



IS-IS Link-protection Topology Independent Loop Free Alternate Fast Reroute

This document describes the functionalities and IS-IS implementation of IP Fast Re-Route feature (IPFRR) using Segment Routing (SR) Topology Independent Loop Free Alternative (TI-LFA) link protection.

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Feature Information for IS-IS Link-protection Topology Independent Loop Free Alternate Fast Reroute

Table 1: Feature Information for IS-IS Link-protection Topology Independent Loop Free Alternate Fast Reroute

Feature Name	Releases	Feature Information
IS-IS Link-protection Topology Independent Loop Free Alternate Fast Reroute	Cisco IOS XE Amsterdam 17.3.2	The following commands were introduced or modified: fast-reroute ti-lfa {level-1 level-2} [maximum-metric value] , isis fast-reroute ti-lfa protection level-1 disable , isis fast-reroute ti-lfa protection {level-1 level-2} [maximum-metric value] , show running all section interface interface-name , show running all section router isis .

Prerequisites for IS-IS Link-protection Topology Independent Loop Free Alternate Fast Reroute

- Enable TI-LFA on all the nodes, before configuring SR-TE for TI-LFA.

```

mpls traffic-eng tunnels
!
segment-routing mpls
  connected-prefix-sid-map
  address-family ipv4
    10.1.1.1/32 index 11 range 1
  exit-address-family
!
interface Loopback1
  ip address 10.1.1.1 255.255.255.255
  ip router isis 1
!
interface Tunnel1
  ip unnumbered Loopback1
  tunnel mode mpls traffic-eng
  tunnel destination 10.6.6.6
  tunnel mpls traffic-eng autoroute announce
  tunnel mpls traffic-eng path-option 10 explicit name IP_PATH segment-routing
!
interface GigabitEthernet2
  ip address 192.168.1.1 255.255.255.0
  ip router isis 1
  negotiation auto
  mpls traffic-eng tunnels
  isis network point-to-point
!
interface GigabitEthernet3
  ip address 192.168.2.1 255.255.255.0
  ip router isis 1
  negotiation auto
  mpls traffic-eng tunnels
  isis network point-to-point
!
router isis 1
  net 49.0001.0010.0100.1001.00
  is-type level-1
  metric-style wide
  log-adjacency-changes
  segment-routing mpls
  fast-reroute per-prefix level-1 all
  fast-reroute ti-lfa level-1
  mpls traffic-eng router-id Loopback1
  mpls traffic-eng level-1
!
ip explicit-path name IP_PATH enable
  next-address 10.4.4.4
  next-address 10.5.5.5
  next-address 10.6.6.6

```

- If a microloop gets created between routers in case of primary and secondary path switch over you need to bring down the convergence time. Use the **microloop avoidance rib-update-delay** command to bring down the convergence time:

```
router isis ipfrr
net 49.0001.0120.1201.2012.00
is-type level-2-only
metric-style wide
log-adjacency-changes
segment-routing mpls
segment-routing prefix-sid-map advertise-local
fast-reroute per-prefix level-2 all
fast-reroute ti-lfa level-2
microloop avoidance rib-update-delay 10000
```

- Enable MPLS-TE nonstop routing (NSR) and IS-IS nonstop forwarding (NSF) to reduce or minimize traffic loss after a high availability (HA) switch over. Use the **mpls traffic-eng nsr** command in global exec mode.

```
mpls traffic-eng nsr
```

Use the **nsf** command under IS-IS.

```
router isis
nsf cisco
nsf interval 0
```

Information About IS-IS Link-protection Topology Independent Loop Free Alternate Fast Reroute

When the local LFA and remote LFA are enabled, there is a good coverage of the prefixes to be protected. However, for some rare topologies that do not have a PQ intersect node, both local and remote LFA will fail to find a release node to protect the failed link. Furthermore, there is no way to prefer a post-convergence path, as the two algorithms have no knowledge of the post-convergence characteristics of the LFA.

To overcome the above limitation, effective Cisco IOS-XE Release 3.18, topology-independent LFA (TI-LFA) is supported on an SR-enabled network.

Topology-Independent Loop Free Alternate

TI-LFA provides supports for the following:

- Link Protection—The LFA provides repair path for failure of the link.
- Local LFA—Whenever a local LFA on the post convergence path is available, it is preferred over TI-LFA because local LFA does not require additional SID for the repair path. That is, the label for the PQ node is not needed for the release node.
- Local LFA for extended P space—For nodes in the extended P space, local LFA is still the most economical method for the repair path. In this case, TI-LFA will not be chosen.
- Tunnel to PQ intersect node—This is similar to remote LFA except that the repair path is guaranteed on the post convergence path using TI-LFA.
- Tunnel to PQ disjoint node—This capability is unique to the TI-LFA in the case when local and remote LFA cannot find a repair path.
- Tunnel to traverse multiple intersect or disjoint PQ nodes, up to the platform's maximum supported labels—TI-LFA provides complete coverage of all prefixes.

- P2P interfaces for the protected link—TI-LFA protects P2P interfaces.
- Asymmetrical links—The ISIS metrics between the neighbors are not the same.
- Multi-homed (anycast) prefix protection—The same prefix may be originated by multiple nodes.
- Protected prefix filtering—The route-map includes or excludes a list of prefixes to be protected and the option to limit the maximum repair distance to the release node.
- Tiebreakers—A subset of existing tiebreakers, applicable to TI-LFA, is supported.

Topology Independent Loop Free Alternate Tie-break

Local and remote LFA use default or user-configured heuristics to break the tie when there is more than one path to protect the prefix. The attributes are used to trim down the number of repair paths at the end of the TI-LFA link protection computation before the load balancing. Local LFA and remote LFA support the following tiebreakers:

- Linecard-disjoint—Prefers the line card disjoint repair path
- Lowest-backup-path-metric—Prefers the repair path with lowest total metric
- Node-protecting—Prefers node protecting repair path
- SRLG-disjoint—Prefers SRLG disjoint repair path
- Load-sharing—Distributes repair paths equally among links and prefixes

When there are two repair paths for a particular prefix, the path that the output port on different line card than that of the primary port is chosen as the repair path. For TI-LFA link protection, the following tiebreakers are supported:

- Linecard-disjoint—Prefers the line card disjoint repair path.
- LC disjoint index—If both the repair paths are on the same line card as that of the primary path, then, both paths are considered as candidates. If one of the path is on a different line card, then that path is chosen as the repair path.
- SRLG index—If both the repair paths have the same SRLG ID as that of the primary path, then, both the paths are considered as candidates. If one of the path has a different srlg id, then path is chosen as the repair path.
- Node-protecting—For TI-LFA node protection, the protected node is removed when computing the post-convergence shortest path. The repair path must direct traffic around the protected node.

The SRLG ID can be configured for each interface. When there are two repair paths for a prefix, the configured SRLG ID for the repair path is compared with that of the primary path SRLG ID. If the SRLG IDs for the secondary path is different than that of the primary, that path is chosen as the repair path. This policy comes into effect only when the primary path is configured with an SRLG ID. It is possible to configure both node and SRLG protection modes for the same interface or the same protocol instance. In that case, an additional TI-LFA node-SRLG combination protection algorithm is run. The TI-LFA node-SRLG combination algorithm removes the protected node and all members of the interface with the same SRLG group when computing the post-convergence SPT.

Interface Fast Reroute Tiebreakers

Interface fast reroute (FRR) tiebreakers are also needed for TI-LFA node and SRLG protection. When interface and protocol instance FRR tiebreakers both are configured, the interface FRR tiebreakers take precedence over the protocol instance. When interface FRR tiebreakers are not configured, the interface inherits the protocol instance FRR tiebreakers.

The following interface FRR tiebreaker commands apply only to the particular interface.

```

isis fast-reroute tie-break
[level-1 | level-2] linecard-disjoint
priority
isis fast-reroute tie-break
[level-1 | level-2] lowest-backup-metric
priority
isis fast-reroute tie-break
[level-1 | level-2] node-protecting
priority
isis fast-reroute tie-break
[level-1 | level-2] srlg-disjoint
priority
isis fast-reroute tie-break
[level-1 | level-2] default

```

Tie-breaker default and explicit tie-breaker on the same interface are mutually exclusive.

The following tie-breakers are enabled by default on all LFAs:

- linecard-disjoint
- lowest-backup-metric
- srlg-disjoint

Effective with Cisco IOS-XE Release 3.18, node-protecting tie-breaker is disabled by default.

How to Configure IS-IS Link-protection Topology Independent Loop Free Alternate Fast Reroute

Perform the following steps to configure Link-protection Topology Independent Loop Free Alternate Fast Reroute.

Configuring Topology Independent Loop Free Alternate Fast Reroute

You can enable TI-LFA using any of the following two methods:

1. **Protocol enablement**—Enables TI-LFA in router isis mode for all IS-IS interfaces. Optionally, use the interface command to exclude the interfaces on which TI-LFA should be disabled.

For example, to enable TI-LFA for all IS-IS interfaces:

```

router isis 1
fast-reroute per-prefix {level-1 | level-2}
fast-reroute ti-lfa {level-1 | level-2} [maximum-metric value]

```



Note The `isis fast-reroute protection level-x` command enables local LFA and is required to enable TI-LFA.

2. **Interface enablement**—Enable TI-LFA selectively on each interface.

```

interface interface-name
isis fast-reroute protection {level-1 | level-2}
isis fast-reroute ti-lfa protection {level-1 | level-2} [maximum-metric value]

```

The **maximum-metric** option specifies the maximum repair distance which a node is still considered eligible as a release node.

When both interface and protocol are TI-LFA enabled, the interface configuration takes precedence over the protocol configuration. TI-LFA is disabled by default.

To disable TI-LFA on a particular interface, use the following command:

```
interface interface-name
isis fast-reroute ti-lfa protection level-1 disable
```

Configuring Topology Independent Loop Free Alternate With Mapping Server

Consider the following topology to understand the configuration:



- IXIA-2 injects ISIS prefixes, and IXIA-1 sends one-way traffic to IXIA-2
- In R1 10,000 prefixes are configured in the segment-routing mapping-server.

The configuration on R1 is:

```
configure terminal
segment-routing mpls
global-block 16 20016
!
connected-prefix-sid-map
address-family ipv4
10.11.11.11/32 index 11 range 1
exit-address-family
!
!
mapping-server
!
prefix-sid-map
address-family ipv4
10.0.0.0/24 index 2 range 1 attach
203.0.113.1/24 index 1 range 1 attach
192.168.0.0/24 index 100 range 10000 attach
exit-address-family
!
!
!
!
interface Loopback0
ip address 10.11.11.11 255.255.255.255
ip router isis ipfrr
!
interface GigabitEthernet0/1/0
ip address 10.14.0.1 255.255.255.0
ip router isis ipfrr
```

```

negotiation auto
isis network point-to-point
!
interface GigabitEthernet0/1/2
ip address 10.0.0.1 255.255.255.0
ip router isis ipfrr
negotiation auto
isis network point-to-point
!
interface GigabitEthernet0/1/4
ip address 203.0.113.2 255.255.255.0
ip router isis ipfrr
negotiation auto
isis network point-to-point
!
router isis ipfrr
net 49.0001.0110.1101.1011.00
is-type level-2-only
metric-style wide
log-adjacency-changes
nsf cisco
segment-routing mpls
segment-routing prefix-sid-map advertise-local
fast-reroute per-prefix level-2 all
fast-reroute ti-lfa level-2
microloop avoidance rib-update-delay 10000

```

On R2 the configuration is

```

configure terminal
!
!
segment-routing mpls
!
connected-prefix-sid-map
address-family ipv4
10.12.12.12/32 index 12 range 1
exit-address-family
!
!
interface Loopback0
ip address 10.12.12.12 255.255.255.255
ip router isis ipfrr
!
interface GigabitEthernet0/1/0
ip address 10.12.0.1 255.255.255.0
ip router isis ipfrr
negotiation auto
isis network point-to-point
!
interface GigabitEthernet0/1/1
ip address 10.11.0.2 255.255.255.0
ip router isis ipfrr
negotiation auto
isis network point-to-point
!
router isis ipfrr
net 49.0001.0120.1201.2012.00
is-type level-2-only
metric-style wide
log-adjacency-changes
nsf cisco
segment-routing mpls
segment-routing prefix-sid-map advertise-local

```

```

fast-reroute per-prefix level-2 all
fast-reroute ti-lfa level-2
microloop avoidance rib-update-delay 10000
!
```

On R3 the configuration is

```

configure terminal
!
mpls traffic-eng tunnels
!
segment-routing mpls
!
connected-prefix-sid-map
address-family ipv4
10.13.13.13/32 index 13 range 1
exit-address-family
!
!
interface Loopback0
ip address 10.13.13.13 255.255.255.255
ip router isis ipfrr
!
interface GigabitEthernet0/0/4
ip address 10.13.0.1 255.255.255.0
ip router isis ipfrr
load-interval 30
speed 1000
no negotiation auto
isis network point-to-point
!
interface GigabitEthernet0/0/5
ip address 10.12.0.2 255.255.255.0
ip router isis ipfrr
negotiation auto
isis network point-to-point
!
router isis ipfrr
net 49.0001.0130.1301.3013.00
is-type level-2-only
metric-style wide
log-adjacency-changes
nsf cisco
segment-routing mpls
segment-routing prefix-sid-map advertise-local
fast-reroute per-prefix level-2 all
fast-reroute ti-lfa level-2
microloop avoidance rib-update-delay 10000
!
```

On R4 the configuration is:

```

configure terminal
!
mpls traffic-eng tunnels
!
segment-routing mpls
!
connected-prefix-sid-map
address-family ipv4
10.14.14.14/32 index 14 range 1
exit-address-family
!
```



```

!
interface Loopback0
ip address 10.14.14.14 255.255.255.255
ip router isis ipfrr
!
interface GigabitEthernet0/0/0
ip address 10.14.0.2 255.255.255.0
ip router isis ipfrr
negotiation auto
isis network point-to-point
!
interface GigabitEthernet0/0/3
ip address 10.13.0.2 255.255.255.0
ip router isis ipfrr
speed 1000
no negotiation auto
isis network point-to-point
!
interface GigabitEthernet0/0/5
ip address 10.120.0.1 255.255.255.0
ip router isis ipfrr
speed 1000
no negotiation auto
isis network point-to-point
!
router isis ipfrr
net 49.0001.0140.1401.4014.00
is-type level-2-only
metric-style wide
log-adjacency-changes
nsf cisco
segment-routing mpls
segment-routing prefix-sid-map advertise-local
fast-reroute per-prefix level-2 all
fast-reroute ti-lfa level-2
microloop avoidance rib-update-delay 10000
!

```

Examples: Configuring IS-IS Link-protection Topology Independent Loop Free Alternate Fast Reroute

Example 1: In the following example, local LFA is configured with linecard-disjoint and srlg-disjoint tiebreakers. Linecard-disjoint is given preference with a lower priority value (10) than the srlg-disjoint (11).

```

router isis access
net 49.0001.2037.0685.b002.00
metric-style wide
fast-flood 10
max-lsp-lifetime 65535
lsp-refresh-interval 65000
spf-interval 5 50 200
prc-interval 5 50 200
lsp-gen-interval 5 5 200
log-adjacency-changes
nsf ietf
segment-routing mpls
fast-reroute per-prefix level-1 all - configures the local LFA
fast-reroute per-prefix level-2 all
fast-reroute remote-lfa level-1 mpls-ldp - enables rLFA (optional)
fast-reroute remote-lfa level-2 mpls-ldp

```

```
fast-reroute ti-lfa level-1 - enables TI-LFA
microloop avoidance rib-update-delay 10000
bfd all-interfaces
```

Example 2—Enable TI-LFA node-protecting tie-breaker on all ISIS level-2 interfaces with priority 100. All other tiebreakers are disabled.

```
router isis
fast-reroute per-prefix level-2 all
fast-reroute ti-lfa level-2
fast-reroute tie-break level-2 node-protecting 100
```

Example 3—Enable TI-LFA node-protecting tie-breaker with priority 100 and TI-LFA SRLG protection with priority 200 on all IS-IS level-2 interfaces. All other tiebreakers are disabled because the node-protecting tie-breaker is configured.

```
router isis
fast-reroute per-prefix level-2 all
fast-reroute ti-lfa level-2
fast-reroute tie-break level-2 node-protecting 100
fast-reroute tie-break level-2 srlg-disjoint 200
```

Example 4—Enable TI-LFA node-protecting tie-breaker with priority 100 on all ISIS level-2 interfaces except on Ethernet0/0. For those IS-IS interfaces, all other tiebreakers are disabled. Ethernet0/0 overwrites the inheritance and uses the default set of tiebreakers with linecard-disjoint, lowest-backup-path-metric, srlg-disjoint enabled.

```
router isis
fast-reroute per-prefix level-2 all
fast-reroute ti-lfa level-2
fast-reroute tie-break level-2 node-protecting 100
!
interface ethernet0/0
ip router isis
isis fast-reroute tie-break level-2 default
```

Example 5—Enable TI-LFA using the default tiebreaker on all IS-IS interfaces except on Ethernet0/0. On Ethernet0/0 enable TI-LFA node-protecting with priority 100 and disable all other tiebreakers.

```
router isis
fast-reroute per-prefix level-2 all
fast-reroute ti-lfa level-2
!
interface ethernet0/0
ip router isis
isis fast-reroute tie-break level-2 node-protecting 100
```

Example 6—Enable TI-LFA node-protecting tie-breaker with priority 200 and linecard-disjoint tie-breaker with priority 100 on all ISIS level-2 interfaces. All other tiebreakers are disabled.

```
router isis
fast-reroute per-prefix level-2 all
fast-reroute ti-lfa level-2
fast-reroute tie-break level-2 linecard-disjoint 100
fast-reroute tie-break level-2 node-protecting 200
```

Verifying the Tiebreaker

To view tiebreakers enabled on the interface, use the following command:

```
show running all | section interface interface-name
```

To view tiebreakers enabled on the router mode, use the following command:

```
show running all | section router isis
```

Verifying the Primary and Repair Paths

In this example, 10.1.1.1 is the protecting neighbor and 10.4.4.4 is the neighbor on the protecting link.

```
Router#
show ip cef 10.1.1.1
10.1.1.1/32
  nexthop 10.1.1.1 GigabitEthernet0/2/0 label [explicit-null|explicit-null]() - slot 2 is
primary interface
  repair: attached-nexthop 10.24.0.2 TenGigabitEthernet0/3/0 - slot 3 is repair interface

  nexthop 10.24.0.2 TenGigabitEthernet0/3/0 label [explicit-null|explicit-null]()
  repair: attached-nexthop 10.1.1.1 GigabitEthernet0/2/0
Router#
show ip cef 10.4.4.4
10.4.4.4/32
  nexthop 10.4.4.4 GigabitEthernet0/2/3 label [explicit-null|16004]() - slot 2 is primary
interface
  repair: attached-nexthop 10.5.5.5 MPLS-SR-Tunnel2
Router# show ip cef 10.4.4.4 int
10.4.4.4/32, epoch 3, RIB[I], refcnt 6, per-destination sharing
sources: RIB, Adj, LTE
feature space:
  IPRM: 0x00028000
  Broker: linked, distributed at 4th priority
  LFD: 10.4.4.4/32 2 local labels
  dflt local label info: global/877 [0x3]
  sr local label info: global/16004 [0x1B]
  contains path extension list
  dflt disposition chain 0x46654200
  label implicit-null
  FRR Primary
    <primary: IP adj out of GigabitEthernet0/2/3, addr 10.4.4.4>
  dflt label switch chain 0x46654268
  label implicit-null
  TAG adj out of GigabitEthernet0/2/3, addr 10.4.4.4
  sr disposition chain 0x46654880
  label explicit-null
  FRR Primary
    <primary: TAG adj out of GigabitEthernet0/2/3, addr 10.4.4.4>
  sr label switch chain 0x46654880
  label explicit-null
  FRR Primary
    <primary: TAG adj out of GigabitEthernet0/2/3, addr 10.4.4.4>
subblocks:
  Adj source: IP adj out of GigabitEthernet0/2/3, addr 10.4.4.4 464C6620
  Dependent covered prefix type adjfib, cover 10.0.0.0/0
ifnums:
  GigabitEthernet0/2/3(11): 10.4.4.4
  MPLS-SR-Tunnel2(1022)
path list 3B1FC930, 15 locks, per-destination, flags 0x4D [shble, hvsh, rif, hwn]
```

```

path 3C04D5E0, share 1/1, type attached nexthop, for IPv4, flags [has-rpr]
  MPLS short path extensions: [rib | lblmrg | srlbl] MOI flags = 0x21 label explicit-null

  nexthop 10.4.4.4 GigabitEthernet0/2/3 label [explicit-null|16004](), IP adj out of
  GigabitEthernet0/2/3, addr 10.4.4.4 464C6620
    repair: attached-nexthop 10.5.5.5 MPLS-SR-Tunnel2 (3C04D6B0)
  path 3C04D6B0, share 1/1, type attached nexthop, for IPv4, flags [rpr, rpr-only]
    MPLS short path extensions: [rib | lblmrg | srlbl] MOI flags = 0x1 label 16004
    nexthop 10.5.5.5 MPLS-SR-Tunnel2 label 16004(), repair, IP midchain out of
  MPLS-SR-Tunnel2 46CE2440
  output chain:
    label [explicit-null|16004]()
    FRR Primary (0x3B209220)
    <primary: TAG adj out of GigabitEthernet0/2/3, addr 10.4.4.4 464C6480> - primary path

    <repair: TAG midchain out of MPLS-SR-Tunnel2 46CE22A0
      label 16()
      label 16003()
      TAG adj out of TenGigabitEthernet0/3/0, addr 10.24.0.2 46CE25E0> - repair
  path

```

Verifying the IS-IS Segment Routing Configuration

```

Router# show isis segment-routing
  ISIS protocol is registered with MFI
  ISIS MFI Client ID:0x63
  Tag Null - Segment-Routing:
    SR State:SR_ENABLED
    Number of SRGB:1
    SRGB Start:14000, Range:1001, srgb_handle:0xE0934788, srgb_state: created
  Address-family IPv4 unicast SR is configured
  Operational state: Enabled

```

The command with keyword **global-block** displays the SRGB and the range for LSPs.

```

Router# show isis segment-routing global-block
  IS-IS Level-1 Segment-routing Global Blocks:
  System ID          SRGB Base    SRGB Range
  nevada              20000       4001
  arizona              * 16000     1000
  utah                 40000       8000

```

The **show isis segment-routing prefix-sid-map** command with keyword **advertise** displays the prefix-sid maps that the router advertises.

```

Router# show isis segment-routing prefix-sid-map adv
  IS-IS Level-1 advertise prefix-sid maps:
  Prefix             SID Index   Range      Flags
  10.16.16.16/32     101        1          1
  10.16.16.17/32     102        1          Attached

```

The **show isis segment-routing prefix-sid-map** command with keyword **receive** displays the prefix-sid maps that the router receives.

```

Router #sh isis segment-routing prefix-sid-map receive
  IS-IS Level-1 receive prefix-sid maps:
  Host               Prefix             SID Index   Range      Flags
  utah                10.16.16.16/32    101        1          1
                    10.16.16.17/32    102        1          Attached

```

To display the connected-SIDs found in the LSPs and passed to the mapping server component, use the **show isis segment-routing connected-sid** command.

```
Router# show isis segment-routing connected-sid
IS-IS Level-1 connected-sids
Host          Prefix          SID Index  Range  Flags
nevada        * 10.1.1.2/32   1002      1
              10.2.2.2/32   20        1
              10.1.1.10/32  10        1
colorado      10.1.1.3/32    33        1
              10.1.1.6/32   6         1
IS-IS Level-2 connected-sids
Host          Prefix          SID Index  Range  Flags
```

Verifying the IS-IS Topology Independent Loop Free Alternate Tunnels

```
Router# show isis fast-reroute ti-lfa tunnel
Fast-Reroute TI-LFA Tunnels:
Tunnel  Interface  Next Hop      End Point      Label      End Point Host
MP1     Et1/0       10.30.1.4     10.1.1.2       41002     nevada
MP2     Et0/0       10.19.1.6     10.1.1.6       60006     colorado
              10.1.1.2     16        nevada
MP3     Et0/0       10.19.1.6     10.1.1.6       60006     colorado
              10.1.1.2     16        nevada
              10.1.1.5     70005     wyoming
```

Verifying the Segment Routing Traffic Engineering With Topology Independent Loop Free Alternate Configuration

```
Router# show mpls traffic-eng tunnels tunnel1
Name: PE1 (Tunnel1) Destination: 10.6.6.6
Status:
  Admin: up      Oper: up      Path: valid      Signalling: connected
  path option 10, (SEGMENT-ROUTING) type explicit IP_PATH (Basis for Setup)
Config Parameters:
  Bandwidth: 0 kbps (Global) Priority: 7 7 Affinity: 0x0/0xFFFF
  Metric Type: TE (default)
  Path Selection:
  Protection: any (default)
  Path-invalidation timeout: 45000 msec (default), Action: Tear
  AutoRoute: enabled LockDown: disabled Loadshare: 0 [0] bw-based
  auto-bw: disabled
  Fault-OAM: disabled, Wrap-Protection: disabled, Wrap-Capable: No
Active Path Option Parameters:
  State: explicit path option 10 is active
  BandwidthOverride: disabled LockDown: disabled Verbatim: disabled
History:
  Tunnel:
  Time since created: 4 hours, 25 minutes
  Time since path change: 4 hours, 21 minutes
  Number of LSP IDs (Tun_Instances) used: 37
  Current LSP: [ID: 37]
  Uptime: 4 hours, 21 minutes
Tun_Instance: 37
Segment-Routing Path Info (isis level-1)
  Segment0[Node]: 10.4.4.4, Label: 16014
  Segment1[Node]: 10.5.5.5, Label: 16015
```

```

Segment2[Node]: 10.6.6.6, Label: 16016
Router# show isis fast-reroute ti-lfa tunnel

Tag 1:
Fast-Reroute TI-LFA Tunnels:
Tunnel Interface Next Hop      End Point      Label      End Point Host
MP1    Gi2          192.168.1.2    10.6.6.6      16016      SR_R6
MP2    Gi3          192.168.2.2    10.6.6.6      16016      SR_R6
Router# show frr-manager client client-name ISIS interfaces detail
TunnelI/F : MP1
  Type : SR
  Next-hop : 192.168.1.2
  End-point : 10.6.6.6
  OutI/F : Gi2
  Adjacency State : 1
  Prefix0 : 10.6.6.6(Label : 16016)
TunnelI/F : MP2
  Type : SR
  Next-hop : 192.168.2.2
  End-point : 10.6.6.6
  OutI/F : Gi3
  Adjacency State : 1
  Prefix0 : 10.6.6.6(Label : 16016)
Router# show ip cef 10.6.6.6 internal

10.6.6.6/32, epoch 2, RIB[I], refcnt 6, per-destination sharing
sources: RIB, LTE
feature space:
  IPRM: 0x00028000
  Broker: linked, distributed at 1st priority
  LFD: 10.6.6.6/32 1 local label
  sr local label info: global/16016 [0x1A]
  contains path extension list
  sr disposition chain 0x7FC6B0BF2AF0
    label implicit-null
    IP midchain out of Tunnel1
    label 16016
    FRR Primary
    <primary: label 16015
      TAG adj out of GigabitEthernet3, addr 192.168.2.2>
  sr label switch chain 0x7FC6B0BF2B88
    label implicit-null
    TAG midchain out of Tunnel1
    label 16016
    FRR Primary
    <primary: label 16015
      TAG adj out of GigabitEthernet3, addr 192.168.2.2>

ifnums:
  Tunnel1(13)
  path list 7FC6B0BBDDE0, 3 locks, per-destination, flags 0x49 [shble, rif, hwcn]
  path 7FC7144D4300, share 1/1, type attached nexthop, for IPv4
  MPLS short path extensions: [rib | prfmfi | lblmrg | srlbl] MOI flags = 0x3 label
implicit-null
  nexthop 10.6.6.6 Tunnel1, IP midchain out of Tunnel1 7FC6B0BBB440
output chain:
  IP midchain out of Tunnel1 7FC6B0BBB440
  label [16016|16016]
  FRR Primary (0x7FC714515460)
  <primary: label 16015
    TAG adj out of GigabitEthernet3, addr 192.168.2.2 7FC6B0BBB630>
  <repair: label 16015
    label 16014
    TAG midchain out of MPLS-SR-Tunnel1 7FC6B0BBAA90

```

```
label 16016
TAG adj out of GigabitEthernet2, addr 192.168.1.2 7FC6B0BBBA10>
```



Note To ensure a less than 50 msec traffic protection with TI-LFA, SR-TE with dynamic path option must use the backup adjacency SID.

To create an SR-TE with dynamic path option, use the following configuration on every router in the topology:

```
router isis 1
fast-reroute per-prefix level-1 all
```

At the tunnel head-end router:

```
interface Tunnel1
ip unnumbered Loopback1
tunnel mode mpls traffic-eng
tunnel destination 10.6.6.6
tunnel mpls traffic-eng autoroute announce
tunnel mpls traffic-eng path-option 1 dynamic segment-routing
tunnel mpls traffic-eng path-selection segment-routing adjacency protected
```

