IS-IS SRv6 Microloop Avoidance Behavior Explained

Contents

Introduction

This document describes a technical overview of IS-IS micro-loops, explains the conditions under which they occur, and describes the principles and mechanisms used to prevent them.

Prerequisites

Requirements

Cisco recommends that you have basic knowledge of Intermediate System to Intermediate System (ISIS) Segment Routing (SR) version 6.

Components Used

The information in this document is based on Device: Network Convergence System (NCS) 540, NCS 5500.

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, ensure that you understand the potential impact of any command.

Microloop Overview

IS-IS is a widely deployed link-state routing protocol used in large-scale Service Provider networks due to its fast convergence and scalability. However, during topology changes such as link or node failures, transient forwarding inconsistencies—commonly known as microloops—can occur while routers update their forwarding information bases (FIBs) at different times. These microloops lead to temporary packet loss, increased latency, or traffic blackholing, which can negatively impact real-time and latency-sensitive applications.

IS-IS routing protocol leverage Segment Routing (SR and SRv6) microloop avoidance mechanisms in order to prevent such transient forwarding loops during network convergence. These mechanisms ensure loop-free forwarding even while the network is transitioning to a new steady state.

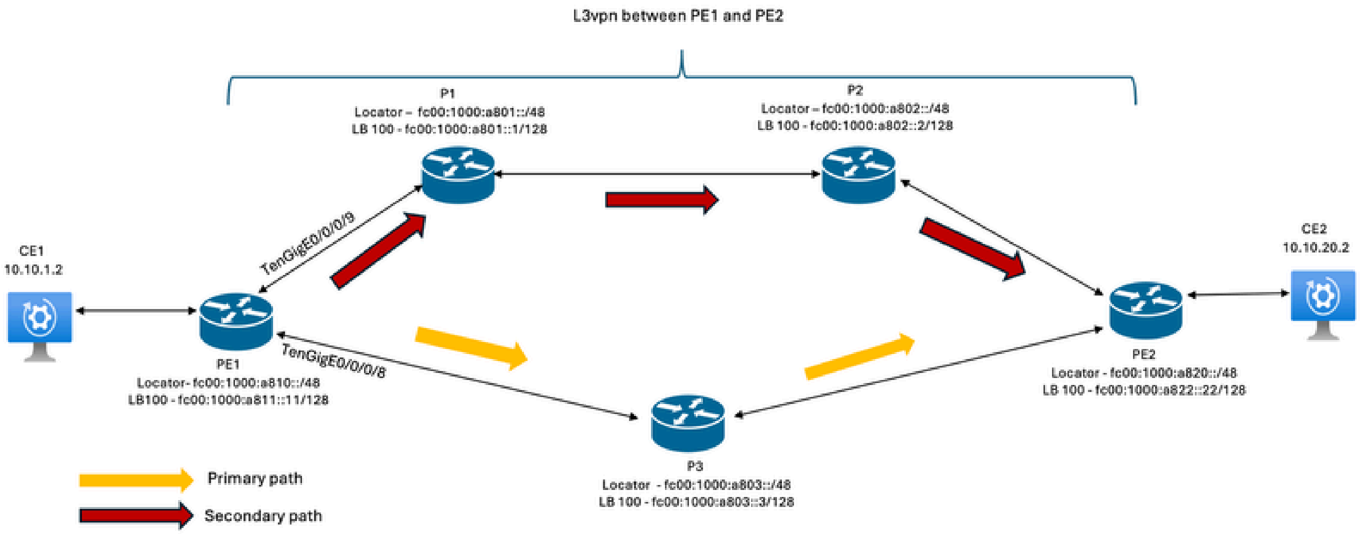

Figure 1. Network Topology Diagram

Generic Configuration

<#root>

```
interface Loopback100
ipv6 address <>

interface <>
ipv6 enable

router isis <>
 is-type level-2-only
 net <>
 address-family ipv6 unicast
  metric-style wide
  microloop avoidance segment-routing

## enables Microloop avoidance mechanism

  microloop avoidance rib-update-delay <>

## specify the time in ms


  router-id Loopback100
  segment-routing srv6
   locator <>

interface Loopback100
  address-family ipv6 unicast

 interface <>
    point-to-point
   address-family ipv6 unicast
   fast-reroute per-prefix
   fast-reroute per-prefix ti-lfa
```

```
## enables topology-independent loop-free alternates (TI-LFA)


segment-routing
 srv6
  encapsulation
   source-address <>
  !
  locators
   locator <>
    micro-segment behavior unode psp-usd

## enables SRv6 Micro-SIDs (uSIDs) the PSP-USD (Penultimate Segment Pop

- Ultimate Segment Pop

) flavor


    prefix <configure the locator >

router bgp <>
vrf <>
  address-family <> unicast
   segment-routing srv6

## steering the packet using SRv6 uSID


    locator <>
```

In Steady-State

When there is no change in the network, 10.10.1.0/24 network is advertised by Provider Edge 1 (PE1) via Border Gateway Protocol (BGP) to Provider Edge 2 (PE2), 10.10.20.0/24 network is advertised by PE2 to PE1.

<#root>

```
RP/0/RP0/CPU0:PE1#show bgp vrf mobility 10.10.1.0/24 detail
BGP routing table entry for 10.10.1.0/24, Route Distinguisher: 10.10.11.11:0

    SRv6-VPN SID: fc00:1000:a810:e003::/64


Local
    0.0.0.0 from 0.0.0.0 (10.10.11.11), if-handle 0x3c000090
      Origin incomplete, metric 0, localpref 100, weight 32768, valid, redistributed, best, group-best,
      Received Path ID 0, Local Path ID 1, version 8
      Extended community:
```

Note: fc00:1000:a810:e003::/64 >> fc00:1000:a810 ## locator of PE1, e003 ## function.

<#root>

```
RP/0/RP0/CPU0: PE1#show bgp vrf mobility 10.10.20.0/24 detail
  Local
    fc00:1000:a822::22 (metric 2000) from fc00:1000:a822::22 (10.10.22.22), if-handle 0x00000000
      Received Label

0xe0030


      Origin incomplete, metric 0, localpref 100, valid, internal, best, group-best, import-candidate, 
      Received Path ID 0, Local Path ID 1, version 714


Extended community:


      PSID-Type:L3, SubTLV Count:1, R:0x00,


       SubTLV:


        T:1(Sid information), Sid:fc00:1000:a820::, F:0x00, R2:0x00, Behavior:63, R3:0x00, SS-TLV Count:


         SubSubTLV:


          T:1(Sid structure):


           Length [Loc-blk,Loc-node,Func,Arg]:[32,16,16,0], Tpose-len:16, Tpose-offset:48

      Source AFI: VPNv4 Unicast, Source VRF: default, Source Route Distinguisher: 10.10.22.22:2
```

Note: This 10.10.20.0/24 is received from PE2 on PE1 with the locator sid fc00:1000:a820:: and function e0030.

<#root>

```
RP/0/RP0/CPU0: PE1#show route vrf mobility 10.10.20.0/24 detail
  Known via "bgp 100", distance 200, metric 0, type internal
  Routing Descriptor Blocks
    fc00:1000:a822::22, from fc00:1000:a822::22
<snip>


SRv6 Headend: H.Encaps.Red [f3216], SID-list {fc00:1000:a820:e003::}
```

Note: In steady state the packets destined to Cusctomer Edge 2 (CE2) are sent to PE2 with Internet

---

Protocol version 6 (IPv6) header destination address fc00:1000:a820:e003::.

Packet sent by PE1 in steady state.

<#root>

```
Frame 2: 136 bytes on wire (1088 bits), 136 bytes captured (1088 bits)
Ethernet II, Src: Cisco_a7:8a:0d (c4:b2:39:a7:8a:0d), Dst: Cisco_ff:d4:16 (a0:b4:39:ff:d4:16)
    Destination: Cisco_ff:d4:16 (a0:b4:39:ff:d4:16)
    Source: Cisco_a7:8a:0d (c4:b2:39:a7:8a:0d)
    Type: IPv6 (0x86dd)
```

Internet Protocol Version 6, Src: fc00:1000:a811::11, Dst: fc00:1000:a820:e003::

```
    0110 .... = Version: 6
    <0110 .... = Version: 6 [This field makes the filter match on "ip.version == 6" possible]>
    .... 0000 0000 .... .... .... .... .... = Traffic Class: 0x00 (DSCP: CS0, ECN: Not-ECT)
    .... 0000 0000 0000 1110 1111 = Flow Label: 0x000ef
    Payload Length: 82
    Next Header: IPIP (4)
    Hop Limit: 254
    Source Address: fc00:1000:a811::11
    <Source or Destination Address: fc00:1000:a811::11>
    <[Source Host: fc00:1000:a811::11]>
    <[Source or Destination Host: fc00:1000:a811::11]>
    Destination Address: fc00:1000:a820:e003::
    <Source or Destination Address: fc00:1000:a820:e003::>
    <[Destination Host: fc00:1000:a820:e003::]>
    <[Source or Destination Host: fc00:1000:a820:e003::]>
Internet Protocol Version 4, Src: 10.10.1.2, Dst: 10.10.20.2
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
    Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
```

Note:

- Src: fc00:1000:a811::11 >> loopback 100 of PE1 used as the source address.
- Dst : fc00:1000:a820:e003:: >> locator of PE2: function.
- the IPv6 transport header, next is the IPv4 payload.

Per-computed primary and back-up path via Topology-Independent - Loop-Free Alternate (TI-LFA).

<#root>

```
RP/0/RP0/CPU0:PE1#show cef ipv6 fc00:1000:a820::
   via fe80::a2b4:39ff:feff:d416/128, TenGigE0/0/0/9, 11 dependencies, weight 0, class 0,
```

backup (TI-LFA

```
) [flags 0xb00]
    path-idx 0 NHID 0x0 [0x8ef0f2b0 0x0]
```

```
    next hop fe80::a2b4:39ff:feff:d416/128, Repair Node(s): fc00:1000:a802::2
    local adjacency
```

SRv6 H.Insert.Red SID-list {fc00:1000:a802::}

```
   via fe80::9ee1:76ff:feca:e8a8/128, TenGigE0/0/0/8, 4 dependencies, weight 0, class 0, protected [fla
    path-idx 1 bkup-idx 0 NHID 0x0 [0x8f2db710 0x0]
    next hop fe80::9ee1:76ff:feca:e8a8/128
```

Sequency Of Events When the Interface TenGigE0/0/0/8 (Primary Path) on PE1 Goes Down

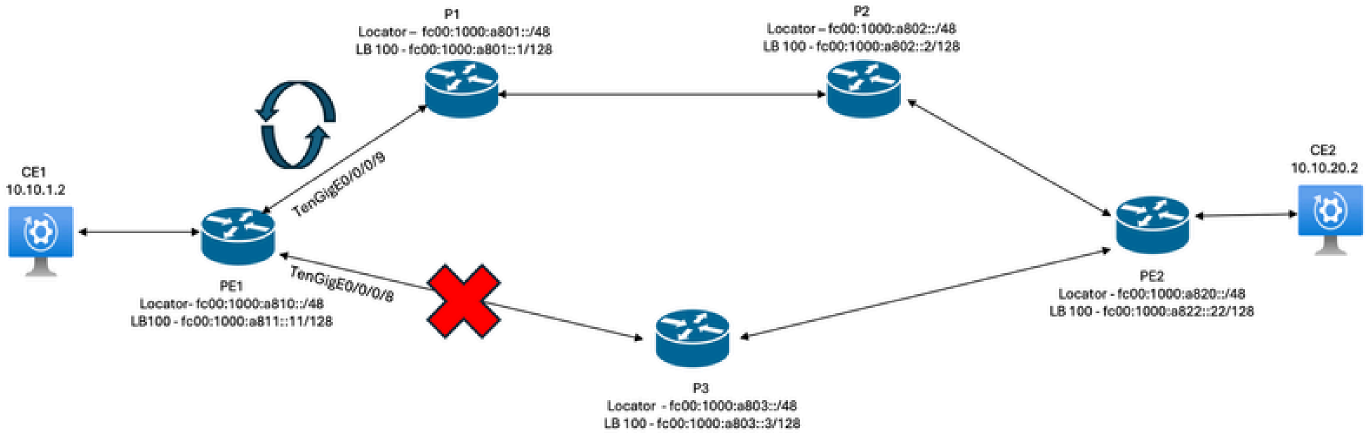

Figure 2. Micro-loop occurrence

On PE1 when the link tengig 0/0/8 goes down, on the backup path between PE1 and P1, a micro-loop is suspected which in turn triggers microloop avoidance (MLA) mechanism on PE1.

<#root>

```
RP/0/RP0/CPU0:PE1#show logging
RP/0/RP0/CPU0:
```

Mar 21 08:30:10.244

```
 UTC: ifmgr[307]: %PKT_INFRA-LINK-5-CHANGED : Interface TenGigE0/0/0/8, changed state to Administrativel
```

When the interface TenGigE0/0/0/8 when down, first there is an Fast Reroute (FRR) event, that is, traffic is sent on the TI-LFA path.

<#root>

```
RP/0/RP0/CPU0:PE1#show cef trace
Mar 21 08:30:10.244 fib/common/frr 0/RP0/CPU0 43# t5991 Common: FRR-ITF-EVENT: proto=3 type=0 ifh=0x3c0
Mar 21 08:30:10.244 fib/common/frr 0/RP0/CPU0 13# t5991 IPv6: FRR-LOOKUP-DONE: evt=0, ifh=0x3c0000a0,
```

Mar 21 08:30:10.244 fib/common/frr 0/RP0/CPU0 12# t5991 IPv6: FRR-ITF-EVENT: Global Active; handle:0x3c0

```
Mar 21 08:30:10.244 fib/common/frr 0/RP0/CPU0 13# t5991 IPv6: FRR-ITF-EVENT: FRR Active; handle:0x3c000
Mar 21 08:30:10.244 fib/common/frr 0/RP0/CPU0 1# t5991 IPv6: FRR-EVENT: evt=0, notify protocol=1, ifh=0
Mar 21 08:30:10.244 fib/common/fast 0/RP0/CPU0 20# t5991 Common: PLAT-UPD-FAST: Proto=common, Obj[FIB_D
```

At 08:30:10:307, there is an IS-IS delete adjacency.

<#root>

```
RP/0/RP0/CPU0:PE1#show isis lsp last 20
```

08:30:10:307

```
    1  Te0/0/0/8          DELADJ
```

At 08:30:10:358, Label Switched Path (LSP) was received, Small Form-Factor Pluggable (SFP) was calculated, and uloop was activated.

<#root>

```
RP/0/RP0/CPU0:PE1#show isis spf-log detail
```

08:30:10:358 FSPF   2   5   2   PE1.00-00 DELADJ LINKBAD

```
  Delay:                 50ms (since first trigger)
                         46257ms (since end of last calculation)
  Trigger Link:          P3.00
  Trigger Next Hop:      P3
  New LSP Arrivals:      0
```

SR uloop: Link Down

Seeing these events more in detail in IS-IS trace, in this case, the configured Routing Information Base (RIB) update delay time is: 65535 ms ~ 65 sec.

<#root>

```
RP/0/RP0/CPU0:PE1#show isis trace all
Mar 21 08:30:10.308 isis/Mring_2801/std 0/RP0/CPU0 t8712 isis_roca_event_schedule_result_debug:329
Mar 21 08:30:10.308 isis/Mring_2801/spf 0/RP0/CPU0 t8712  isis_roca_spf_linkchanged_trigger:2609
```

Mar 21 08:30:10.358 isis/Mring_2801/std 0/RP0/CPU0 6669# t8712 isis_roca_event_start:1541

Mar 21 08:30:10.358 isis/Mring_2801/sr_ 0/RP0/CPU0 t8712 isis_roca_sr_uloop_prep:3069

```
Mar 21 08:30:10.358 isis/Mring_2801/sr_ 0/RP0/CPU0 8451# t8712  isis_roca_uloop_install_exp_path:3915
```

Mar 21 08:30:10.358 isis/Mring_2801/sr_ 0/RP0/CPU0 t8712   isis_roca_prefix_update_run:1040

```
Mar 21 08:30:10.864 isis/Mring_2801/std 0/RP0/CPU0 t8712 isis_roca_frr_run:1538
```

```
Mar 21 08:31:15.893 isis/Mring_2801/sr_ 0/RP0/CPU0 t8712 isis_ip_rib_worker_delayed_update_run:2344
```

RIB status at the time when MLA is active.

<#root>

```
RP/0/RP0/CPU0:PE1#show route ipv6 fc00:1000:a820:: detail
Routing entry for fc00:1000:a820::/48
  Routing Descriptor Blocks
    fe80::a2b4:39ff:feff:d416, from fc00:1000:a822::22, via TenGigE0/0/0/9
      Route metric is 6000
<snip>
      SRv6 Headend: H.Insert.Red [f3216], SID-list {fc00:1000:a802::} ##
```

```
this locator of P2 is inserted before the SRH
```

Cisco Express Forwarding (CEF) status at the time when MLA is active.

<#root>

```
RP/0/RP0/CPU0: PE1#show cef ipv6 fc00:1000:a820:: detail
local adjacency to TenGigE0/0/0/9
<snip>
   via fe80::a2b4:39ff:feff:d416/128, TenGigE0/0/0/9, 10 dependencies, weight 0, class 0 [flags 0x0]
    SRv6 H.Insert.Red SID-list {fc00:1000:a802::}
```

```
## P node (locator of P2)sid is inserted into the packet
```

```
    Load distribution: 0 (refcount 9)
    Hash  OK  Interface                 Address
    0     Y   TenGigE0/0/0/9            fe80::a2b4:39ff:feff:d416
```

A packet originating from PE1 is forwarded via P1 with P2s Micro-Segment Identifier (uSID) as the first active destination. When the packet reaches P2, the SRv6 behavior associated with the uSID triggers Segment Routing Header (SRH) decapsulation, after which the original packet is forwarded to PE2 under MLA forwarding.

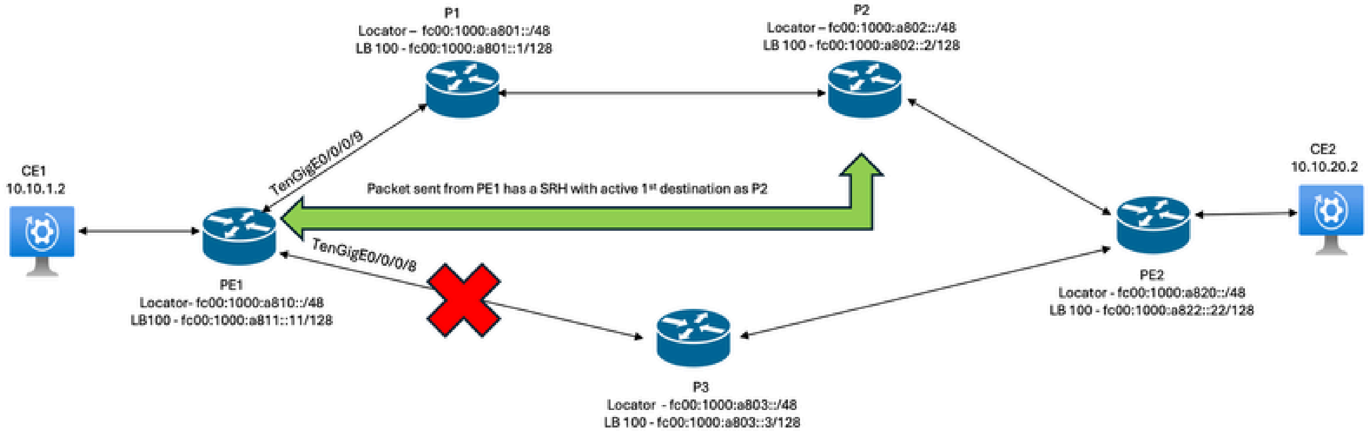

Figure 3. The path taken during MLA

Packet forwarded by PE1 and P1 during MLA.

<#root>

```
Frame 1: 160 bytes on wire (1280 bits), 160 bytes captured (1280 bits)
Ethernet II, Src: Cisco_a7:8a:0d (c4:b2:39:a7:8a:0d), Dst: Cisco_ff:d4:16 (a0:b4:39:ff:d4:16)
```

Internet Protocol Version 6, Src: fc00:1000:a811::11, Dst: fc00:1000:a802:: >> during MLA the 1st active

```
0110 .... = Version: 6
<0110 .... = Version: 6 [This field makes the filter match on "ip.version == 6" possible]>
.... 0000 0000 .... .... .... .... .... = Traffic Class: 0x00 (DSCP: CS0, ECN: Not-ECT)
.... 0000 0000 0000 1110 1111 = Flow Label: 0x000ef
Payload Length: 106
```

Next Header: Routing Header for IPv6 (43) >> indicates the next header is a SRH

```
Hop Limit: 254
Source Address: fc00:1000:a811::11
<Source or Destination Address: fc00:1000:a811::11>
<[Source Host: fc00:1000:a811::11]>
<[Source or Destination Host: fc00:1000:a811::11]>
Destination Address: fc00:1000:a802::
<Source or Destination Address: fc00:1000:a802::>
<[Destination Host: fc00:1000:a802::]>
<[Source or Destination Host: fc00:1000:a802::]>
```

Routing Header for IPv6 (Segment Routing) >>>>>>>>> SRH header which contains the orginal PE2 locator

```
Next Header: IPIP (4)
Length: 2
[Length: 24 bytes]
Type: Segment Routing (4)
```

Segments Left: 1

```
Last Entry: 0
Flags: 0x00
Tag: 0000
```

Address[0]: fc00:1000:a820:e003:: >>>>>>>>>>>>>>>> PE2 locator : function

```
Internet Protocol Version 4, Src: 10.10.1.2, Dst: 10.10.20.2
0100 .... = Version: 4
.... 0101 = Header Length: 20 bytes (5)
```

After decapsulation, the orginal packet is sent by P2 and the SRH is removed by P2 during MLA.

<#root>

```
Frame 1: 136 bytes on wire (1088 bits), 136 bytes captured (1088 bits)
Ethernet II, Src: Cisco_87:d8:58 (b0:a6:51:87:d8:58), Dst: Cisco_af:48:01 (c8:47:09:af:48:01)
```

Internet Protocol Version 6, Src: fc00:1000:a811::11, Dst: fc00:1000:a820:e003::

```
0110 .... = Version: 6
<0110 .... = Version: 6 [This field makes the filter match on "ip.version == 6" possible]>
.... 0000 0000 .... .... .... .... .... = Traffic Class: 0x00 (DSCP: CS0, ECN: Not-ECT)
.... 0000 0000 0000 1110 1111 = Flow Label: 0x000ef
Payload Length: 82
Next Header: IPIP (4)
Hop Limit: 252
Source Address: fc00:1000:a811::11
<Source or Destination Address: fc00:1000:a811::11>
<[Source Host: fc00:1000:a811::11]>
<[Source or Destination Host: fc00:1000:a811::11]>
Destination Address: fc00:1000:a820:e003::
<Source or Destination Address: fc00:1000:a820:e003::>
<[Destination Host: fc00:1000:a820:e003::]>
<[Source or Destination Host: fc00:1000:a820:e003::]>
Internet Protocol Version 4, Src: 10.10.1.2, Dst: 10.10.20.2
Data (62 bytes)
```

After convergency (after RIB update delay timer), the SRH inserted is removed and the packet is sent on the converged best Interior Gateway Protocol (IGP) path.

```
RP/0/RP0/CPU0: PE1#show cef ipv6 fc00:1000:a822::22/128
local adjacency to TenGigE0/0/0/9
 Prefix Len 128, traffic index 0, precedence n/a, priority 1
   via fe80::a2b4:39ff:feff:d416/128, TenGigE0/0/0/9, 9 dependencies, weight 0, class 0 [flags 0x0]
    path-idx 0 NHID 0x0 [0x8ef0f2b0 0x0]
    next hop fe80::a2b4:39ff:feff:d416/128
    local adjacency
```

Timeline Summary

Time	Action	Mechanism
08:30:10.244	Link failure, traffic shift to backup path	TI-LFA
08:30:10:307	LSP received, new Shortest Path First (SPF) calculated	MLA (triggered)
08:30:10.358	RIB update is delayed, traffic is using MLA tunnel	MLA (active)
08:31:15.893	Delay timer expiries, final path installed in FIB	Full convergency

Conclusion

This document detailed how IS-IS–advertised SRv6 uSID paths support MLA during network convergence.

By encoding ordered topological intent directly into the uSID list, traffic is steered through a deterministic sequence of nodes, ensuring loop-free forwarding even while IS-IS SPF calculations are temporarily inconsistent across the network.

During convergence, packets egressing from ingress PEs takes the precomputed uSID sequence, traversing intermediate P nodes without relying on transient IGP next-hop decisions. The decapsulation behavior at the designated uSID endpoint ensures clean transition back to native forwarding once the protected segment is completed. This tightly coupled interaction between IS-IS control-plane updates and SRv6 uSID data-plane behaviors enables fast and deterministic rerouting.

IS-IS uSID–based MLA provides a scalable, topology-aware, and operationally simple solution for microloop-free convergence, making it well suited for large SRv6-enabled networks where fast reroute and deterministic traffic steering are critical.

Commands

- **#show isis instance <> ipv6 microloop avoidance <prefix> detail**
- **#show isis**