0
RP/0/0/CPU0:xrivr-3(config-if)# destination 10.1.1.10
RP/0/0/CPU0:xrivr-3(config-if)# path-option 1 explicit name PATH4_4-6_5_BSID segment-routing
RP/0/0/CPU0:xrivr-3(config-if)# commit

RP/0/0/CPU0:xrivr-3# show mpls traffic-eng tunnels 1 detail
Name: tunnel-tel Destination: 10.1.1.10 Ifhandle:0x780
  Signalled-Name: xrivr-3_t1
  Status:
    Admin: up Oper: up Path: valid Signalling: connected
    path option 1, (Segment-Routing) type explicit PATH4_6_5 (Basis for Setup)
<...>
  Binding SID: 24008
<...>
  Segment-Routing Path Info (IS-IS 1 level-2)
    Segment0[Node]: 10.1.1.4, Label: 16004
    Segment1[Link]: 192.168.46.4 - 192.168.46.6, Label: 24003
    Segment2[Node]: 10.1.1.5, Label: 16005
    Segment3[ - ]: Label: 24012
```

Step 3 Configure an SR-TE policy on node 1 to node 3 and push the binding-SID of the SR-TE policy at node 3 (24008) to stitch to the SR-TE policy on node 3.

Example:

```
RP/0/0/CPU0:xrivr-1(config)# explicit-path name PATH3_BSID
RP/0/0/CPU0:xrivr-1(config-expl-path)# index 10 next-address strict ipv4 unicast 10.1.1.3
RP/0/0/CPU0:xrivr-1(config-expl-path)# index 20 next-label 24008
RP/0/0/CPU0:xrivr-1(config-expl-path)# exit
```

```

RP/0/0/CPU0:xrivr-1(config)# interface tunnel-tel
RP/0/0/CPU0:xrivr-1(config-if)# ipv4 unnumbered Loopback0
RP/0/0/CPU0:xrivr-1(config-if)# destination 10.1.1.10
RP/0/0/CPU0:xrivr-1(config-if)# path-option 1 explicit name PATH3_BSID segment-routing
RP/0/0/CPU0:xrivr-1(config-if)# commit

RP/0/0/CPU0:xrivr-1# show mpls traffic-eng tunnels 1 detail
Name: tunnel-tel Destination: 10.1.1.10 Ifhandle:0x2f80
  Signalled-Name: xrivr-1_t1
  Status:
    Admin: up Oper: up Path: valid Signalling: connected
    path option 1, (Segment-Routing) type explicit PATH3_BSID (Basis for Setup)
<...>
  Binding SID: 24002
<...>
  Segment-Routing Path Info (IS-IS 1 level-2)
    Segment0[Node]: 10.1.1.3, Label: 16003
    Segment1[ - ]: Label: 24008

```

The path is a chain of SR-TE policies stitched together using the binding-SIDs, providing a seamless end-to-end path.

```

RP/0/0/CPU0:xrivr-1# traceroute 10.1.1.10
Type escape sequence to abort.
Tracing the route to 10.1.1.10
 0  99.1.2.2 [MPLS: Labels 16003/24008 Exp 0] 29 msec  19 msec  19 msec
 1  99.2.3.3 [MPLS: Label 24008 Exp 0] 29 msec  19 msec  19 msec
 2  99.3.4.4 [MPLS: Labels 24003/16005/24012 Exp 0] 29 msec  19 msec  19 msec
 3  99.4.6.6 [MPLS: Labels 16005/24012 Exp 0] 29 msec  29 msec  19 msec
 4  99.5.6.5 [MPLS: Label 24012 Exp 0] 29 msec  29 msec  19 msec
 5  99.5.9.9 [MPLS: Label 16010 Exp 0] 19 msec  19 msec  19 msec
 6  99.9.10.10 29 msec  19 msec  19 msec

```

