

# SRv6 Networks Troubleshooting

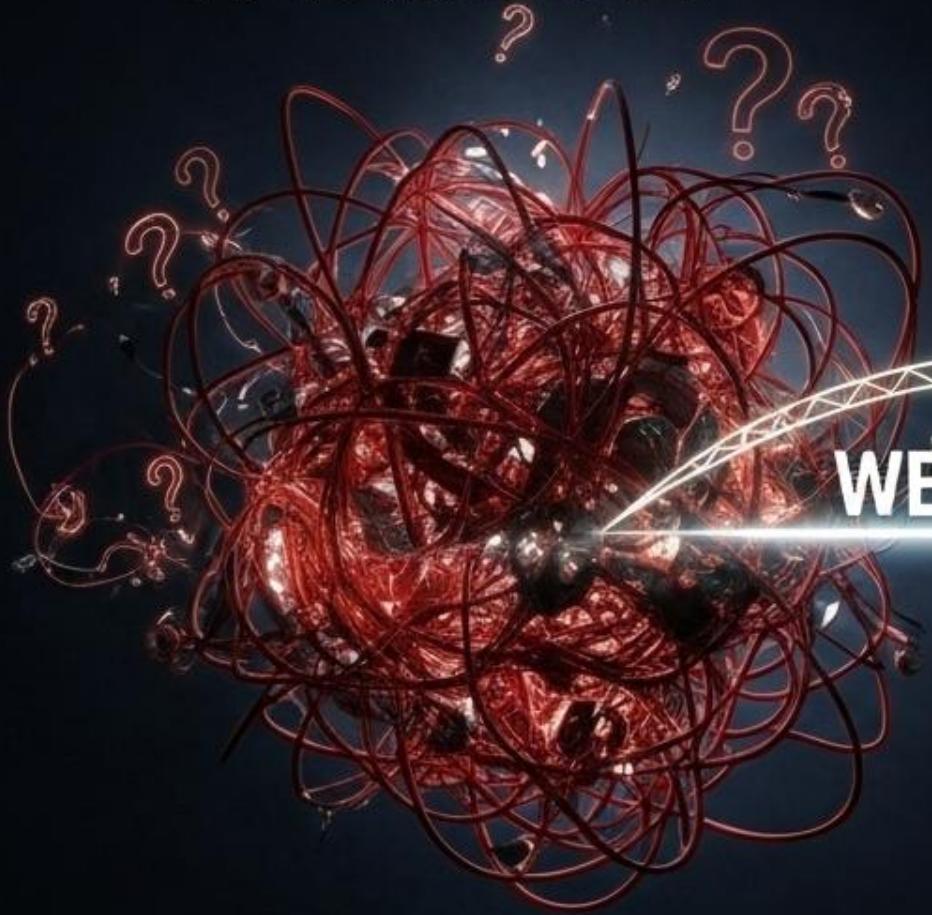
Quick Fixes and Implementation Best Practices

Ashish Panda

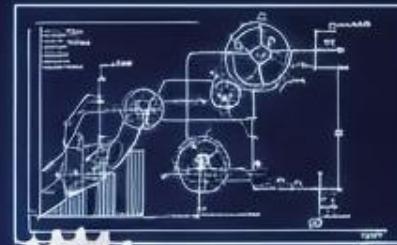
Sr. Technical Leader, @reachtoashish

**cisco** Live !

# A PROBLEM



WELL STATED



“

Charles Kettering,  
VP R&D, General Motors

BRKMPLE-2397

**IS HALF  
SOLVED.**

# Cisco Webex App

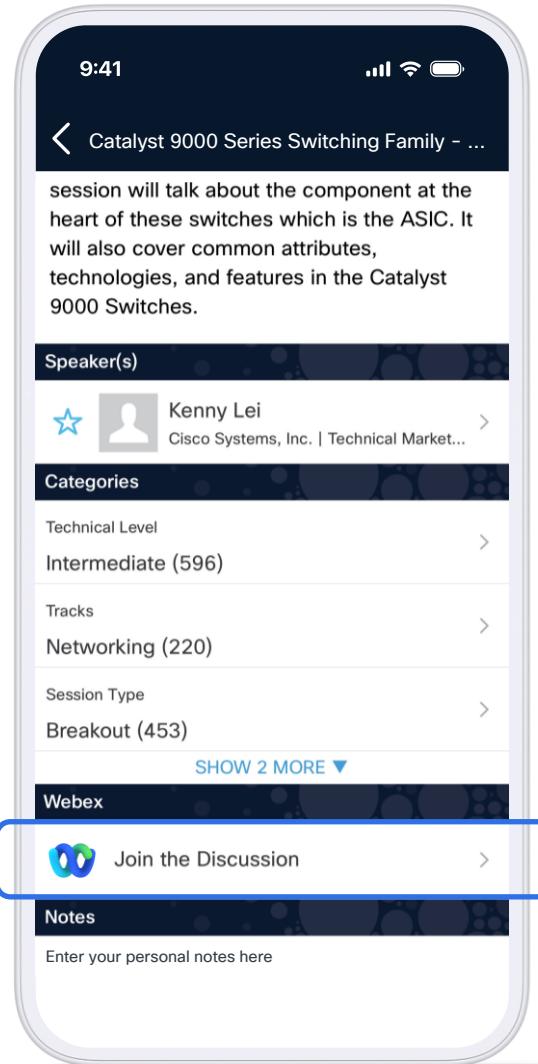
## Questions?

Use Cisco Webex App to chat with the speaker after the session

## How

- 1 Find this session in the Cisco Live Mobile App
- 2 Click “Join the Discussion”
- 3 Install the Webex App or go directly to the Webex space
- 4 Enter messages/questions in the Webex space

**Webex spaces will be moderated by the speaker until 14 November 2025.**



[https://ciscolive.ciscoevents.com/  
ciscolivebot/#BRKMPLS-2397](https://ciscolive.ciscoevents.com/ciscolivebot/#BRKMPLS-2397)

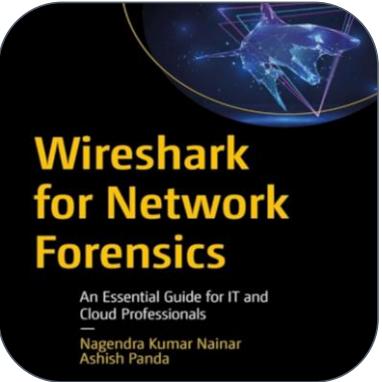
# Agenda

- 01 SRv6 uSID recap
- 02 SRv6 uSID Control plane Troubleshooting
- 03 SRv6 uSID data plane troubleshooting
- 04 Real world failure scenarios
- 05 SRv6 Troubleshooting & Design Best Practices

# About Me



Problem Solver



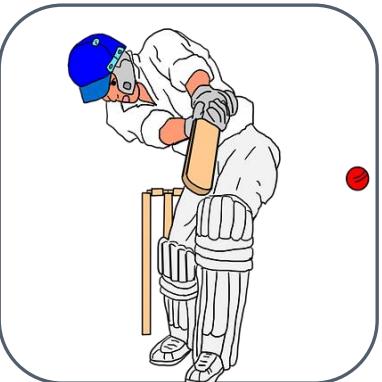
Author



2xCCIE



Inventor



Cricketer



Trekker

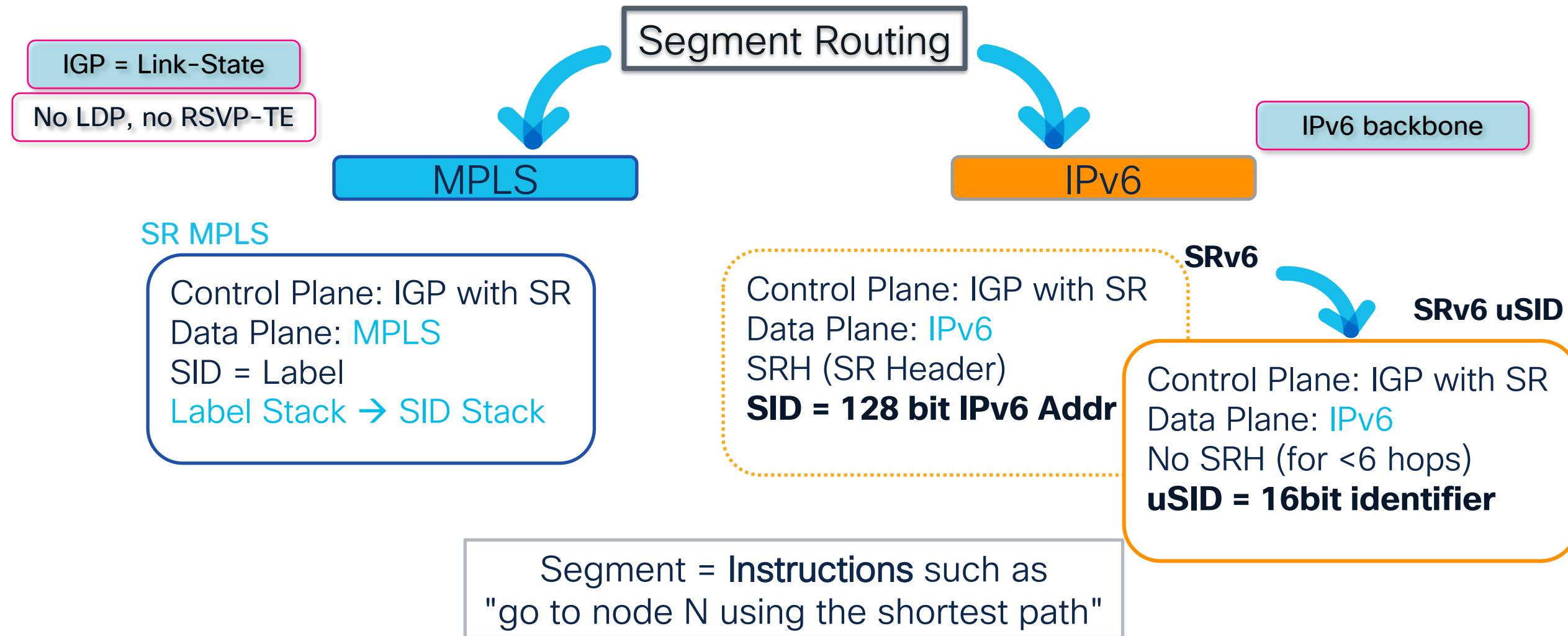
# Before We Get Started

- Basic knowledge on SR is expected
- Focus on SRv6 Micro SID (uSID)
- Configuration & Troubleshooting based on IOS-XR
  - Similar in IOS(-XE)
- Stay up-to-date



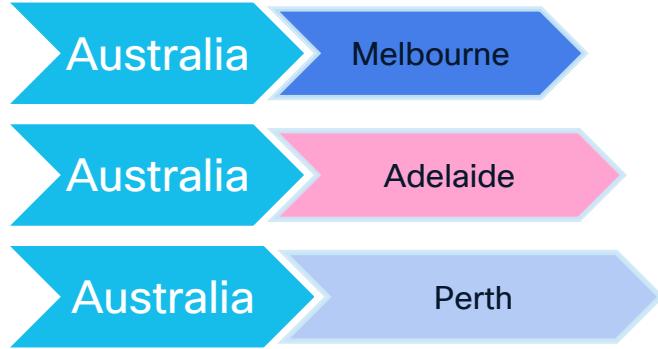
<http://www.segment-routing.net/>

# Segment Routing Evolution

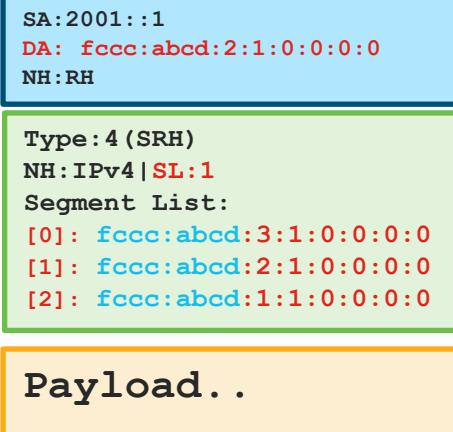


# SRv6 Full SID vs uSID

- 3 Nested Envelopes with Full address



SRV6 Encapsulation



SRV6 uSID Encapsulation



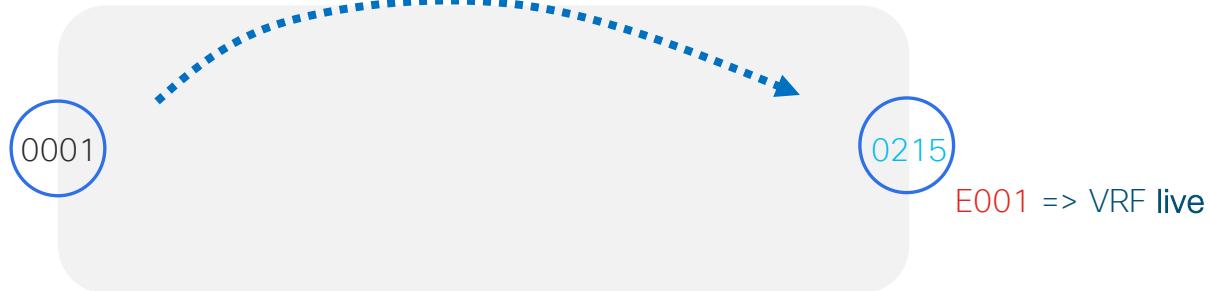
# SRv6 Locator and uSID (F3216)

- Identifies Node and Services

Locator = SID Block(32) + uSID Identifier(16)

Reach Node 215 with SRv6 Locator

DA = FCCC:0001:**0215**::/48



SRv6 uSID to a service (L3VPN)

e.g. Reach 1.1.10/24 in VRF **live** via  
FCCC:0001:**0215**:**E001**::/64

## Example

`fccc:0001:0215::/48`

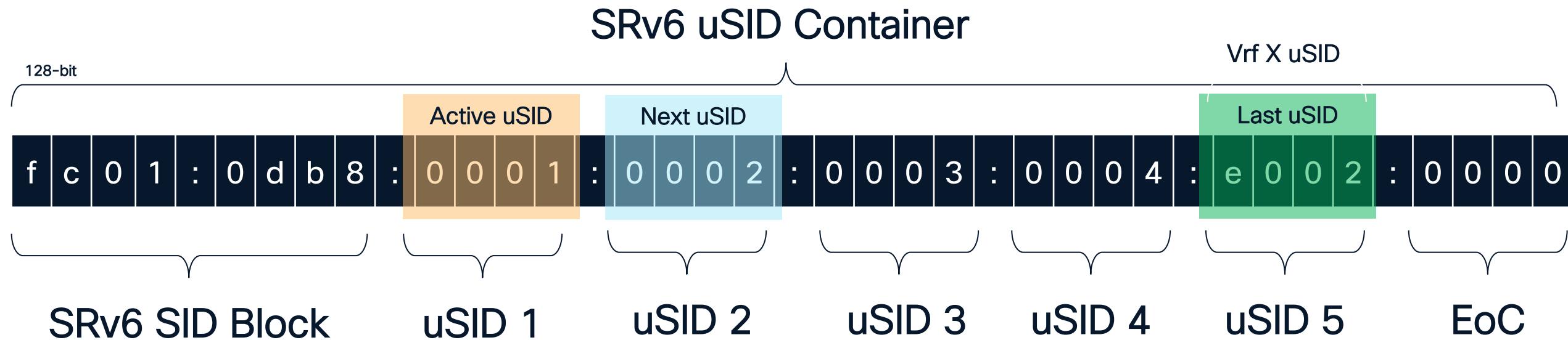
uSID Block

uSID = **0215**

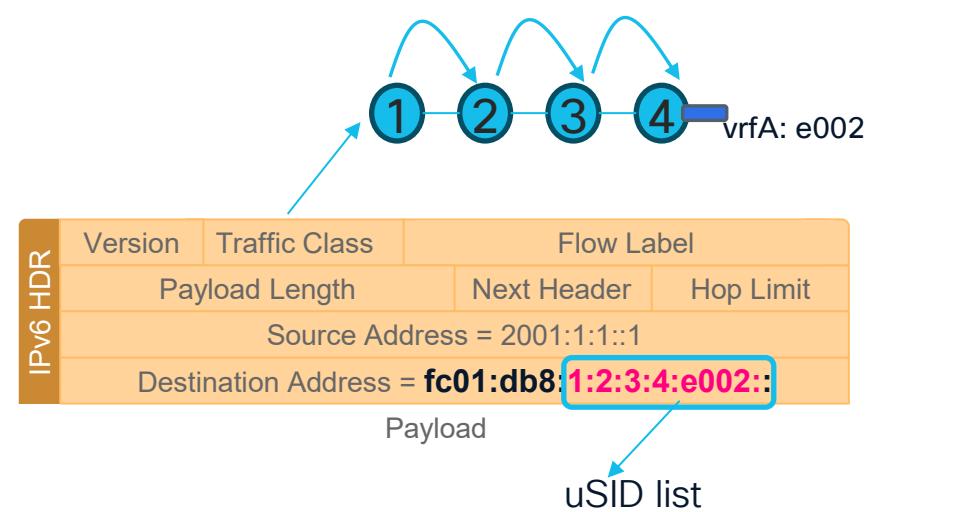
02 = Domain

15 = Node ID

# SRv6 – uSID Encoding

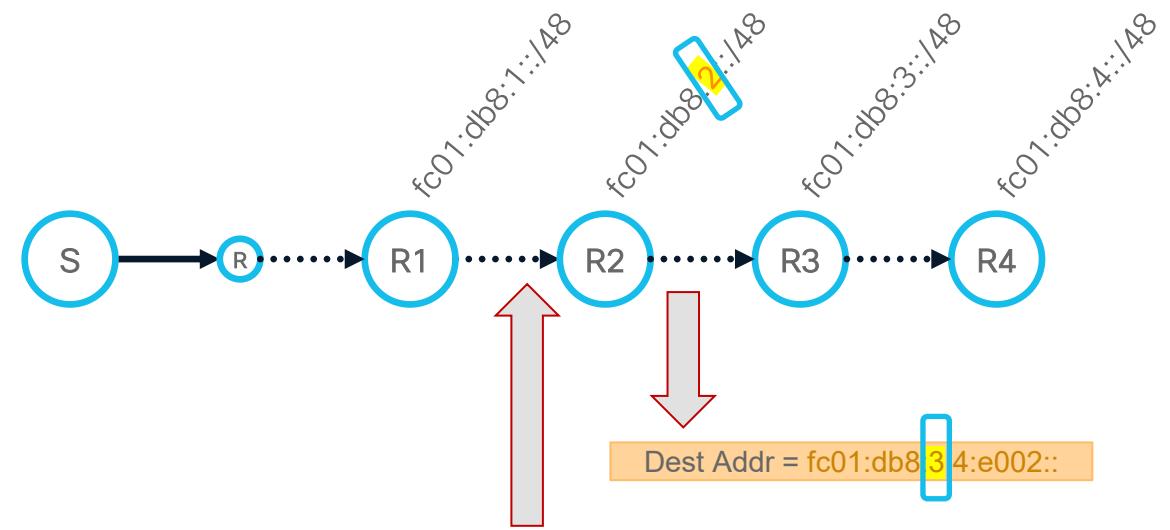


- SRv6 SID Block ( per Network/Domain) – 32 bits
- Compressed SID or uSID – 16 bits
- EoC – End of Container (value 0000)



# SRv6 – uSID – SR Endpoint Node

- R2, a node receives packet with active uSID = 2, same as *its own*
- Applies “Next” behavior
  - Shifts uSID to the left
  - Activates the next uSID
- Forwards according to the new IP DA



IPv6 HDR	Version	Traffic Class	Flow Label		
			Payload Length	Next Header	Hop Limit
			Source Address = 2001:1:1:1		
			Destination Address = fc01:db8:2:3:4:e002::		



# SRv6 / uSID – Functions and Behaviors

```
RP/0/RP0/CPU0:P3#show segment-routing srv6 sid  
*** Locator: 'default' ***
```

SID	Behavior	Context	Owner	State	RW
2001:db8:aa00:3:1::	<b>End</b> (PSP/USD)	'default':1	sidmgr	InUse	Y
2001:db8:aa00:3:40::	<b>End.X</b> (PSP/USD)	[Gi0/0/0/1, Link-Local]:P	isis-1	InUse	Y
2001:db8:aa00:3:41::	<b>End.X</b> (PSP/USD)	[Gi0/0/0/1, Link-Local]	isis-1	InUse	Y
2001:db8:aa00:3:42::	<b>End.X</b> (PSP/USD)	[Gi0/0/0/2, Link-Local]:P	isis-1	InUse	Y
2001:db8:aa00:3:43::	<b>End.X</b> (PSP/USD)	[Gi0/0/0/2, Link-Local]	isis-1	InUse	Y

SRv6

```
RP/0/RP0/CPU0:PE1#show segment-routing srv6 sid  
*** Locator: 'MAIN' ***
```

SID	Behavior	Context	Owner	State	RW
fcbb:bb00:101::	<b>uN</b> (PSP/USD)	'default':257	<b>sidmgr</b>	InUse	Y
fcbb:bb00:101: <b>e000</b> ::	<b>uA</b> (PSP/USD)	[Gi0/0/0/2, Link-Local]:0	<b>isis-1</b>	InUse	Y
fcbb:bb00:101: <b>e001</b> ::	<b>uA</b> (PSP/USD)	[Gi0/0/0/1, Link-Local]:0	<b>isis-1</b>	InUse	Y
fcbb:bb00:101: <b>e002</b> ::	<b>uDT4</b>	'one'	<b>bgp-65001</b>	InUse	Y
fcbb:bb00:101: <b>e003</b> ::	<b>uB6</b> (Insert.Red)	'srte_c_100_ep_2001:1:101::2' (100, 2001:1:101::2)	<b>xtc_srv6</b>	InUse	Y

uSID

**uDT4** - IPv4 L3VPN Function

**uA** - Adjacency SID Behavior

**uB6** - SR Policy Binding SID

# SRv6 SID/uSID Endpoint behavior signaling

SID function	uSID function	Usage
End	uN	SRv6 version of prefix-SID
End.X	uA	L3 cross-connect, SRv6 version of Adj-SID
End.T	uT	IPv6 table lookup
End.DX6	uDX6	Decapsulate and perform IPv6 cross-connect, per-CE IPv6 L3VPN use case
End.DX4	uDX4	Decapsulate and perform IPv4 cross-connect, per-CE IPv4 L3VPN use case
End.DT6	uDT6	Decapsulate and perform IPv6 route lookup, per-VRF IPv6 L3VPN use case
End.DT4	uDT4	Decapsulate and perform IPv4 route lookup, per-VRF IPv4 L3VPN use case
End.DT46	uDT46	Decapsulate and perform IPv4 or IPv6 route lookup, per-VRF IP L3VPN use case
End.DX2	uDX2	Decapsulate and perform L2 cross-connect, P2P L2VPN use case
End.DX2V		Decapsulate and perform L2 VLAN lookup, P2P L2VPN using VLANs use case
End.DT2U	uDT2U	Decapsulate and perform unicast MAC lookup, L2VPN ELAN use case
End.DT2M	uDT2M	Decapsulate and perform L2 flooding, L2VPN ELAN use case
End.B6.Encaps	uB6	Identifies SRv6 SID bound to a SRv6 Policy, binding SID
End.B6.Encaps.Red		End.B6 with reduced SRH
End.BM		Endpoint bound to an SR-MPLS Policy

RFC8986,

[draft-ietf-spring-srv6-srh-compression-18](#),

[draft-filsfils-spring-net-pgm-extension-srv6-usid-16](#)

# Bringing up SRv6 uSID

```
router isis 1
  is-type level-2-only
  net 49.0001.0000.0000.0001.00
!
address-family ipv6 unicast
  metric-style wide
  router-id Loopback0
  segment-routing srv6
    locator MAIN
  !
!
interface Loopback0
  address-family ipv6 unicast
  !
!
interface GigabitEthernet0/0/0/1
  address-family ipv6 unicast
  !
```

It is all IPv6

Map Locator to IGP

```
segment-routing
  srv6
  locators
    locator MAIN
      micro-segment behavior unode psp-usd
      prefix fcbb:bb00:101::/48
```

With this command: uSID  
Without this command: SRv6 Full-Sid

- **F3216 Format :**
  - 32-bit uSID block (e.g. fcbb:bb00)
  - 16-bit uSID IDs 3216 (e.g. 0101)
- Same uSID block (e.g. fcbb:bb00) on all routers in the SRv6 domain
- up to 8 uSID locators to support SRv6 Flexible Algorithm. (e.g. fcbb:bb<algo>)



# SRv6 Configured, but Packets dropping?

# Platform Dependency Enabling SRv6 uSID

- NCS5500 (J+) / NCS540 / NCS560

- Requires global hw-module profile configuration

hw-module profile segment-routing srv6 mode micro-segment format f3216

- *Chassis reload is required*

- NCS5500 (J2) / NCS5700 (J2)

- SRv6 works in J2 native mode only (Mixed ASICs not supported)

hw-module profile npu native-mode-enable

- *Chassis reload is required*

- *If there are non J2 cards on NCS5500, they will go down after enabling Native mode.*

```
RP/0/RP1/CPU0:P4#show logging | i srv6
<SNIP>
%PLATFORM-PLAT_FIB-3-HW_PROG_ERROR : HW Programming failed for table,srv6nh key,0xf1c0000040011845,unit,0,dpa_trans_id,193829,failure-
reason,Unavail

%ROUTING-FIB-3-PD_FAIL : FIB platform error: fib_srv6_gbl_platform_upd 215: PD action GBL_UPDATE failed for srv6 gbl upd SRV6 SHM ptr
0x308e04e0a8 srv6 enabled upd_flags 0x7e : 0x4f9c0800 'DPA' detected the 'warning' condition 'SDK - Internal error'
```

# Troubleshooting SRv6 uSID Control Plane

# Possible Control Plane Issues



## Symptoms

- SID not learnt
- Unexpected SID
- Traffic not taking desired path
- Locator conflicts
- SR Policy down, traffic not taking policy path,



## Cause

- IGP configuration issues (redistribution, filtering)
- BGP advertisement issues : check at every hop.
- Misconfiguration
  - Locator
  - Carrier, algorithm
  - SRv6 type (uSID/Base)
- PCE, Topology, Policy configuration issues

# SRv6 uSID in the IGP

# Verifying Local SRv6 SIDs

```
RP/0/RP0/CPU0:PE1#show segment-routing srv6 sid
```

\*\*\* Locator: 'MAIN' \*\*\*

SID	Behavior	Context	Owner	State	RW
fcbb:bb00:101::	uN (PSP/USD)	'default':257	sidmgr	InUse	Y
fcbb:bb00:101:e000::	uA (PSP/USD)	[Gi0/0/0/1, Link-Local]:0	isis-1	InUse	Y
fcbb:bb00:101:e001::	uA (PSP/USD)	[Gi0/0/0/2, Link-Local]:0	isis-1	InUse	Y
fcbb:bb00:101:e002::	uB6 (Insert.Red)	'srte_c_100_ep_2001:1:101::2' (100, 2001:1:101::2)	xtc_srv6	InUse	Y
fcbb:bb00:101:e003::	uDT4	'one'	bgp-65001	InUse	Y

## Check Local SRv6 Routes

```
RP/0/RP0/CPU0:PE1#show route ipv6 local-srv6
```

- L fcbb:bb00:101:e002::/64, SRv6 Endpoint uB6 (Insert.Red)  
[0/11] via fe80::5054:ff:fe02:a55e, 01:16:22, GigabitEthernet0/0/0/2
- L fcbb:bb00:101:e003::/64, SRv6 Endpoint uDT4  
[0/0] via ::ffff:0.0.0.0 (nexthop in vrf one), 01:25:20
- L fcbb:bb00:101:e000::/64, SRv6 Endpoint uA (shift)  
[0/0] via fe80::5054:ff:fe02:7033, 01:23:44, GigabitEthernet0/0/0/1
- L fcbb:bb00:101:e001::/64, SRv6 Endpoint uA (shift)  
[0/0] via fe80::5054:ff:fe02:7034, 01:23:44, GigabitEthernet0/0/0/2
- L fcbb:bb00:101::/48, SRv6 Endpoint uN (shift)  
[0/0] via ::, 01:45:54
- L fcbb:bb00:101::/64, SRv6 Endpoint uN (PSP/USD)  
[0/0] via ::, 01:45:54

# Verifying remote IGP SRv6 SIDs

```
RP/0/RP0/CPU0:PE1#show route ipv6 isis
<SNIP>
i L2 fc00:c000:3::/48
    [115/11] via fe80::aec:f5ff:fe1b:b420, 6d22h, Bundle-Ether613
i L2 fc00:c000:4::/48
    [115/21] via fe80::aec:f5ff:fe30:8e3c, 6d22h, Bundle-Ether612
i L2 fc00:c000:102::/48
    [115/11] via fe80::aec:f5ff:fe30:8e3c, 6d22h, Bundle-Ether612
i L2 fc00:c000:200::/40
    [115/31] via fe80::aec:f5ff:fe1b:b420, 00:05:24, Bundle-Ether613
RP/0/RP0/CPU0:PE1#
```

## Check SRv6 Route detail

```
RP/0/RP0/CPU0:PE1_BGL18-4-TS-N55A2#show route ipv6 fc00:c000:102::/48 detail
Tue Oct 1 08:45:33.434 UTC

Routing entry for fc00:c000:102::/48
Known via "isis ACCESS", distance 115, metric 11, SRv6-locator, type level-2
Installed Sep 24 10:32:27.034 for 6d22h
Routing Descriptor Blocks
    fe80::aec:f5ff:fe30:8e3c, from 2001::100:1:1:2, via Bundle-Ether612
    Route metric is 11
```

## Filter SRv6 SID Block for Global SIDs

```
RP/0/RP0/CPU0:PE1#show route ipv6 isis | I fc00
<SNIP>
i L2 fc00:c000:3::/48
i L2 fc00:c000:4::/48
i L2 fc00:c000:102::/48
i L2 fc00:c000:200::/40
RP/0/RP0/CPU0:PE1#
```

## Filter from ISIS database

```
RP/0/RP0/CPU0:PE1#show isis database verbose | i "Locator|uN|uA"
SRv6 Locator: MT (IPv6 Unicast) fc00:c000:101::/48 D:0 Metric: 1 Algorithm: 0
    END SID: fc00:c000:101:: uN (PSP/USD)
    END.X SID: fc00:c000:101:e003:: B:1 S:0 P:0 uA (PSP/USD) Alg:0
    END.X SID: fc00:c000:101:e004:: B:0 S:0 P:0 uA (PSP/USD) Alg:0
SRv6 Locator: MT (IPv6 Unicast) fc00:c000:102::/48 D:0 Metric: 1 Algorithm: 0
    END SID: fc00:c000:102:: uN (PSP/USD)
    END.X SID: fc00:c000:102:e000:: B:0 S:0 P:0 uA (PSP/USD) Alg:0
SRv6 Locator: MT (IPv6 Unicast) fc00:c000:3::/48 D:0 Metric: 0 Algorithm: 0
    END SID: fc00:c000:3:: uN (PSP/USD)
    END.X SID: fc00:c000:3:e000:: B:0 S:0 P:0 uA (PSP/USD) Alg:0 ...<SNIP>
```

# SRv6 Capable routers: ISIS Locator advertisement

RFC9352

- New SRv6 Locator top-level TLV (27) Announces SRv6 Locators
  - Sub-TLVs
    - 5 (SRv6 End SID Sub-TLV)
    - 25 (SRv6 Capabilities Sub-TLV)
    - 43 (SRv6 End.X SID Sub-TLV)
    - 44 (SRv6 LAN End.X SID Sub-TLV)
  - Several new sub-sub-TLVs are defined

```
RP/0/RP0/CPU0:PE1#show isis database PE1.00-00 verbose

IS-IS core (Level-2) Link State Database
LSPID          LSP Seq Num  LSP Checksum  LSP Holdtime/Rcvd  ATT/P/OL
PE1.00-00      * 0x0000001a  0xdfae        727  /*           0/0/0
<snip>
SRv6 Locator: MT (IPv6 Unicast) fcbb:bb00:101::/48 D:0 Metric: 1 Algorithm: 0
  Prefix Attribute Flags: X:0 R:0 N:0 E:0 A:0
  END SID: fcbb:bb00:101:: uN (PSP/USD)
    SID Structure:
      Block Length: 32, Node-ID Length: 16, Func-Length: 0, Args-Length: 80
<snip>
<SNIP>
  END.X SID: fc00:c000:101:e005:: B:1 S:0 P:0 uA (PSP/USD) Alg:0
    SID Structure:
      Block Length: 32, Node-ID Length: 16, Func-Length: 16, Args-Length: 64
  END.X SID: fc00:c000:101:e006:: B:0 S:0 P:0 uA (PSP/USD) Alg:0
    SID Structure:
      Block Length: 32, Node-ID Length: 16, Func-Length: 16, Args-Length: 64
<snip>
```

ISIS Link State Protocol Data Unit

Wireshark

SRv6 Locator (t=27, l=47) ← TLV  
<snip>  
**SRv6 Locator:** fcbb:bb00:101::/48 (Algorithm: 0)  
Metric: 1  
Flags: 0x00  
Algorithm: Shortest Path First (SPF) (0)  
Locator Size: 48  
Locator: fcbb:bb00:101::  
SubCLV Length: 31  
**subTLV: Prefix Attribute Flags** (c=4, l=1): Flags:---  
**subTLV: SRv6 End SID** (c=5, l=26)  
Code: SRv6 End SID (5)  
Length: 26  
Flags: 0x00  
**Endpoint Behavior:** End (NEXT-CSID/PSP/USD) (48)  
SID: fcbb:bb00:101::  
SubSubCLV Length: 6  
**subsubTLV: SRv6 SID Structure** (c=1, l=4)  
Locator Block Length: 32  
Locator Node Length: 16  
Function Length: 0  
Arguments Length: 80

# Non SRv6 aware routers Locator reachability

RFC9352

- Additional advertisement in Prefix Reachability TLV (236 or 237)
  - Allows non-SRv6 routers reach Locator subnet

```
show isis database PE1.00-00 verbose

IS-IS core (Level-2) Link State Database
LSPID          LSP Seq Num  LSP Checksum  LSP Holdtime/Rcvd
ATT/P/OL
PE1.00-00      * 0x0000001a  0xdfae        727  /*           0/0/0
<snip>
Metric: 10      MT (IPv6 Unicast) IPv6 2001:db8::1/128
  Prefix Attribute Flags: X:0 R:0 N:1 E:0 A:0
  Source Router ID: 2001:db8::1
Metric: 1      MT (IPv6 Unicast) IPv6 fcbb:bb00:101::/48
  Prefix Attribute Flags: X:0 R:0 N:0 E:0 A:0
<snip>
```

**ISIS Link State Protocol Data Unit** **Wireshark**

Multi Topology Reachable IPv6 Prefixes (t=237, l=62)

<snip>

IPv6 Reachability: 2001:db8::1/128

**IPv6 Reachability: fcbb:bb00:101::/48**

**Metric:** 1

0... .... = Distribution: Up

.0... .... = Distribution: Internal

.1... .... = Sub-TLV: Yes

**Prefix Length:** 48

**IPv6 prefix:** fcbb:bb00:101::

SubCLV Length: 3

subTLV: Prefix Attribute Flags (c=4, l=1): Flags-Code: Prefix Attribute Flags (4)

Length: 1

Flags: 0x00

0... .... = External Prefix: Not set

.0... .... = Re-advertisement: Not set

.0... .... = Node: Not set

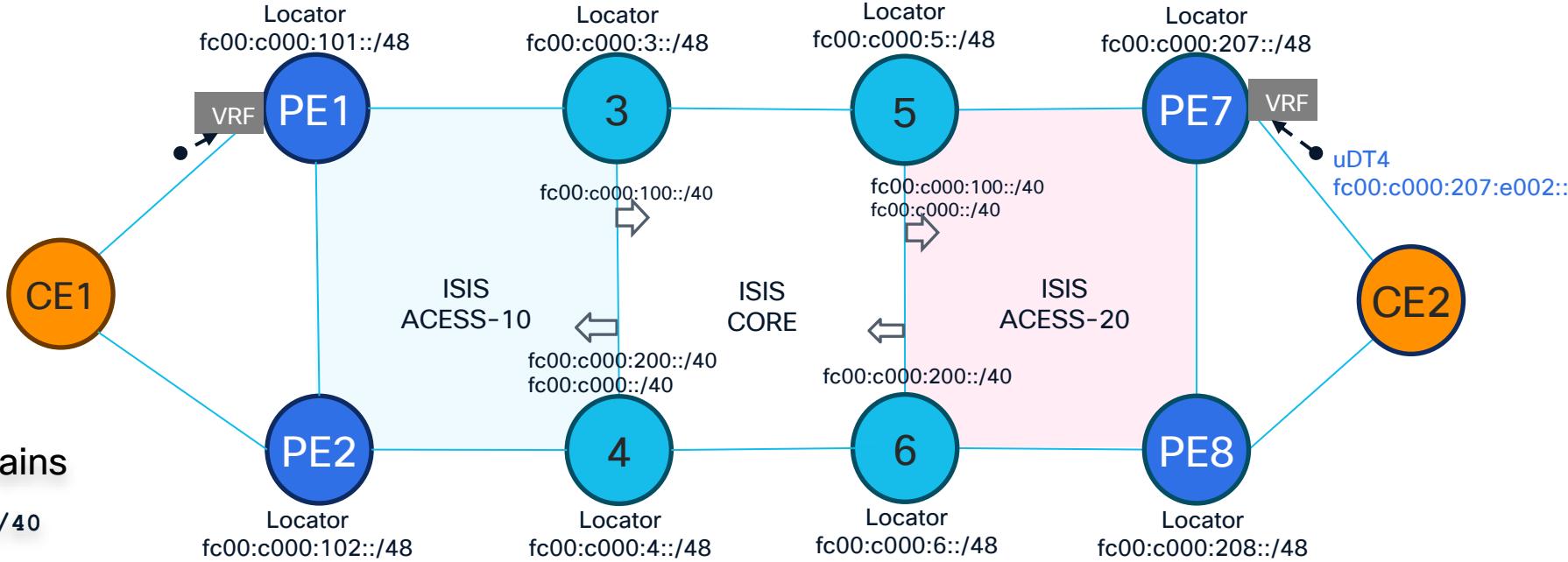
# Router in Different IGP domain

- BGP-LU NOT needed
- Only /40 Summary across domains

```
RP/0/RP0/CPU0:PE1#show route ipv6 | i /40
<SNIP>
i L2 fc00:c000::/40
i L2 fc00:c000:200::/40
RP/0/RP0/CPU0:PE1#
```

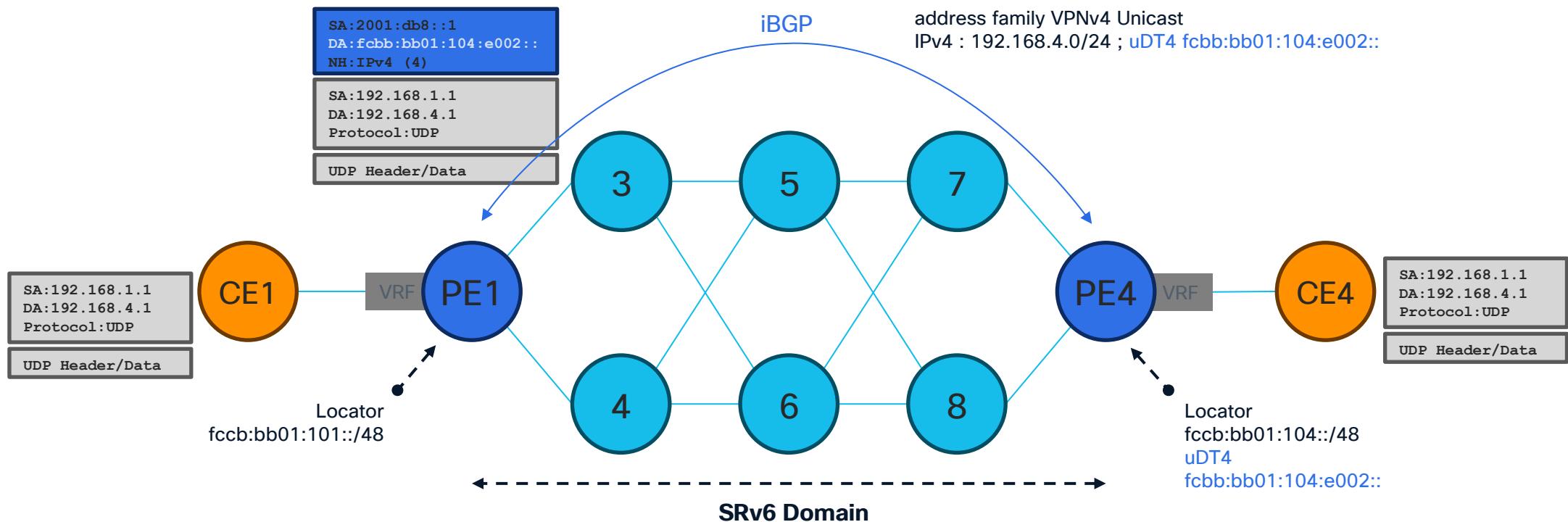
```
RP/0/RP0/CPU0:PE1#show isis database P3 verbose
<SNIP>
IPv6 Router ID: fc00:c000:3::3
IPv6 Address: fc00:c000:3::3
Metric: 31          MT (IPv6 Unicast) IPv6-Ext-InAr fc00:c000:200::/40
  Prefix Attribute Flags: X:0 R:0 N:0 E:0 A:0
Metric: 10          MT (IPv6 Unicast) IPv6-Ext-InAr fc00:c000::/40
  Admin. Tag: 100
  Prefix Attribute Flags: X:0 R:0 N:0 E:0 A:0
```

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



# **Overlay Services: L3VPN & BGP**

# SRv6 Overlay Services – L3VPN



- Locator is advertised by IS-ISv6
- Service SID (instead of label) is advertised by egress PE MP-BGP
  - Ingress PE encapsulates the payload with IPv6 DA = (Egress Locator + Service SID)
  - SRv6 TE or TI-LFA/Microloop Avoidance may require multiple SIDs
  - Intermediate routers need to understand IPv6 Only

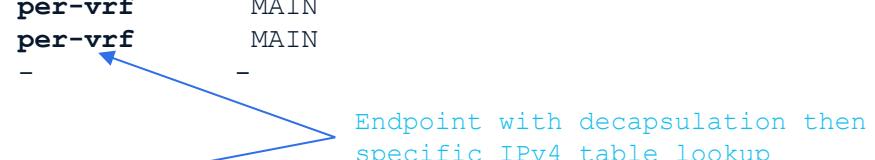
# SRv6 Overlay Services – L3VPN

- Configure SRv6 Locator
  - Map to the VRF under right AF (ipv4/ipv6)
  - Define the Allocation Mode (Per-vrf/Per-ce)

```
!
router bgp 65534
address-family vpnv4 unicast
!
vrf SRV6_VRF
rd 100:1
address-family ipv4 unicast
segment-routing srv6
locator MAIN
alloc mode per-vrf
!
redistribute connected !-- 192.168.1/24
redistribute static !-- 192.168.11/24
!
```

```
RP/0/RP0/CPU0:PE1#show bgp vrf SRV6_VRF local-sids
<snip>
Origin codes: i - IGP, e - EGP, ? - incomplete
Network          Local Sid
Route Distinguisher: 100:1 (default for vrf SRV6_VRF)
Route Distinguisher Version: 35
*> 192.168.1.0/24      fcbb:bb00:101:e006::
*> 192.168.11.0/24     fcbb:bb00:101:e006::
*>i100.0.0.70/32      NO SRv6 Sid
RP/0/RP0/CPU0:PE1#show segment-routing srv6 sid
```

SID	Behavior	Context	Owner	State	RW
fcbb:bb00:101:e006::	uDT4	'SRV6_VRF'	bgp-65534	InUse	Y



# Services - Verifying BGP SRv6 SIDs

Check SRv6  
BGP allocated  
Local SIDs

```
RP/0/RP0/CPU0:PE1#show bgp vrf SRV6_VRF local-sids
<snip>
Origin codes: i - IGP, e - EGP, ? - incomplete
Network          Local Sid
Route Distinguisher: 100:1 (default for vrf SRV6_VRF)
Route Distinguisher Version: 35
*> 192.168.1.0/24    fcbb:bb00:101:e006::      Alloc mode   Locator
*> 192.168.11.0/24   fcbb:bb00:101:e006::      per-vrf       MAIN
*>i100.0.0.70/32     NO SRv6 Sid                 per-vrf       MAIN
                               -
RP/0/RP0/CPU0:PE1#
```

Egress PE

No local allocation as Received prefix.

Check SRv6  
BGP Received  
SIDs

```
RP/0/RP0/CPU0:PE1#show bgp vrf SRV6_VRF received-sids | e NO
<SNIP>
Network          Next Hop           Received
Sid
Route Distinguisher: 100:1 (default for vrf vrf1)
Route Distinguisher Version: 1733
*>i100.0.0.70/32  100.4.4.1        fcbb:bb00:104:e002::
```

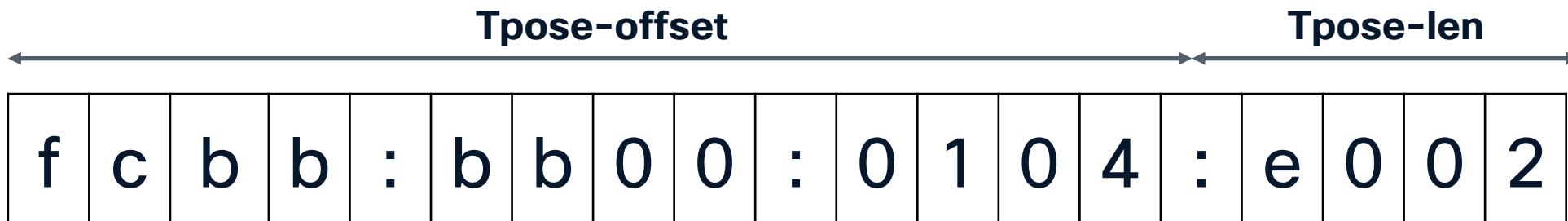
Ingress PE

# SRv6 Overlay Services – L3VPN

## Advertising the SRv6 Service SID

RFC9252

```
RP/0/RP0/CPU0:PE1#show bgp vpng4 unicast vrf 100 192.168.4.0/24 detail
<snip>
  Received Label 0xe0020 ← 20-bit value
  <snip>
  PSID-Type:L3, SubTLV Count:1, R:0x00,
  SubTLV:
    T:1(Sid information), Sid:fcbb:bb00:104::(Transposed), F:0x00, R2:0x00, Behavior:63, R3:0x00, SS-TLV Count:1
    SubSubTLV:
      T:1(Sid structure):
        Length [Loc-blk,Loc-node,Func,Arg]:[32,16,16,0], Tpose-len:16, Tpose-offset:48
```



- Transposition Scheme
  - Variable part of the SRv6 SID in the NLRI Label field
  - Common part of the SRv6 SID in the SRv6 SID Information Sub-TLV
  - SRv6 SID fields length and the offset of the variable part along with its length in the SRv6 SID Structure Sub-Sub-TLV

# SRv6 Overlay Services – L3VPN

## Route Programming (Imposition)

```
RP/0/RP0/CPU0:PE1#show route vrf 100 192.168.4.0/24 detail
```

```
Routing entry for 192.168.4.0/24
Known via "bgp 65534", distance 200, metric 0, type internal
Installed Nov 9 18:19:48.109 for 1d20h
Routing Descriptor Blocks
 2001:db8::4, from 2001:db8::2
    Nexthop in Vrf: "default", Table: "default", IPv6 Unicast, Table Id: 0xe0800000
      Route metric is 0
      Label: None
      Tunnel ID: None
      Binding Label: None
      Extended communities count: 0
      Source RD attributes: 0x0000:100:4
      NHID: 0x0 (Ref: 0)
      SRv6 Headend: H.Encaps.Red [f3216], SID-list {fcbb:bb00:104:e002::}
      MPLS eid:0x1184b00000001
      Route version is 0x1 (1)
      No local label
      IP Precedence: Not Set
      QoS Group ID: Not Set
      Flow-tag: Not Set
      Fwd-class: Not Set
      Route Priority: RIB_PRIORITY_RECURSIVE (12) SVD Type RIB_SVD_TYPE_REMOTE
      Download Priority 3, Download Version 19
      No advertising protos.
```

```
RP/0/RP0/CPU0:PE1#show route ipv6 fcbb:bb00:104:e002::
```

Remote PE Service SID

```
Routing entry for fcbb:bb00:104::/48
Known via "isis core", distance 115, metric 21, SRv6-locator, type level-2
Installed Nov 9 18:19:31.026 for 1d20h
Routing Descriptor Blocks
  fe80::c6b2:39ff:fea7:7f09, from 2001:db8::4
    Route metric is 21
  fe80::eaf:31ff:fec9:bc1d, from 2001:db8::4, via TenGigE0/0/0/1
    Route metric is 21
  No advertising protos.
```

via TenGigE0/0/0/0

# SRv6 Overlay Services – L3VPN Locator Programming (Imposition)

```
RP/0/RP0/CPU0:PE1#show cef vrf 100 192.168.4.0/24

192.168.4.0/24, version 19, SRv6 Headend, internal 0x5000001 0x30 (ptr 0x8c488be8) [1], 0x0 (0x0), 0x0
(0x8cd86560)
Updated Nov 9 18:19:48.185
Prefix Len 24, traffic index 0, precedence n/a, priority 3
gateway array (0x8d183098) reference count 2, flags 0x2010, source rib (7), 0 backups
[1 type 3 flags 0x48441 (0x8ad66b18) ext 0x0 (0x0)]
LW-LDI[type=0, refc=0, ptr=0x0, sh-ldi=0x0]
gateway array update type-time 1 Nov 9 18:19:48.185
LDI Update time Nov 9 18:19:48.197

Level 1 - Load distribution: 0
[0] via fcbb:bb00:104::/128, recursive

via fcbb:bb00:104::/128, 5 dependencies, recursive [flags 0x6000]
path-idx 0 NHID 0x0 [0x8b24d690 0x0]
next hop VRF - 'default', table - 0xe0800000
next hop fcbb:bb00:104::/128 via fcbb:bb00:104::/48
SRv6 H.Encaps.Red SID-list {fcbb:bb00:104:e002::}
```

Load distribution: 0 1 (refcount 1)

Hash	OK	Interface
0	Y	TenGigE0/0/0/1
1	Y	TenGigE0/0/0/0

Address
fe80::c6b2:39ff:fea7:7f09
fe80::eaf:31ff:fec9:bc1d

Dump Hardware CEF Chain: show cef ipv6 fcbb:bb00:104:e002:: hardware egress detail location 0/0/CPU0

# SRv6 Overlay Services – L3VPN Forwarding and Programming (Disposition)

## Route Look up for Allocated SRv6 uSID

```
RP/0/RP0/CPU0:PE1#show route ipv6 fcbb:bb00:101:e006::  
Routing entry for fcbb:bb00:101:e006::/64  
Known via "local-srv6 bgp-65534", distance 0, metric 0, SRv6 Endpoint uDT4,  
SRv6 Format f3216  
Installed Nov 9 18:19:48.108 for 1d20h  
Routing Descriptor Blocks  
    directly connected  
    Nexthop in Vrf: "100", Table: "default", IPv4 Unicast, Table Id: 0xe0000001  
    Route metric is 0  
    No advertising protos.
```

1

## Forwarding Look up for Allocated SRv6 uSID

### Forwarding Look up for Allocated SRv6 uSID

```
RP/0/RP0/CPU0:PE1#show cef ipv6 fcbb:bb00:101:e006::  
fcbb:bb00:101:e006::/64, version 40, SRv6 Endpoint uDT4, internal 0x1000001 0x0 (ptr  
0x8b24d820) [1], 0x400 (0x8b20ed18), 0x0 (0x8cd86488)  
Updated Nov 9 18:19:48.110  
Prefix Len 64, traffic index 0, precedence n/a, priority 0  
gateway array (0x8b0a1398) reference count 1, flags 0x0, source rib (7), 0 backups  
[2 type 3 flags 0x8401 (0x8b144d58) ext 0x0 (0x0)]  
LW-LDI[type=3, refc=1, ptr=0x8b20ed18, sh-ldi=0x8b144d58]  
gateway array update type-time 1 Nov 9 18:19:48.110  
LDI Update time Nov 9 18:19:48.111  
LW-LDI-TS Nov 9 18:19:48.111  
Accounting: Disabled  
via ::ffff:0.0.0.0/128, 0 dependencies, weight 0, class 0 [flags 0x0]  
path-idx 0 NHID 0x0 [0x8a0f6108 0x0]  
next hop VRF - '100', table - 0xe0000001  
next hop ::ffff:0.0.0.0/128  
  
Load distribution: 0 (refcount 2)  
  
Hash OK Interface Address  
0 Y recursive Lookup in table
```

2

## Forwarding Look up for IPv4 inner header in VRF

```
RP/0/RP0/CPU0:PE1# show cef vrf 100 172.16.0.60/32  
<SNIP>  
via 10.6.11.1/32, 5 dependencies, recursive, bgp-ext [flags 0x6020]  
path-idx 0 NHID 0x0 [0x8b13f420 0x0]  
next hop 10.6.11.1/32 via 10.6.11.1/32  
  
Load distribution: 0 (refcount 1)  
  
Hash OK Interface Address  
0 Y Bundle-Ether61.1 10.6.11.1
```

3

Dump Hardware CEF Chain: `show cef ipv6 fcbb:bb00:101:e006:: hardware egress detail location 0/0/CPU0`

# Real problem scenarios

# SRv6 Prefix not advertised to RR

- The Problem : BGP prefix Received from CE with eBGP but not advertising to SRv6 Route Reflector
  - No Filtering configured

```
outer bgp 100
vrf SRV6_VRF
rd 600:1
address-family ipv4 unicast
segment-routing srv6
locator MAIN
alloc mode per-ce
!
redistribute connected
!
neighbor 10.6.11.1
remote-as 1
address-family ipv4 unicast
route-policy PASS in
route-policy PASS out
!
```

```
RP/0/RP0/CPU0:PE1#show bgp vrf SRV6_VRF 172.16.0.60/32
Thu Oct 16 06:23:45.242 UTC
BGP routing table entry for 172.16.0.60/32, Route Distinguisher: 600:1
Versions:
  Process          bRIB/RIB  SendTblVer
  Speaker           54          54
Last Modified: Oct 16 06:21:38.654 for 00:02:06
Paths: (1 available, best #1)
Not advertised to any peer
Path #1: Received by speaker 0
Not advertised to any peer
1
  10.6.11.1 from 10.6.11.1 (193.0.0.1)
    Origin IGP, metric 0, localpref 100, valid, external, best, group-best, import-candidate
    Received Path ID 0, Local Path ID 1, version 54
    Extended community: RT:66:66 RT:106:1
    Origin-AS validity: (disabled)
RP/0/RP0/CPU0:PE1#
```

# Fix : SRv6 Prefix not advertising (per-ce)

- PE should have allocated SIDs for local prefixes
- Allocation mode was seen as blank

```
RP/0/RP0/CPU0:PE1_BGL18-4-TS-N55A2#show bgp vrf SRV6_VRF local-sids
<SNIP>
      Network          Local Sid           Alloc mode   Locator
Route Distinguisher: 600:1 (default for vrf SRV6_VRF)
Route Distinguisher Version: 57
*> 10.6.11.0/24      fc00:c000:101:e002::    per-vrf     MAIN
*          fc00:c000:101:e002::    per-vrf     MAIN
*>i100.0.0.70/32    NO SRv6 Sid          -           -
*> 172.16.0.60/32   NO SRv6 Sid          -           -
*> 172.16.0.61/32   NO SRv6 Sid          -           -
*> 172.16.0.62/32   NO SRv6 Sid          -           -
```

- Fixed After changing the mode

Local prefixes. Allocation mode should be shown..

```
router bgp 100
vrf SRV6_VRF
rd 600:1
address-family ipv4 unicast
segment-routing srv6
locator MAIN
alloc mode per-vrf
!
```

```
RP/0/RP0/CPU0:PE1_BGL18-4-TS-N55A2#show bgp vrf SRV6_VRF local-sids
<SNIP>
      Network          Local Sid           Alloc mode   Locator
<SNIP>
*> 10.6.11.0/24      fc00:c000:101:e002::    per-vrf     MAIN
*          fc00:c000:101:e002::    per-vrf     MAIN
*>i100.0.0.70/32    NO SRv6 Sid          -           -
*> 172.16.0.60/32   fc00:c000:101:e002::    per-vrf     MAIN
*> 172.16.0.61/32   fc00:c000:101:e002::    per-vrf     MAIN
*> 172.16.0.62/32   fc00:c000:101:e002::    per-vrf     MAIN
```

# Scenario : Received SID mismatch (NH change)

- L3VPN Egress PE dropping packet
- Ingress PE receiving wrong uSID for the VRF

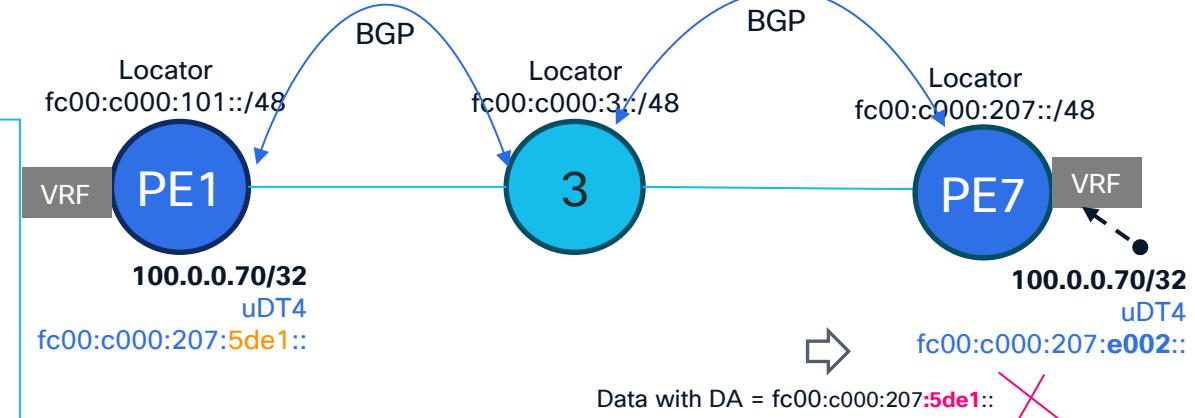
```
RP/0/RP0/CPU0:PE7#show bgp vrf SRV6_VRF 100.0.0.70/32
BGP routing table entry for 100.0.0.70/32, Route Distinguisher: 600:7
<SNIP>
SRV6-VPN SID: fc00:c000:207:e002::/64
```

Source PE7

```
RP/0/RP0/CPU0:PE1#show bgp vrf SRV6_VRF 100.0.0.70/32
BGP routing table entry for 100.0.0.70/32, Route Distinguisher: 600:1
<SNIP>
Local
fc00:c000:3::3 (metric 10) from fc00:c000:3::3 (100.7.7.1)
Received Label 0x5de1
```

Receiver PE1



- Found the Next Hop changed to the Route reflector fc00:c000:3::3
- Checked RR (R3) is changing SID while sending to PE1
- Fix : Remove misconfiguration of “next-hop-self”

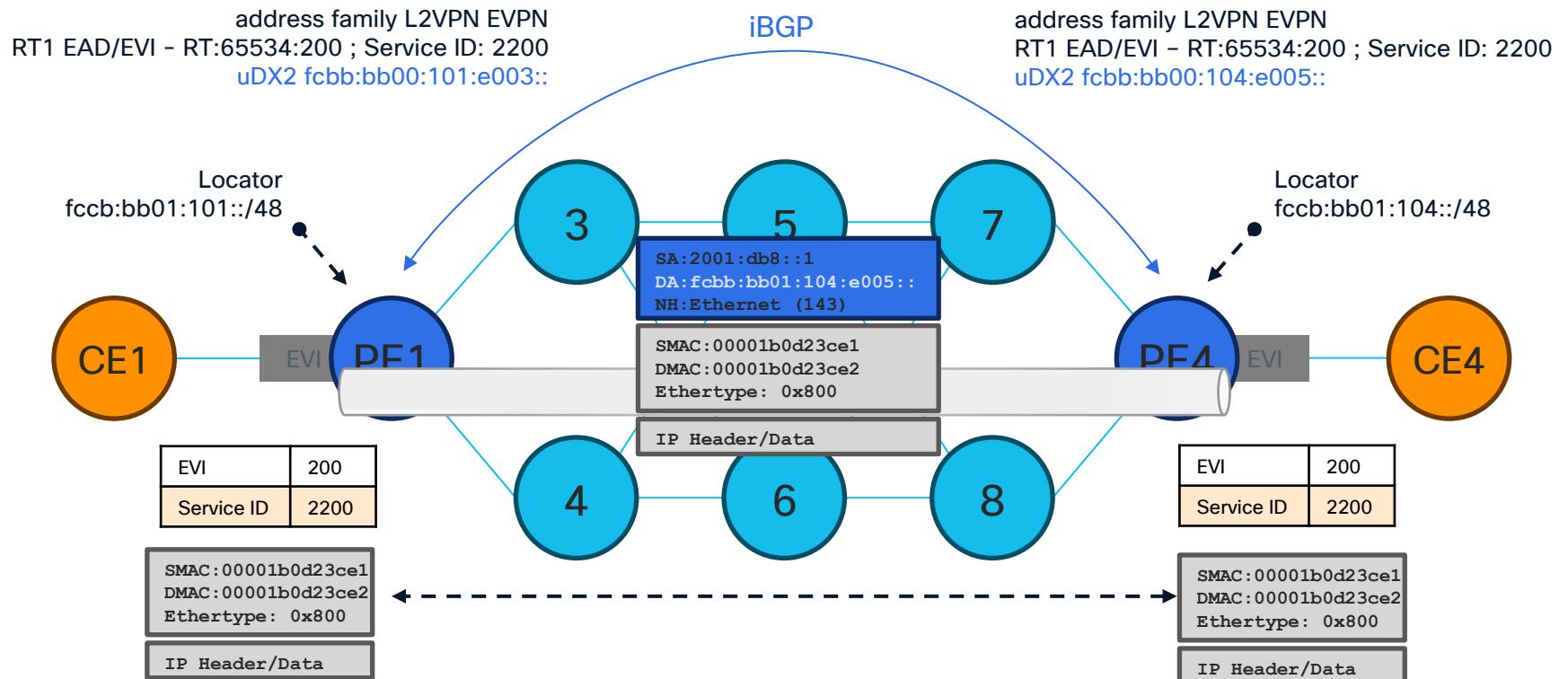
```
RP/0/RP0/CPU0:PE1#show bgp vrf SRV6_VRF 100.0.0.70/32
BGP routing table entry for 100.0.0.70/32, Route Distinguisher: 600:1
<SNIP>
Local
fc00:c000:207::7 from fc00:c000:3::3 (100.7.7.1)
Received Label 0xe0020
```

After fix

T:1(Sid information), Sid:fc00:c000:207::, Behavior:63, SS-TLV Count:1

# Troubleshooting L2 Overlay Services: EVPN & BGP

# SRv6 Eline – EVPN VPWS



- EVPN VPWS over SRv6 services only require a single SID
  - SRv6 TE or TI-LFA/Microloop Avoidance may require multiple SIDs
- No LDP, No MPLS data plane, Stateless

# SRv6 Eline Services - EVPN VPWS Configuration

- Options for Associating SRv6 Locator

1. EVPN Global
  2. Specific EVI
  3. specific EVI Service

```
evpn
!
evi 200
segment-routing srv6
locator MAIN
```

```
12vpn
  xconnect group ELINE
    p2p 200
      interface TenGigE0/0/0/2.200
      neighbor evpn evi 200 service 2200 segment-routing srv6 locator MAIN
```

```
router bgp 65534
  address-family l2vpn evpn
  !
  neighbor 2001:db8::2
    address-family l2vpn evpn
  !
evpn
  interface TenGigE0/0/0/2
    ethernet-segment
      identifier type 0 11.11.11.11.11.11.11.11.11
  !
segment-routing srv6
  locator MAIN
  !
l2vpn
  xconnect group ELINE
    p2p 200
    interface TenGigE0/0/0/2.200
    neighbor evpn evi 200 service 2200 segment-routing srv6
    !  
← Option1: For all EVIs  
↓ Encapsulation
```

# SRv6 Overlay Services – EVPN VPWS

## RouteType1 Advertising the SRv6 Service SID

[RFC9252](#)

[RFC8214](#)

```
RP/0/RP0/CPU0:PE1#show bgp 12vpn evpn rd 10.0.0.1:200 [1][0044.4444.4444.4444.4444][2200]/120 detail
<snip>
    Received Label 0xe00500
    <snip>
    PSID-Type:L2, SubTLV Count:1, R:0x00,
    SubTLV:
        T:1(Sid information), Sid:fccb:bb00:104::(Transposed), F:0x00, R2:0x00, Behavior:65, R3:0x00, SS-TLV Count:1
        SubSubTLV:
            T:1(Sid structure):
                Length [Loc-blk,Loc-node,Func,Arg]:[32,16,16,0], Tpose-len:16, Tpose-offset:48
```

Route Type1  
(EAD/EVI)

uDX2

Decapsulation and L2 Cross-Connect



T (Type)	1	SRv6 SID Information Sub-TLV
SID VALUE	fccb:bb00:104::	Remote PE Locator
F	0x00	Flags - set to 0 (none defined, unknown MUST be ignored)
R2,R3	0x00	Reserved - set to 0 (ignored)
Behavior	65	SRv6 Endpoint Behavior (End.DX2 with NEXT-CSID, uDX2)

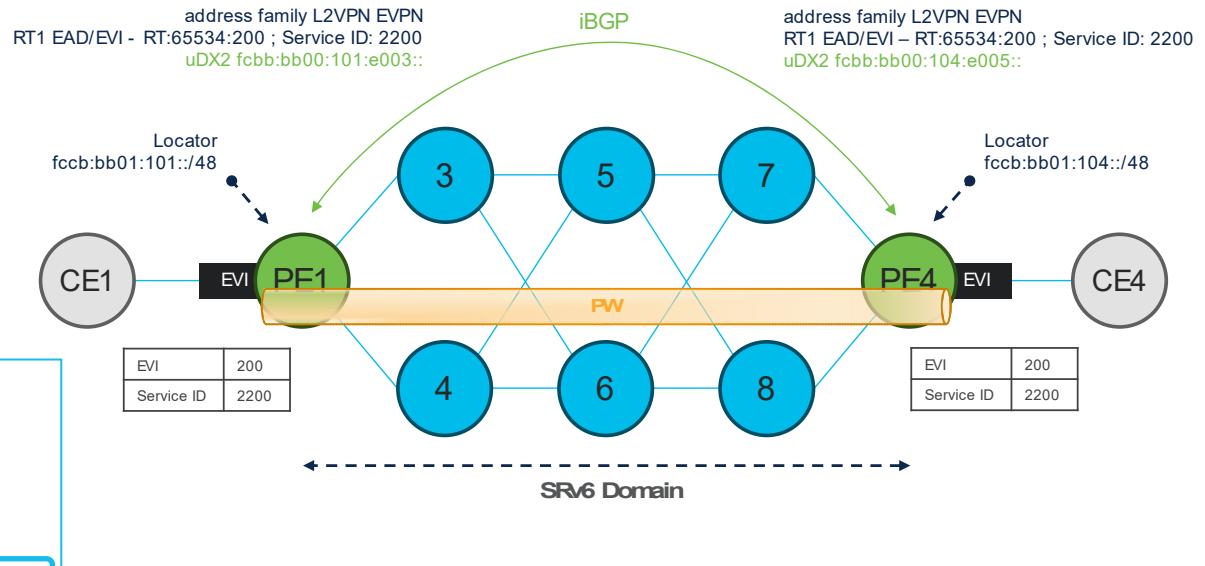
T (Type)	1	SRv6 SID Structure Sub-Sub-TLV (1)
Length	[32,16,16,0]	Length [Loc-blk,Loc-node,Func,Arg]
Tpose-len	16	size in bits for the part of the SID that has been transposed (or shifted) into an MPLS Label field
Tpose-offset	48	offset position in bits for the part of the SID that has been transposed (or shifted) into an MPLS Label field

# SRv6 Overlay Services – EVPN VPWS

## Received SRv6 Service SIDs

- Received uSID on PE4 (egress)

```
RP/0/RP0/CPU0:PE4#show bgp 12vpn evpn rd 10.0.0.1:200 received-sids
<snip>
Network          Next Hop
Route Distinguisher: 10.0.0.1:200
Route Distinguisher Version: 16
*>i[1][0011.1111.1111.1111.1111][2200]/120
                           Received Sid
                           2001:db8::1
                           fcbb:bb00:101:e003::
```



- Allocated uSID on PE1(ingress)

```
RP/0/RP0/CPU0:PE1#show segment-routing srv6 sid
*** Locator: 'MAIN' ***
SID          Behavior      Context      uDX2
fcbb:bb00:101:e003::  200:2200      uDX2
<snip>
```

uDX2	Decapsulation and L2 Cross-Connect
EVI:Service ID	200:2200
Owner	l2vpn_srv6
State	InUse
RW	Y

Ingress received & Egress Allocated uSID must match

# Imposition Programming- EVPN VPWS

```
RP/0/RP0/CPU0:PE1#show route vrf **iid ipv6 ::ffff:10.0.0.1 detail
Routing entry for ::ffff:10.0.0.1/128
Known via "local-iid 12vpn_iid", distance 0, metric 0
Installed Nov 14 16:11:35.647 for 1d00h
Routing Descriptor Blocks
 2001:db8::4 directly connected
    Nexthop in Vrf: "default", Table: "default", IPv6 Unicast, Table Id: 0xe0800000
      Route metric is 0
<SNIP>
  NHID: 0x0 (Ref: 0)
  SRv6 Headend: H.Encaps.L2.Red [f3216], SID-list {fcbb:bb00:104:e005::}
  MPLS eid:0x1184e00000002
```

```
RP/0/RP0/CPU0:PE1#show cef vrf **iid ipv6 ::ffff:10.0.0.1 location 0/0/CPU0
::ffff:10.0.0.1/128, version 42, SRv6 Headend, IID (EVPN-MH), internal 0x100000
<SNIP>
  Level 1 - Load distribution: 0
  [0] via fcbb:bb00:104::/128, recursive
  Accounting: Disabled
    via fcbb:bb00:104::/128, 7 dependencies, recursive [flags 0x0]
<SNIP>
  SRv6 H.Encaps.L2.Red SID-list {fcbb:bb00:104:e005::}
```

Hash	OK	Interface	Address
0	Y	TenGigE0/0/0/1	fe80::c6b2:39ff:fea7:7f09
1	Y	TenGigE0/0/0/0	fe80::eaf:31ff:fec9:bc1d

```
Dump Hardware CEF Chain: show cef vrf **iid ipv6 ::ffff:10.0.0.1 hardware egress detail location 0/0/CPU0
```

```
RP/0/RP0/CPU0:PE1#show l2vpn xconnect group ELINE xc-name 200 detail
Group ELINE, XC 200, state is up; Interworking none
  AC: TenGigE0/0/0/2.200, state is up
  <snip>
  MTU 1500; XC ID 0x1; interworking none
  <snip>
  EVPN: neighbor ::ffff:10.0.0.1, PW ID: evi 200, ac-id 2200, state is up
  ( established )
    XC ID 0xc0000003
    Encapsulation SRv6
    <snip>
      SRv6 Local Remote
      -----
      -----
      uDX2 fcbb:bb00:101:e003:: fcbb:bb00:104:e005::: 2200 2200
      AC ID 2200 0
      MTU 1514 N/A
      Locator MAIN N/A
      Locator Resolved Yes N/A
      SRv6 Headend H.Encaps.L2.Red N/A
```

ROUTE Look up for the Internal ID

CEF Look up for the Internal ID

# Disposition Programming- EVPN VPWS

```
RP/0/RP0/CPU0:PE1#show route ipv6 fcbb:bb00:101:e003:: detail

Routing entry for fcbb:bb00:101:e003::/64
Known via "local-srv6 12vpn_srv6", distance 0, metric 0, SRv6
Endpoint uDX2, SRv6 Format f3216
Installed Dec 27 11:39:53.827 for 00:12:44
Routing Descriptor Blocks
  directly connected, via TenGigE0/0/0/2
    Route metric is 0
    Label: None
    Tunnel ID: None
    Binding Label: None
    Extended communities count: 0
    NHID: 0x20001 (Ref: 2)
    NHID eid: 0xffffffffffff
      L2 Info: xcld: 0x1, L2 Iface: 0x8002 (TenGigE0/0/0/2.200),
      shg_id: 0, bridge_id: 0xffffffff
<SNIP>
```

RIB/Route Look up  
for the local SID

```
RP/0/RP0/CPU0:PE1#show l2vpn xconnect group ELINE xc-name 200 detail
```

```
Group ELINE, XC 200, state is up; Interworking none
AC: TenGigE0/0/0/2.200, state is up
<snip>
MTU 1500; XC ID 0x1; interworking none
<snip>
EVPN: neighbor ::ffff:10.0.0.1, PW ID: evi 200, ac-id 2200, state is up ( established )
  XC ID 0xc0000003
  Encapsulation SRv6
  <snip>
    SRv6          Local          Remote
    -----+-----+
    uDX2          fcbb:bb00:101:e003::  fcbb:bb00:104:e005::
    AC ID         2200           2200
    MTU          1514           0
    Locator       MAIN           N/A
    Locator Resolved Yes           N/A
    SRv6 Headend H.Encaps.L2.Red N/A
  <snip>
```

Find the local SID

```
RP/0/RP0/CPU0:PE1#show cef ipv6 fcbb:bb00:101:e003:: location 0/0/CPU0
```

Local SID CEF look up

```
fcbb:bb00:101:e003::/64, version 59, SRv6 Endpoint uDX2, internal 0x1000001 0x0 (ptr 0x8d648398) [1], 0x400 (0x8d61e6c8), 0x0 (0x8e3a9778)
<SNIP>
  via ::/128, TenGigE0/0/0/2, 2 dependencies, weight 0, class 0 [flags 0x0]
  path-idx 0 NHID 0x20001 [0x8e956898 0x0]
  next hop ::/128
  local adjacency
  AC Interface: Te0/0/0/2.200
  XConnect ID: 0x1
  Bridge ID: 0xffffffff
  Load distribution: 0 (refcount 3)

  Hash OK Interface          Address
  0   Y   TenGigE0/0/0/2      point2point
RP/0/RP0/CPU0:PE1#
```

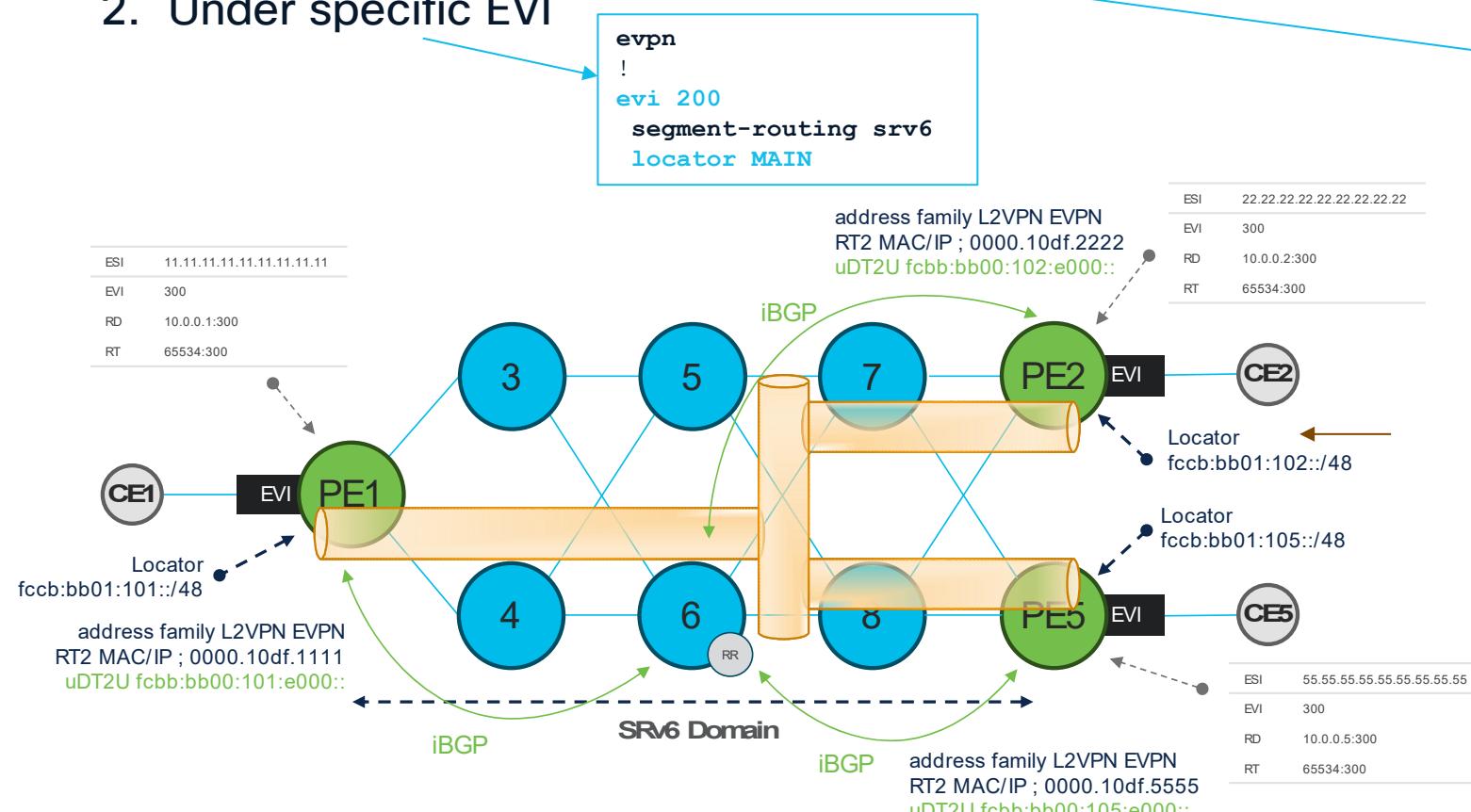
Dump Hardware CEF Chain: show cef ipv6 fcbb:bb00:101:e003:: hardware egress detail location 0/0/CPU0

CEFLook up for the  
local SID

# SRv6 Overlay Services – EVPN ELAN Configuration

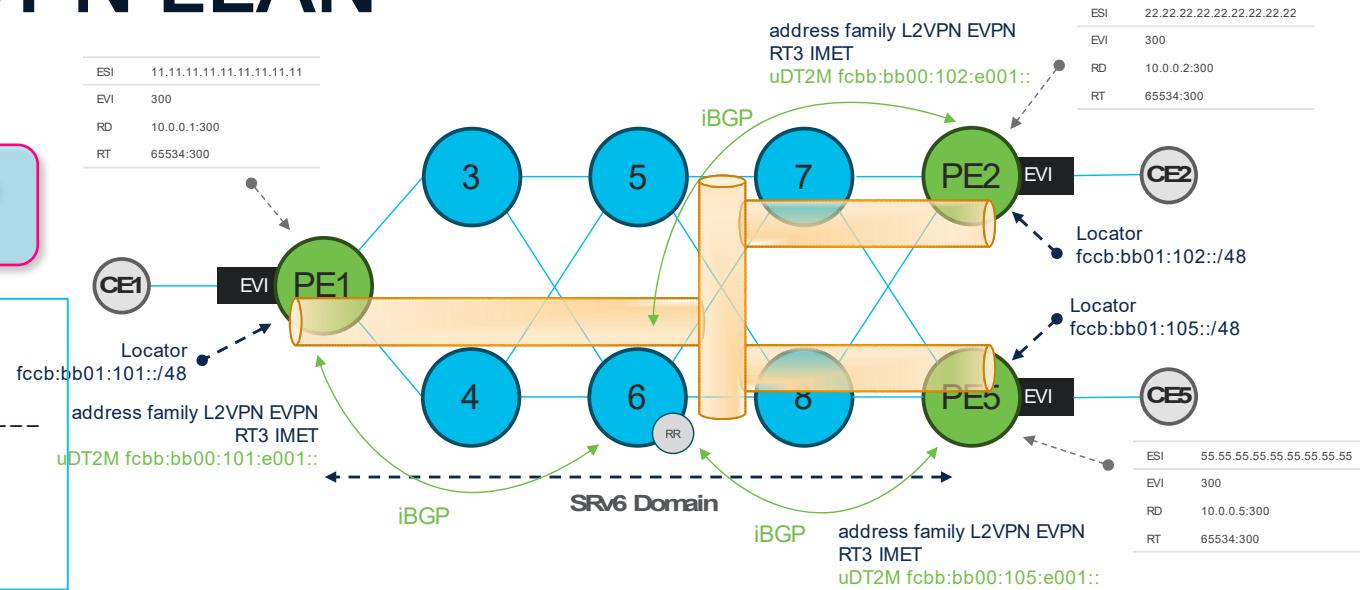
- Options for Configuring SRv6 Locator

- Under EVPN Global
- Under specific EVI



# SRv6 Overlay Services - EVPN ELAN

## SRv6 SIDs



```
RP/0/RP0/CPU0:PE1#show l2route evpn mac all
```

Topo ID	Mac Address	Producer	Next Hop(s)
1	0000.10df.1111	LOCAL	TenGigE0/0/0/2.300, N/A
1	0000.10df.2222	L2VPN	::ffff:10.0.0.3/IID/V6, N/A
1	0000.10df.5555	L2VPN	::ffff:10.0.0.4/IID/V6, N/A

```
RP/0/RP0/CPU0:PE2# show bgp 12vpn evpn rd 10.0.0.1:300 received-sids
```

Network	Next Hop	Received Sid
<snip>		
*>i <b>[2]</b> [0] [48] [0000.10df.1111] [0]/104	2001:db8::1	<b>fccb:bb00</b>
*>i <b>[3]</b> [0] [32] [10.0.0.1]/80	2001:db8::1	<b>fccb:bb00</b>

```
RP/0/RP0/CPU0:PE1#show segment-routing srv6 sid all
```

*** Locator: 'MAIN' ***		Find the local SID			
SID	Behavior	Context	Owner	State	RW
<b>fcbb:bb00:101:e000::</b>	<b>uDT2U</b>	300:0	12vpn_srv6	InUse	Y
<b>fcbb:bb00:101:e001::</b>	<b>uDT2M</b>	300:0	12vpn_srv6	InUse	Y

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BRKMPLS-2397



# Route Type 2 - Advertising the SRv6 Service SID

[RFC9252](#)

[RFC7432](#)

RT2 helps with MAC/IP reachability

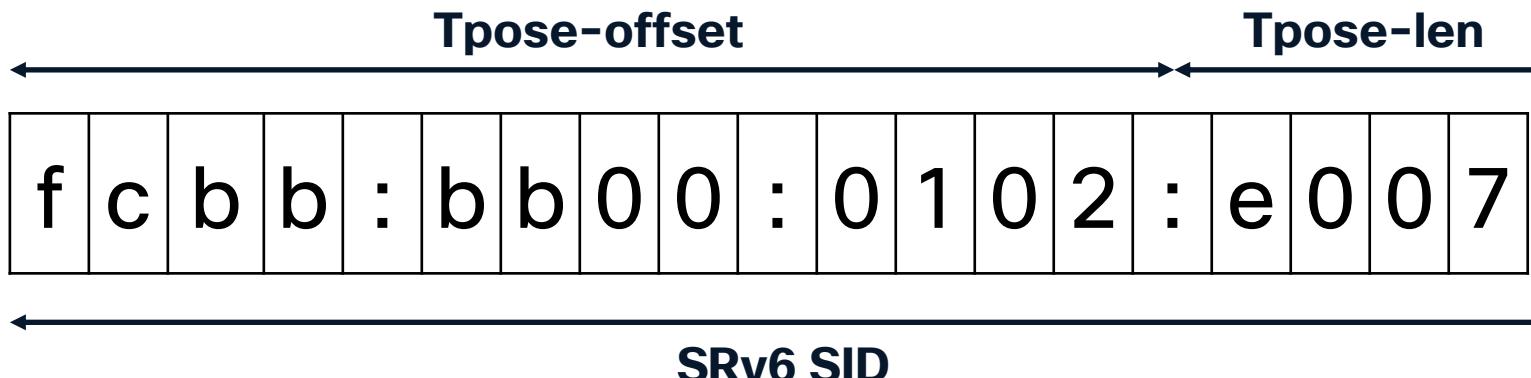
```
RP/0/RP0/CPU0:PE1#show bgp 12vpn evpn rd 10.0.0.5:300 [2][0][48][0000.10df.5555][0]/104 detail ← BGP RT2 MAC/IP
<snip>
Received Label 0xe00000 ← 24-bit value
<snip>
PSID-Type:L2, SubTLV Count:1, R:0x00,
SubTLV:
T:1(Sid information), Sid:fcbb:bb00:105::(Transposed), F:0x00, R2:0x00, Behavior:67, R3:0x00, SS-TLV Count:1
SubSubTLV:
T:1(Sid structure):
Length [Loc-blk,Loc-node,Func,Arg]:[32,16,16,0], Tpose-len:16, Tpose-offset:48
```



# Route Type 3 - Advertising the SRv6 Service SID

helps with BUM replication

```
RP/0/RP0/CPU0:PE1#show bgp 12vpn evpn rd 10.0.0.2:400 [3][0][32][10.0.0.2]/80 detail ← BGP RT3 IMET
BGP routing table entry for [3][0][32][10.0.0.2]/80, Route Distinguisher: 10.0.0.2:400
<snip>
Local
 2001:db8::2 (metric 20) from 2001:db8::2 (10.0.0.2), if-handle 0x00000000
<snip>
Extended community: EVPN L2 ATTRS:0x00:0 RT:65534:400
PMSI: flags 0x00, type 6, label 0xe00700, ID 0xa0000002
PSID-Type:L2, SubTLV Count:1, R:0x00,
SubTLV:
  T:1(Sid information), Sid:fcbb:bb00:102::(Transposed), F:0x00, R2:0x00, Behavior:68, R3:0x00, SS-TLV Count:1
  SubSubTLV:
    T:1(Sid structure):
      Length [Loc-blk,Loc-node,Func,Arg]:[32,16,16,16], Tpose-len:16, Tpose-offset:48
```



# SRv6 Overlay Services – EVPN ELAN

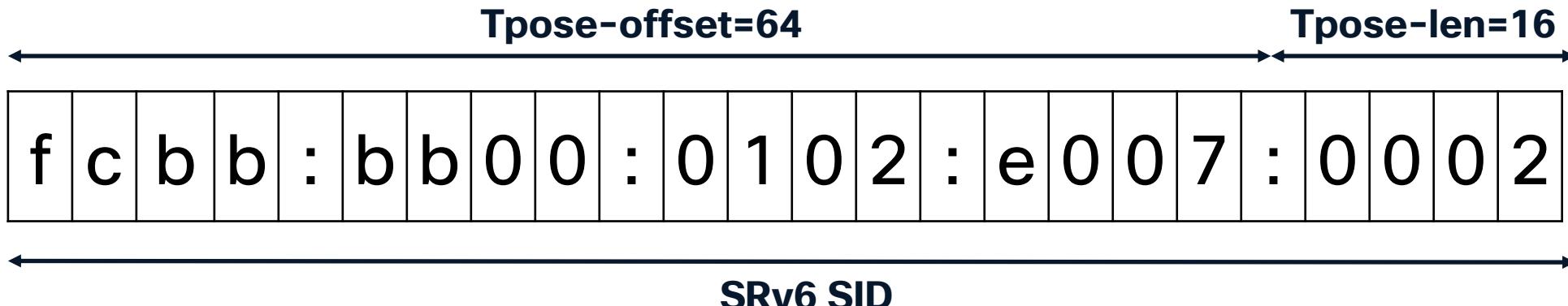
## EVPN Route Type 1 EAD-ES - ARG

EAD-ES Route Type-1 helps with Split-Horizon Drops in same ES

```
RP/0/RP0/CPU0:PE1#show bgp 12vpn evpn rd 10.0.0.2:2 [1][10.0.0.2:2][0011.2211.2211.2211.2211][4294967295]/184 detail ← BGP RT1 EAD-ES
BGP routing table entry for [1][10.0.0.2:2][0011.2211.2211.2211.2211][4294967295]/184, Route Distinguisher: 10.0.0.2:2
<snip>
Local
 2001:db8::2 (metric 20) from 2001:db8::2 (10.0.0.2), if-handle 0x00000000
 Received Label 0x0
<snip>
Extended community: EVPN ESI Label:0x00:32 RT:65534:400
PSID-Type:L2, SubTLV Count:1, R:0x00,
SubTLV:
  T:1(Sid information), Sid:::(Transposed), F:0x00, R2:0x00, Behavior:24, R3:0x00, SS-TLV Count:1
  SubSubTLV:
    T:1(Sid structure):
      Length [Loc-blk,Loc-node,Func,Arg]:[32,16,16,16], Tpose-len:16, Tpose-offset:64
      
```

Arg length, Tpose-len

32 is in Decimal to 20 digit binary = 00000000 00000010 0000  
Arg (First 16 bits considered) = 0x0002



# SRv6 uSID Protection/FRR

# Ti-LFA - SRv6 - 2-Segment Example

```
RP/0/RP0/CPU0:xr02#show route ipv6 fcbb:bb00:7::1/128
<SNIP>
Routing entry for fcbb:bb00:7::1/128
Known via "isis core", distance 115, metric 10, type level-2
Installed Oct 10 07:59:39.438 for 00:01:30
Routing Descriptor Blocks
fe80::42:acff:fe18:8002, from fcbb:bb00:7::1, via GigabitEthernet0/0/0/0, Backup (TI-LFA)
Repair Node(s): fcbb:bb00:13::1
Route metric is 140
fe80::42:acff:fe18:9003, from fcbb:bb00:7::1, via GigabitEthernet0/0/0/2, Protected
```

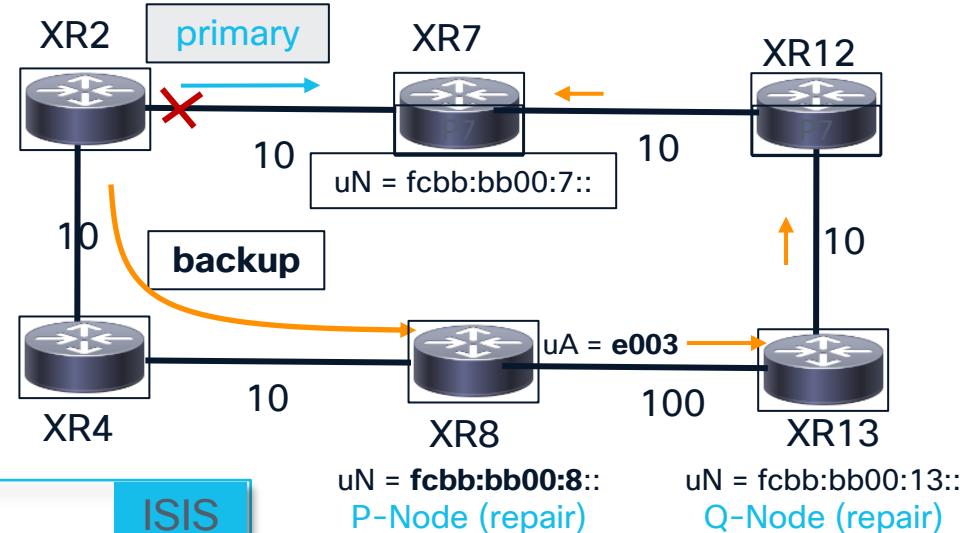
RIB

```
RP/0/RP0/CPU0:xr02#show isis ipv6 fast-reroute fcbb:bb00:7::1/128
<SNIP>
L2 fcbb:bb00:7::1/128 [10/115]
via fe80::42:acff:fe18:9003, GigabitEthernet0/0/0/2, xr07, Weight: 0
Backup path: TI-LFA (link), via fe80::42:acff:fe18:8002, GigabitEthernet0/0/0/0 xr04, Weight: 0, Metric: 140
P node: xr08.00 [fcbb:bb00:8::1], SRv6 SID: fcbb:bb00:8:: uN (PSP/USD)
Q node: xr13.00 [fcbb:bb00:13::1], SRv6 SID: fcbb:bb00:8:e003:: uA (PSP/USD)
Backup-src: xr07.00
```

ISIS

```
RP/0/RP0/CPU0:xr02#show cef ipv6 fcbb:bb00:7::1/128
fcbb:bb00:7::1/128, version 119, SRv6 Headend, ...
<SNIP>
via fe80::42:acff:fe18:8002/128, GigabitEthernet0/0/0/0, 14 dependencies, weight 0, class 0, backup (TI-LFA) [flags 0xb00]
path-idx 0 NHID 0x20004 [0x87697aa0 0x0]
next hop fe80::42:acff:fe18:8002/128, Repair Node(s): fcbb:bb00:13::1
local adjacency
SRv6 H.Insert.Red SID-list {fcbb:bb00:8:e003::}
via fe80::42:acff:fe18:9003/128, GigabitEthernet0/0/0/2, 4 dependencies, weight 0, class 0, protected [flags 0x400]
```

FIB



# Ti-LFA - SRv6 - Single-Segment Example

- Ping from XR02 & Packet **captured on backup path** during primary failure

```
RP/0/RP0/CPU0:xr02#ping fcbb:bb00:7::1 count 10000000  
<SNIP>
```

Wireshark

```
> Frame 3421: 138 bytes on wire (1104 bits), 138 bytes captured (1104 bits) on interface sshdump.exe, id 0  
> Ethernet II, Src: 02:42:ac:18:80:03 (02:42:ac:18:80:03), Dst: 02:42:ac:18:80:02 (02:42:ac:18:80:02)  
▼ Internet Protocol Version 6, Src: fcbb:bb00:2::1, Dst: fcbb:bb00:8:e003::  
    0110 .... = Version: 6  
    .... 0000 0000 .... .... .... = Traffic Class: 0x00 (DSCP: CS0, ECN: Not-ECT)  
    .... 0000 0000 0000 0000 = Flow Label: 0x00000  
    Payload Length: 84  
    Next Header: Routing Header for IPv6 (43)  
    Hop Limit: 60  
    Source Address: fcbb:bb00:2::1  
    Destination Address: fcbb:bb00:8:e003::  
▼ Routing Header for IPv6 (Segment Routing)  
    Next Header: ICMPv6 (58)  
    Length: 2  
    [Length: 24 bytes]  
    Type: Segment Routing (4)  
    Segments Left: 1  
    Last Entry: 0  
    Flags: 0x00  
    Tag: 0000  
    Address[0]: fcbb:bb00:7::1  
> Internet Control Message Protocol v6
```

DA = repair node uN (8)+ uA SID (e003)

SRH

original destination IPv6 address

# Troubleshooting SRv6 uSID Traffic Engineering

# Configuring SRv6 Policy with Explicit SID List

```
segment-routing
  srv6
    locators
      locator MAIN
        micro-segment behavior unode psp-usd
        prefix fcbb:bb00:101::/48
      !
      locator MINDELAY
        micro-segment behavior unode psp-usd
        prefix fcbb:bb88:101::/48
        algorithm 128
```

Prerequisites : Enable your locators

```
segment-routing
  traffic-eng
    srv6
    !
    segment-lists
      srv6
        sid-format usid-f3216
      !
      segment-list PE1-P4-P5-P8-PE2
        srv6
          index 10 sid fcbb:bb00:104::
          index 20 sid fcbb:bb00:105::
          index 30 sid fcbb:bb00:108::
        !
      policy PE1-to-PE2
        srv6
          locator MAIN binding-sid dynamic behavior ub6-insert-reduced
        !
        source-address ipv6 2001:1:101::1
        color 100 end-point ipv6 2001:1:101::2
        candidate-paths
          preference 100
            explicit segment-list PE1-P4-P5-P8-PE2
```

Specify segment lists to use F3216 format

Create an Explicit ordered srv6 segment list

Define Policy & Associate Color, Endpoint , Locator , segment lists

# Policy verification - Failing Policy

```
RP/0/RP0/CPU0:PE1#show segment-routing traffic-eng policy name  
srte_c_610_ep_fc00:c000:207::7
```

Thu Oct 17 04:28:26.641 UTC

SR-TE policy database

```
-----  
Color: 610, End-point: fc00:c000:207::7  
Name: srte_c_610_ep_fc00:c000:207::7  
Status:  
    Admin: up Operational: down for 09:13:35 (since Oct 16  
19:14:50.878)  
Candidate-paths:  
    Preference: 200 (configuration) (inactive)  
    Name: Policy_PE7_610  
    Last error: SRv6 SIDs failed verification  
Requested BSID: dynamic  
PCC info:  
    Symbolic name: cfg_Policy_PE7_610_discr_200  
    PLSP-ID: 12  
Constraints:  
    Protection Type: protected-preferred  
    Maximum SID Depth: 7  
Explicit: segment-list PE7-SRv6 (inactive)  
    Weight: 1, Metric Type: TE  
    SID[0]: fc00:c000:3::3/128  
    SID[1]: fc00:c000:5::5/128  
    SID[2]: fc00:c000:207::7/128  
SRv6 Information:  
    Locator: MAIN  
    Binding SID requested: Dynamic  
    Binding SID behavior: uB6 (Insert.Red)  
Attributes:  
    Forward Class: 0  
    Steering labeled-services disabled: no  
    Steering BGP disabled: no  
    IPv6 caps enable: yes ...<SNIP>
```

```
RP/0/RP0/CPU0:PE1#show segment-routing traffic-eng forwarding policy  
endpoint ipv6 fc00:c000:207::7
```

SR-TE Policy Forwarding database

```
-----  
Color: 610, End-point: fc00:c000:207::7  
Name: srte_c_610_ep_fc00:c000:207::7
```

Policy Packets/Bytes Switched: ?/?

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

Forwarding command output will show empty

Check state and Last Error to Find the reason

# SRv6 Policy common errors

The head end of an SR Policy updates the validity of a SID list upon network topological change.

- **Inactive policy**
  - No valid path found
- **Invalid path**
  - A Path is invalid as soon as it has no matching constraints
- **Invalid SID list**
  - It is empty
  - The headend is unable to resolve the first SID into one or more outgoing interface(s) and next hop(s)
  - The headend is unable to resolve any non-first SID expressed as an IP address
- **Unreachable**
  - The headend has no path to the SID in its SR-TE database or IPv6 routing table

## topology issues

Working topology shows as follows.  
Failed one will be empty.

```
RP/0/RP0/CPU0:PE1#show segment-routing traffic-eng ipv6 topology | uti egrep  
-B5 "SID fc00:c000:4::"  
Thu Oct 17 18:29:02.018 UTC  
  Remote node:  
    TE router ID: 100.2.2.1  
    Host name: PE2  
    ISIS system ID: 0000.0000.0002 level-2 domain ID: 400  
    Flex-algo Metric: Min Latency 10  
    SRv6_SID[0]: SID fc00:c000:4::  
      End-function:48 Algo: 0:  
    SRv6_SID[1]: SID fc00:c000:4::
```

# Policy verification - Working Policy

```
RP/0/RP0/CPU0:PE1#show segment-routing traffic-eng policy endpoint ipv6 fc00:c000:207::7

SR-TE policy database
-----
Color: 610, End-point: fc00:c000:207::7
Name: srte_c_610_ep_fc00:c000:207::7
Status:
  Admin: up Operational: up for 00:05:03 (since Oct 17 04:43:50.098)
Candidate-paths:
  Preference: 200 (configuration) (active)
    Name: Policy_PE7_610
    Requested BSID: dynamic
    PCC info:
      Symbolic name: cfg_Policy_PE7_610_discr_200
      PLSP-ID: 12
  Constraints:
    Protection Type: protected-preferred
    Maximum SID Depth: 7
Explicit: segment-list PE7-SRv6 (valid)
  Weight: 1, Metric Type: TE
    SID[0]: fc00:c000:3::/48
      Format: f3216
      LBL:32 LNL:16 FL:0 AL:80
    SID[1]: fc00:c000:5::/48
      Format: f3216
      LBL:32 LNL:16 FL:0 AL:80
    SID[2]: fc00:c000:207::/48
      Format: f3216
      LBL:32 LNL:16 FL:0 AL:80
SRv6 Information:
  Locator: MAIN
  Binding SID requested: Dynamic
  Binding SID behavior: uB6 (Insert.Red)
Attributes:
  Binding SID: fc00:c000:101:e007::
Forward Class: Not Configured
Steering labeled-services disabled: no <...SNIP>
```

```
RP/0/RP0/CPU0:PE1#show segment-routing traffic-eng forwarding policy name srte_c_610_ep_fc00:c000:207::7
Thu Oct 17 04:47:28.860 UTC

SR-TE Policy Forwarding database
-----
Color: 610, End-point: fc00:c000:207::7
Name: srte_c_610_ep_fc00:c000:207::7
Binding SID: fc00:c000:101:e007::
Active LSP:
  Candidate path:
    Preference: 200 (configuration)
    Name: Policy_PE7_610
  Segment lists:
    SL[0]:
      Name: PE7-SRv6
      SL ID: 0xa000001
      Normalized Weight: 1
      Switched Packets/Bytes: ?/?
    Paths:
      Path[0]:
        Outgoing Interfaces: Bundle-Ether613
        Next Hop: fe80::aec:f5ff:fe1b:b420
        FRR Pure Backup: No
        ECMP/LFA Backup: No
      SID stack (Top -> Bottom): {fc00:c000:3::/48, fc00:c000:5::/48, fc00:c000:207::/48}
        Path-id: 1, Weight: 1
      Policy Packets/Bytes Switched: ?/?
```

# Troubleshooting SRv6 Data Plane

# Troubleshooting Approach

- Regular IPv6 forwarding troubleshooting

## 1. Find the drop location

- Regular Ping/traceroute IPv6
- [New] Carrier based Ping/traceroute IPv6

## 2. Packet counters, captures

## 3. CEF programming

- Regular Ping and Trace

```
RP/0/RP0/CPU0:PE1#trace fc00:c000:207::7 source lo0
Tue Oct 1 10:34:43.445 UTC
```

```
Type escape sequence to abort.
Tracing the route to fc00:c000:207::1
```

```
1 2001:db8::10:1:3:3 2 msec 1 msec 1 msec
2 2001:db8::10:3:5:5 4 msec 3 msec 3 msec
3 fc00:c000:207::7 2 msec 2 msec 1 msec
RP/0/RP0/CPU0:PE1#
```

```
RP/0/RP0/CPU0:PE1#ping fc00:c000:207::7 source lo0
Tue Oct 1 11:00:20.454 UTC
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to fc00:c000:207::7,
timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max
= 1/1/2 ms
RP/0/RP0/CPU0:PE1#
```

# IPv6 Traceroute with Carrier

```
RP/0/RP0/CPU0:PE1#trace fc00:c000:207::7 source lo0 via srv6-carriers fc00:c000:102::,fc00:c000:4::,fc00:c000:3:: probe 1
<SNIP>
Tracing the route to fc00:c000:207::7
1 fc00:c000:102::2
    [IP tunnel: DA=fc00:c000:102:: SRH Stack 0 =(fc00:c000:207::7    fc00:c000:3::    fc00:c000:4:: ,SL=3) ] 2 msec
2 2002:db8::100:1:1:4
    [IP tunnel: DA=fc00:c000:4:: SRH Stack 0 =(fc00:c000:207::7    fc00:c000:3::    fc00:c000:4:: ,SL=2) ] 2 msec
3 2002:db8::100:1:1:3
    [IP tunnel: DA=fc00:c000:3:: SRH Stack 0 =(fc00:c000:207::7    fc00:c000:3::    fc00:c000:4:: ,SL=1) ] 6 msec
4 2001:db8::10:3:5:5 3 msec
5 fc00:c000:207::7 2 msec
RP/0/RP0/CPU0:PE1#
```

You can do a traceroute to a destination and specify one or more midpoint router or path to follow

```
RP/0/RP0/CPU0:PE1#trace fc00:c000:207::7 source lo0 via srv6-carrier fc00:c000:101:e007:: probe 1
```

Thu Oct 17 05:18:07.261 UTC

Type escape sequence to abort.

Tracing the route to fc00:c000:207::7

```
1 fc00:c000:3::3 2 msec
2 ?
3 ?
4 ?
```

Failing: Trace via a SRv6 policy binding SID which is dropping packets at Hop 2

# SRv6 Carrier Based Ping

- Specify single or multiple SIDs (in comma separated)

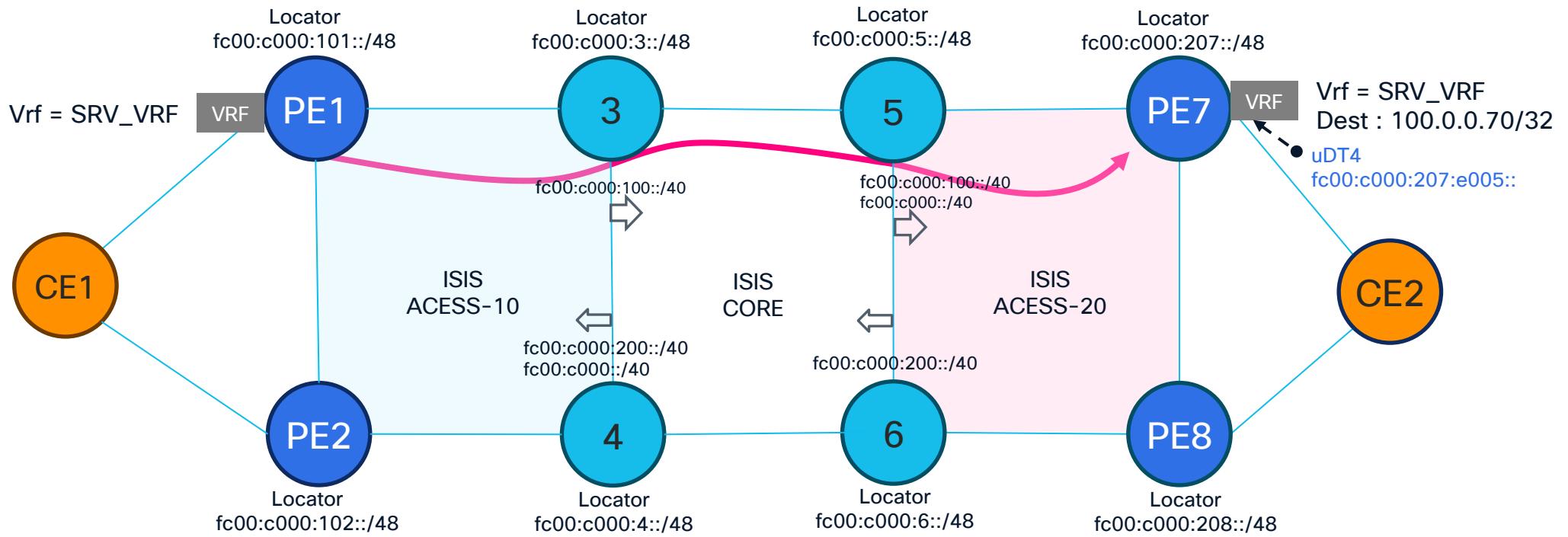
```
RP/0/RP0/CPU0:PE1#ping fc00:c000:207::7 source lo0 via srv6-carriers fc00:c000:6::  
Wed Oct 2 15:23:07.186 UTC  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to fc00:c000:207::7, timeout is 2 seconds:  
.....  
Success rate is 0 percent (0/5)  
RP/0/RP0/CPU0:PE1_BGL18-4-TS-N55A2#
```

```
RP/0/RP0/CPU0:PE1#ping fc00:c000:207::7 source lo0 via srv6-carriers fc00:c000:4::  
Wed Oct 2 15:22:56.523 UTC  
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to fc00:c000:207::7, timeout is 2 seconds:  
!!!!!  
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/2/3 ms
```

# Real world Case study

# SRv6 Packet drop in the path

- Scenario : IPv4 data is carried over SRv6 L3VPN Service between PE1 and PE7
- PROBLEM : Ping fails Over SRv6 explicit Policy connecting PE1 with PE7. Ping works fine if SR TE is disabled



# Verify Basic Control Plane

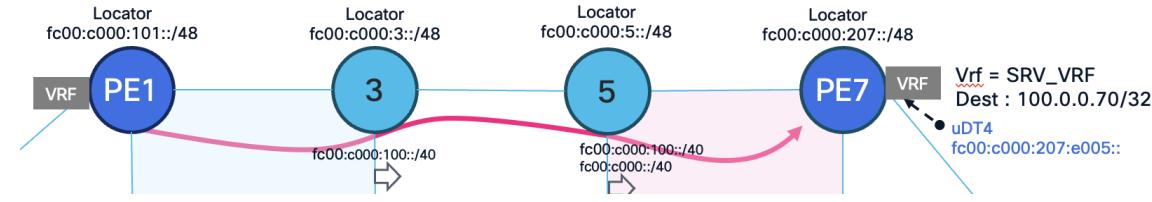
## Egress : PE7

```
RP/0/RP0/CPU0:PE7#show bgp vrf SRV6_VRF 100.0.0.70/32
BGP routing table entry for 100.0.0.70/32, Route Distinguisher: 600:7
Versions:
  Process          bRIB/RIB  SendTblVer
  Speaker          8135      8135
    SRv6-VPN SID: fc00:c000:207:e005::/64
Last Modified: Oct 16 10:26:38.000 for lwd
Paths: (1 available, best #1)
  Advertised to PE update-groups (with more than one peer):
<SNIP>
  Extended community: Color:610 RT:66:66 RT:106:1
RP/0/RP0/CPU0:PE7_BGL18-4-TS-N540#
```

**Egress PE originated SID & Color**

## Ingress : PE1

```
RP/0/RP0/CPU0:PE1#show bgp vrf SRV6_VRF 100.0.0.70/32
BGP routing table entry for 100.0.0.70/32, Route Distinguisher: 600:1
<SNIP>
  Local
    fc00:c000:207::7 C:610 (bsid: fc00:c000:101:e007::) (metric 31) from
    fc00:c000:3::3 (100.7.7.1)
      Received Label 0xe0050
<SNIP>
  SR policy color 610, up, not-registered, bSID fc00:c000:101:e007::
  PSID-Type:L3, SubTLV Count:1
    SubTLV:
      T:1(Sid information), Sid:fc00:c000:207::, Behavior:63, SS-TLV
      Count:1
        SubSubTLV:
          T:1(Sid structure):
            Source AFI: VPNv4 Unicast, Source VRF: default, Source Route
            Distinguisher: 600:1
Egress SID Matches with Ingress SID & points to SR Policy BSID
```



## SRv6TE Headend : PE1

```
RP/0/RP0/CPU0:PE1_BGL18-4-TS-N55A2#show segment-routing
traffic-eng policy name srte_c_610_ep_fc00:c000:207::7
SR-TE policy database
```

### Validate Policy state & SID list

```
Color: 610, End-point: fc00:c000:207::7
Name: srte_c_610_ep_fc00:c000:207::7
Status:
  Admin: up Operational: up for 00:03:17
Candidate-paths:
  Preference: 300 (configuration) (active)
  Name: Policy_PE7_610
  Requested BSID: dynamic
  PCC info:
    Symbolic name: cfg_Policy_PE7_610_discr_300
    PLSP-ID: 15
  Constraints:
  Protection Type: protected-preferred
  Maximum SID Depth: 7
  Explicit: segment-list P3-P5-SRv6 (valid)
  Weight: 1, Metric Type: TE
    SID[0]: fc00:c000:3::/48
    Format: f3216
    LBL:32 LNL:16 FL:0 AL:80
    SID[1]: fc00:c000:5::/48
    Format: f3216
    LBL:32 LNL:16 FL:0 AL:80
<SNIP>
Attributes:
  Binding SID: fc00:c000:101:e007::
```

# Verify Policy path ping, trace and counters

```
RP/0/RP0/CPU0:PE1_BGL18-4-TS-N55A2#trace segment-routing srv6 policy name  
srte_c_610_ep_fc00:c000:207::7 probe 1  
Fri Oct 25 10:05:53.967 UTC
```

Type escape sequence to abort.  
Tracing the route to srte\_c\_610\_ep\_fc00:c000:207::7

```
1 fc00:c000:3::3  
    [IP tunnel: DA=fc00:c000:3:: SRH Stack 0 =(fc00:c000:5:: ,SL=1) ]  
    [IP tunnel: DA=fc00:c000:3:: SRH Stack 1 =(fc00:c000:5:: ,SL=0) ] 2 msec  
2 *  
3 *
```

```
RP/0/RP0/CPU0:PE1_BGL18-4-TS-N55A2#ping segment-routing srv6 policy name  
srte_c_610_ep_fc00:c000:207::7  
Fri Oct 25 10:08:24.982 UTC
```

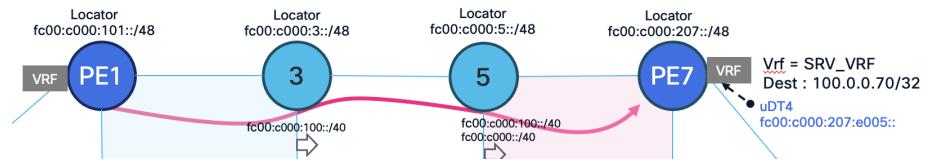
Type escape sequence to abort.  
Sending 5, 100-byte ICMP Echos to srte\_c\_610\_ep\_fc00:c000:207::7, timeout is 2 seconds:  
.....  
Success rate is 0 percent (0/5)

```
RP/0/RP0/CPU0:PE1_BGL18-4-TS-N55A2#
```

```
RP/0/RP0/CPU0:PE1#ping vrf SRV6_VRF 100.0.0.70 timeout 0 count  
1000
```

```
RP/0/RSP1/CPU0:P3#show interfaces be613 | i "packets in"  
1033 packets input, 189138 bytes, 0 total input drops  
RP/0/RSP1/CPU0:P3#  
RP/0/RSP1/CPU0:P3#show interfaces be635 | i "packets out"  
1048 packets output, 200719 bytes, 0 total output drops  
RP/0/RSP1/CPU0:P3_BGL18-4-TS-9906-2#
```

```
RP/0/RP0/CPU0:P5#clear counter  
RP/0/RP0/CPU0:P5#show interfaces be635 | i "packets in"  
Fri Oct 25 10:55:17.083 UTC  
1037 packets input, 191531 bytes, 0 total input drops  
RP/0/RP0/CPU0:P5#show interfaces be657 | i "packets out"  
63 packets output, 55176 bytes, 0 total output drops  
RP/0/RP0/CPU0:P5#
```



SRv6 trace drops at P5

SRv6 ping fails

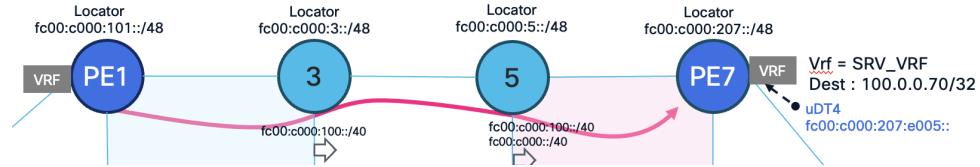
PE1 sends 1000 pings to destination

P3 receives & forwards fine

P5 Drops\*\*. In 1000+ but Out 63

\*\*Incase high data rate, ACL counters / capture can help.  
Refer [TACSPG-2003](#)

# L3VPN CEF programming – no SRTE



- Check the PI CEF followed by Platform specific CEF chain

```
RP/0/RP0/CPU0:PE1#show cef vrf SRV6_VRF 100.0.0.70/32
100.0.0.70/32, version 563, SRv6 Headend, internal 0x5000001 0x30 (ptr 0x8b1c4228) [1], 0x0 (0x0), 0x0 (0x8c9a05f0)
Updated Oct 3 08:30:49.352
Prefix Len 32, traffic index 0, precedence n/a, priority 3
<SNIP>
[0] via fc00:c000:207::/128, recursive

via fc00:c000:207::/128, 3 dependencies, recursive [flags 0x6000]
path-idx 0 NHID 0x0 [0x8b14fa20 0x0]
next hop VRF - 'default', table - 0xe0800000
next hop fc00:c000:207::/128 via fc00:c000:200::/40
SRv6 H.Encaps.Red SID-list {fc00:c000:207:e005::}

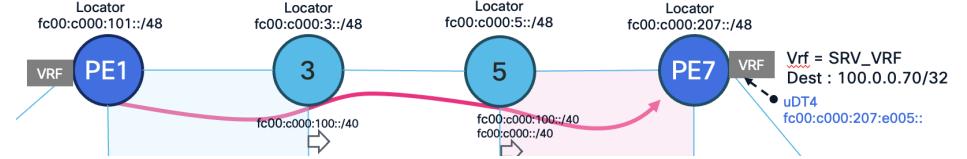
Load distribution: 0 (refcount 1)

Hash OK Interface Address
0 Y Bundle-Ether613 fe80::aec:f5ff:fe1b:b420

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

Insert SID received by BGP  
from remote PE

# CEF programming - with SRTE



- Check the PI CEF followed by Platform specific CEF chain

```
RP/0/RP0/CPU0:PE1#show cef vrf SRV6_VRF 100.0.0.70/32
100.0.0.70/32, version 994, SRv6 Headend, internal 0x5000001 0x30 (ptr 0x8b1b6b50) [1], 0x0 (0x0), 0x0 (0x8c9a0758)
Prefix Len 32, traffic index 0, precedence n/a, priority 3
  gateway array (0x8d02b188) reference count 2, flags 0x2010, source rib (7), 0 backups
<SNIP>
```

```
Level 1 - Load distribution: 0
[0] via fc00:c000:101:e007::/128, recursive
```

```
via local-srv6-sid fc00:c000:101:e007::, 3 dependencies, recursive [flags 0x6000]
  path-idx 0 NHID 0x0 [0x8b14f118 0x0]
  recursion-via-/64
  next hop VRF - 'default', table - 0xe0800000
  next hop fc00:c000:101:e007:: via fc00:c000:101:e007::/64
    SRv6 H.Encaps.Red SID-list {fc00:c000:207:e005::}
    SRv6 H.Insert.Red SID-list {fc00:c000:3:5:207::}
```

```
Load distribution: 0 (refcount 1)
```

Hash	OK	Interface
0	Y	Bundle-Ether613

Address
fe80::aec:f5ff:fe1b:b420

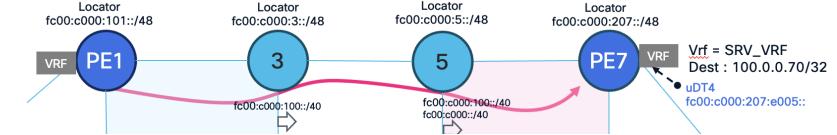
SRv6 policy Binding SID  
(BSID = e007)

Final SID insertion list from BSID  
= 3:5:207

# CEF programming – with mid node dropping

- Check the PI CEF followed by Platform specific CEF chain

```
RP/0/RP0/CPU0:P5#show cef ipv6 fc00:c000:5:207::  
Thu Oct 17 07:53:40.250 UTC  
::/0, version 0, proxy default, default route handler, drop adjacency,  
internal 0x1001011 0xf0 (ptr 0x9ad440b8) [1], 0x400 (0x9a5878e8), 0x0 (0x0)  
Updated Jul 9 09:45:58.746  
Prefix Len 0, traffic index 0, precedence n/a, priority 15  
gateway array (0x9a422728) reference count 1, flags 0x200, source default  
(13), 0 backups  
[2 type 3 flags 0xa401 (0x9a4cfbb8) ext 0x0 (0x0)]  
LW-LDI[type=3, refc=1, ptr=0x9a5878e8, shldi=0x9a4cfbb8]  
gateway array update type-time 1 Jul 9 09:45:58.746  
LDI Update time Jul 9 09:45:58.749  
LW-LDI-TS Jul 9 09:45:58.749  
via ::/128, 11 dependencies, weight 0, class 0 [flags 0x0]  
path-idx 0 NHID 0x0 [0x9a2c34d0 0x0]  
next hop ::/128  
drop adjacency  
Load distribution: 0 (refcount 2)  
Hash OK Interface Address  
0 Y recursive drop
```



fc00:c000:5:207:: = IPv6 destination after P3 left shifts and removes SID “3”

CEF/FIB doesn't have a forwarding entry and have drop adjacency

```
RP/0/RP0/CPU0:P5#show log last 10  
<SNIP>  
  
RP/0/RP0/CPU0:Oct 25 10:21:51.766 UTC:  
npu_drvr[373]: %ROUTING-FIB-2-ROUTE_PROG_FAILED :  
Route Programming failed: trans_id 6431915 npu 0  
act 4 vrf 0 pfx fc00:c000:e000::/48 err 0x4f90d05f
```

Log shows programming issues too

# Possible Data plane Issues



## Symptoms

- Packet getting dropped in the path
- Packet not taking the desired path
- Protection issues - Packet drop during link or node failures



## Cause

- Headend insertion not working properly
- Incorrect SID in the packet
- Missing SID / routes in the path
- Incorrect data plane programming
- Unsupported forwarding mode on NCS5500 (Compatibility)
- Mismatch SRv6 type or block configuration

# Still have issues. What next?

- Platform specific CEF hardware troubleshooting (out of scope)
- Platform Capabilities, Scale, Resource

```
PE1#show segment-routing srv6 manager
<SNIP>
Summary:
  Number of Locators: 1 (1 operational)
  Number of SIDs: 10 (0 stale)
  Max SID resources: 8176
  Number of free SID resources: 8166
OOR:
  Thresholds (resources): Green 409, Warning 246
  Status: Resource Available
    History: (0 cleared, 0 warnings, 0 full)
  Block fc00:c000::/32:
    Number of SIDs free: 7670
    Max SIDs: 7680
    Thresholds: Green 384, Warning 231
    Status: Resource Available
      History: (0 cleared, 0 warnings, 0 full)
```

- Find out actual HW resource going to Out Of Resource (SID/FEC/Encap) state

```
PE1#show controllers npu resources all location <>
```

- Follow Network design best practices

# List of Helpful commands

- Features that couldn't be covered today

- Flex Algo

```
show segment-routing srv6 locator #Verify Flexalgo locator  
show segment-routing srv6 sid all #check the Flexalgo allocated SIDs  
show isis flex-algo <Algo ID> #check Flexalgo database definition  
show isis ipv6 route flex-algo <Algo ID> #Flexalgo specific routes  
show isis database <LSP ID> verbose #check Flefalgo definition & SIDs
```

- TILFA single segment

```
show segment-routing srv6 sid all #check the allocated uA protect SIDs  
show isis adjacency detail #check the uA SIDs  
show isis database <LSP ID> verbose # check the B=1 for protected uA  
show isis interface <int> # check TILFA is enabled  
show isis ipv6 fast-reroute summary # check protection coverage  
show isis ipv6 fast-reroute <prefix> # check P Q node & SID details  
show route ipv6 <prefix> # check primary path is protected  
show cef ipv6 <prefix> # check Forwarding SID programming
```

- Micro Loop Avoidance

```
show isis microloop avoidance #Verify Micrloop avoidance state and history  
show isis | b Microloop #Verify Micrloop avoidance is enabled  
& check RIB update delay  
& during failure uLoop Avoidance state as Active  
Show route[cef] ipv6 <prefix> # check repair node and SID
```

- ODN & PCE based Policies

```
show segment-routing traffic-eng policy color <color#> tabular #list of policy  
show segment-routing srv6 sid #check BSIDs allocated for policy  
show cef ipv6 <BSID># check the inserted SID list  
Ping/trace segment-routing srv6 policy name <name> # check ping response  
show pce lsp tabular # on PCE check policy state  
show pce lsp name <policy name in pcc> detail # on PCE check policy details
```

# Best Practices

# Recommended SRv6 Address Space Allocation



**Private ULA FC00::/8**

/24 block from this (95% deployments)



**SRv6 reserved 5F00::/16**

/24 block from this (catching up)

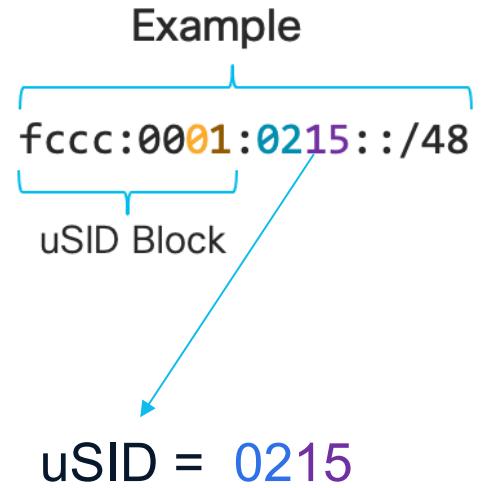


**Global Unicast Address**

Supported, Not advised

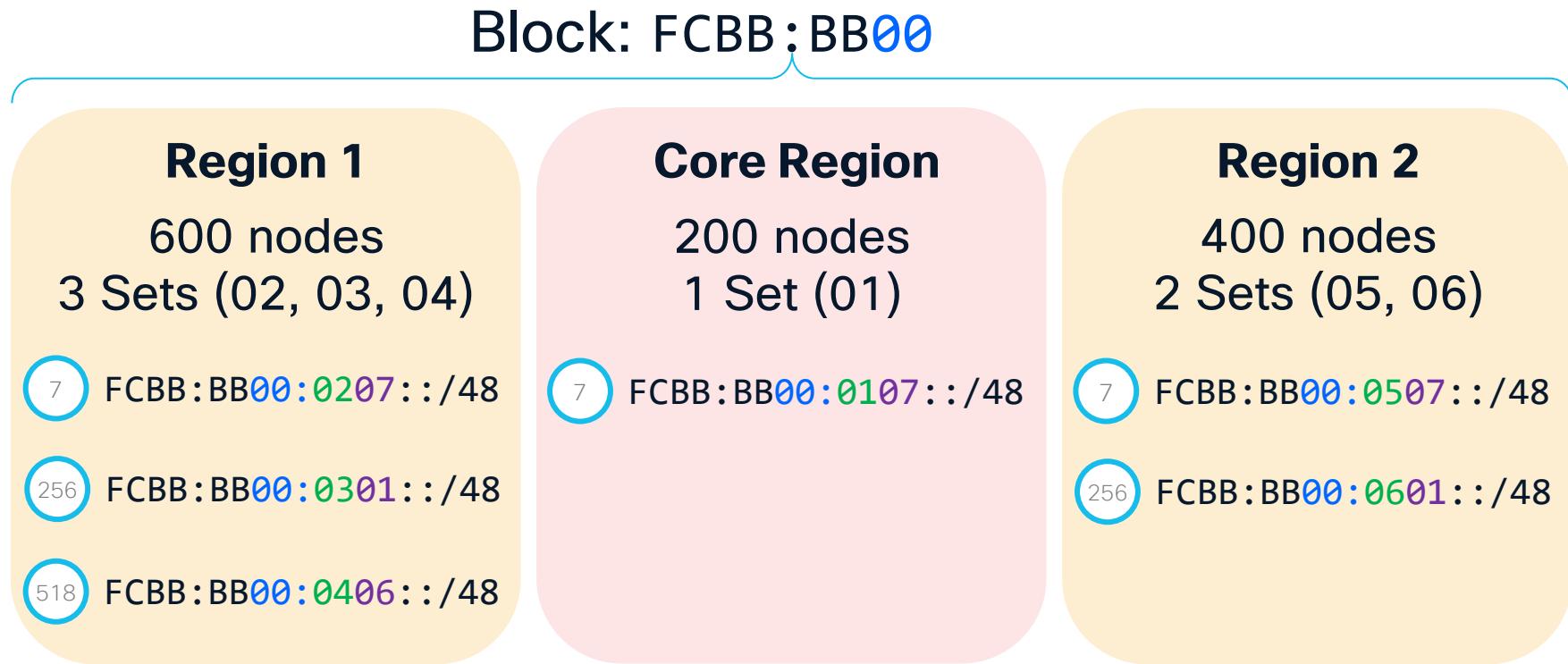
# Hierarchical uSID Block and uSID Sets

- /32 uSID Block = FC**BB:BB****SL**::  
    **BB BB** = 65536 blocks, **SL** = Slice / Flex Algo
- 65536 Blocks/**SL** are available with 32 bits
  - Example if We chose Block **FCCC00**.
    - uSID Block **FCCC:0000::/32** = **00** Assign to Low-cost slice (algo 0)
    - uSID Block **FCCC:0001::/32**, **01** Assign to Low-delay slice (algo 128)
- 16bit uSID Identifier Allocated in sets of 256 addresses
  - For N nodes in the region, sets required (per flex algo)  
        Sets = N / 256,  
        e.g for 600 Nodes = 3 Sets



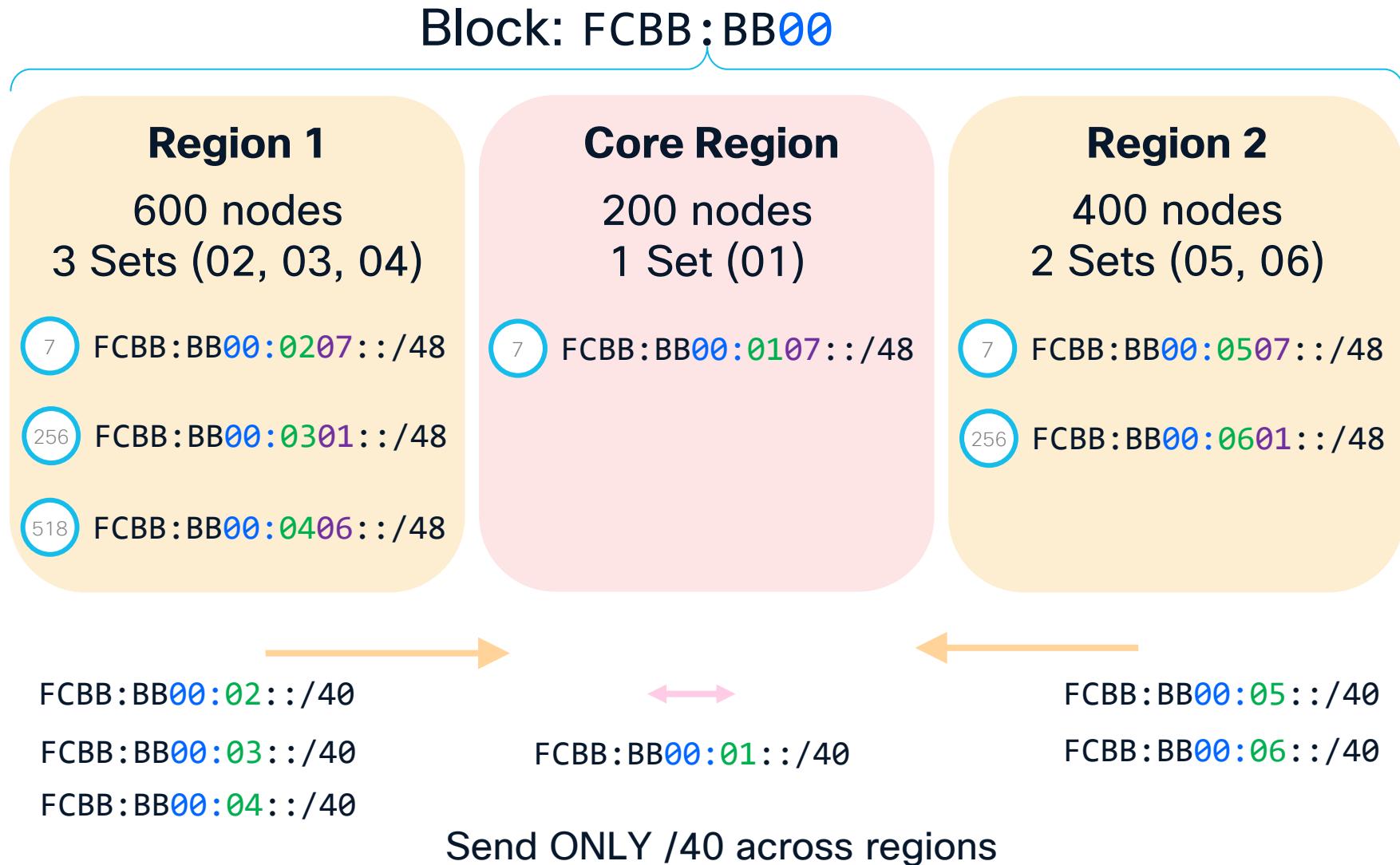
02 = Set / Domain  
15 = Node ID

# uSID Allocation Example

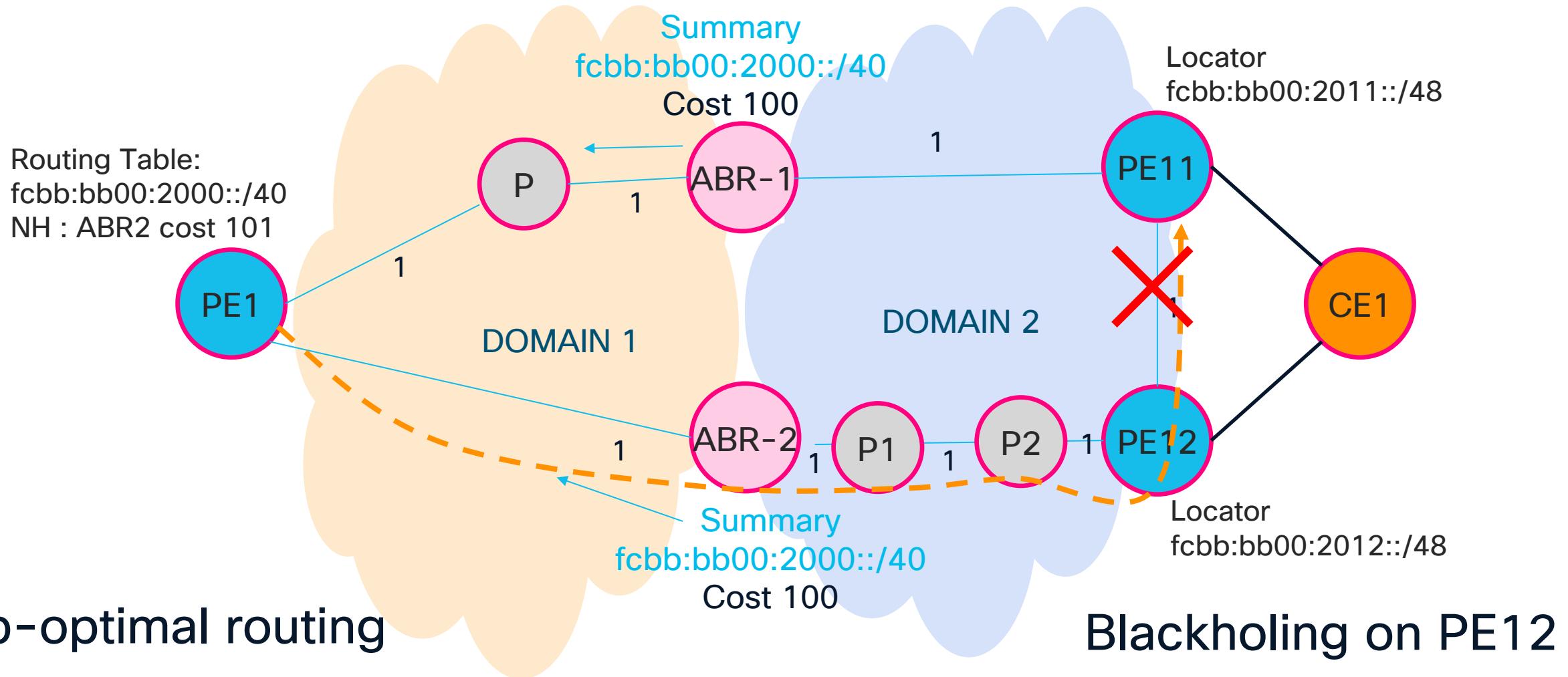


- unallocated uSIDs in Sets are for future growth
  - E.g. Region1 : 601 – 768
- Add More Sets if number of nodes increase

# Hierarchy enables Summarization & Scale up



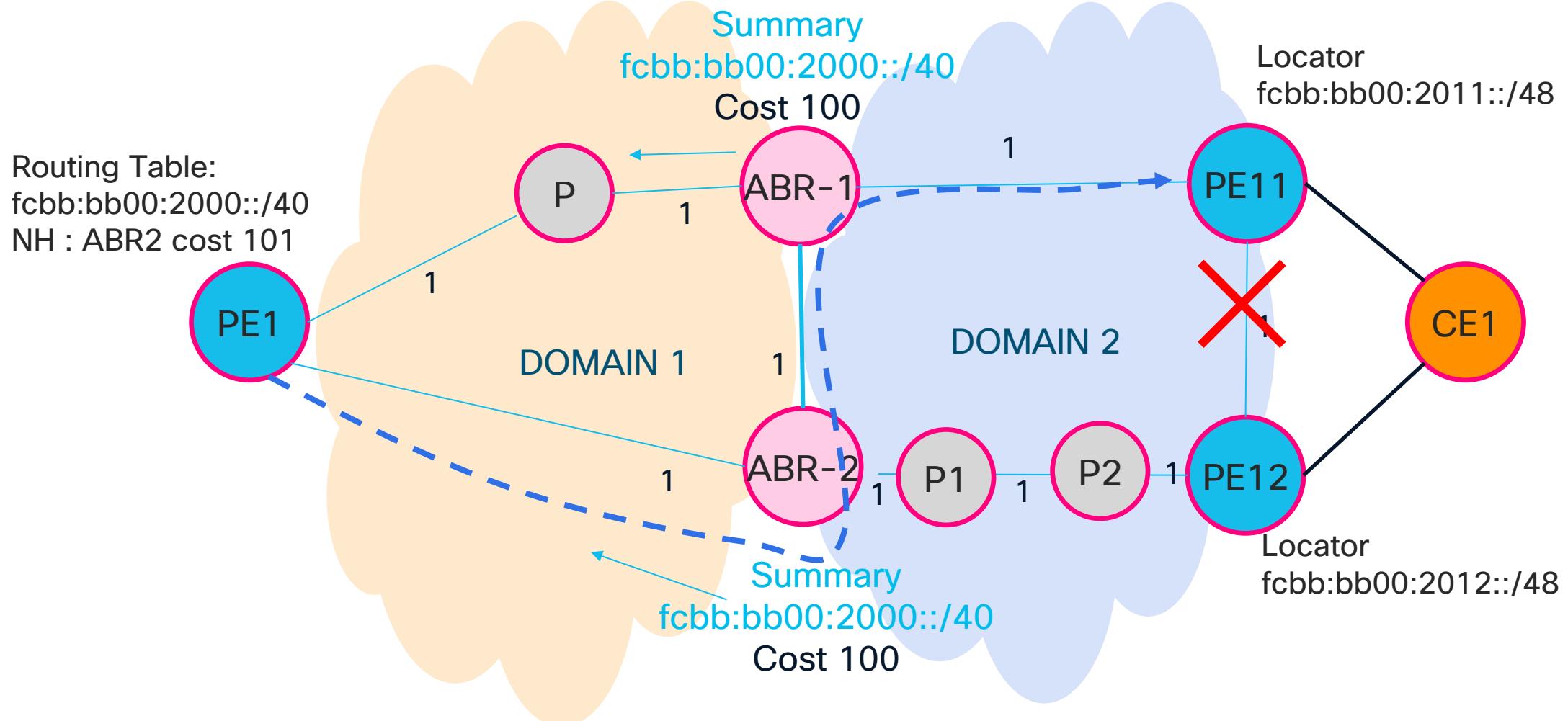
# Problem: Open Ring Architecture



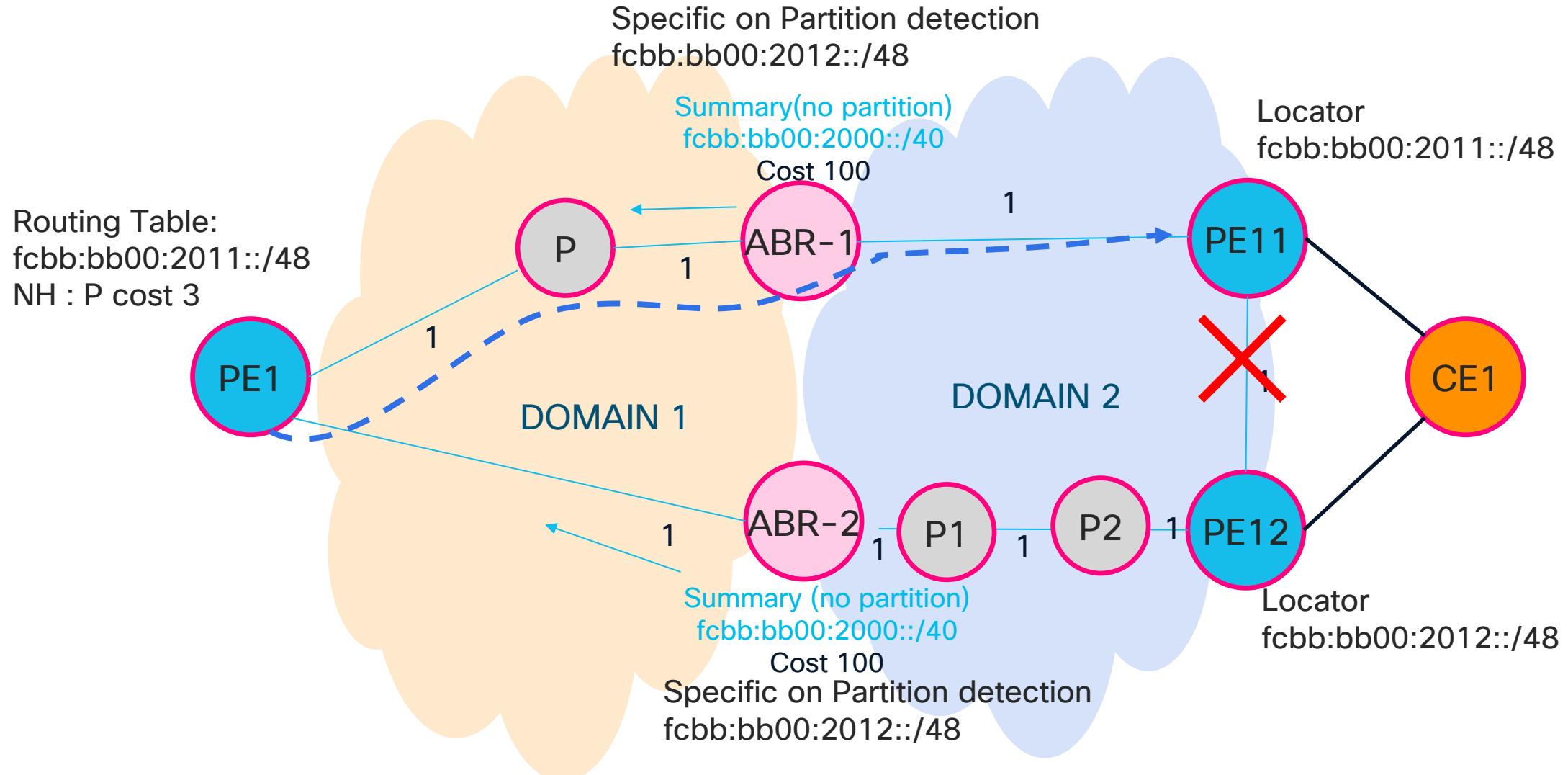
Sub-optimal routing

Blackholing on PE12

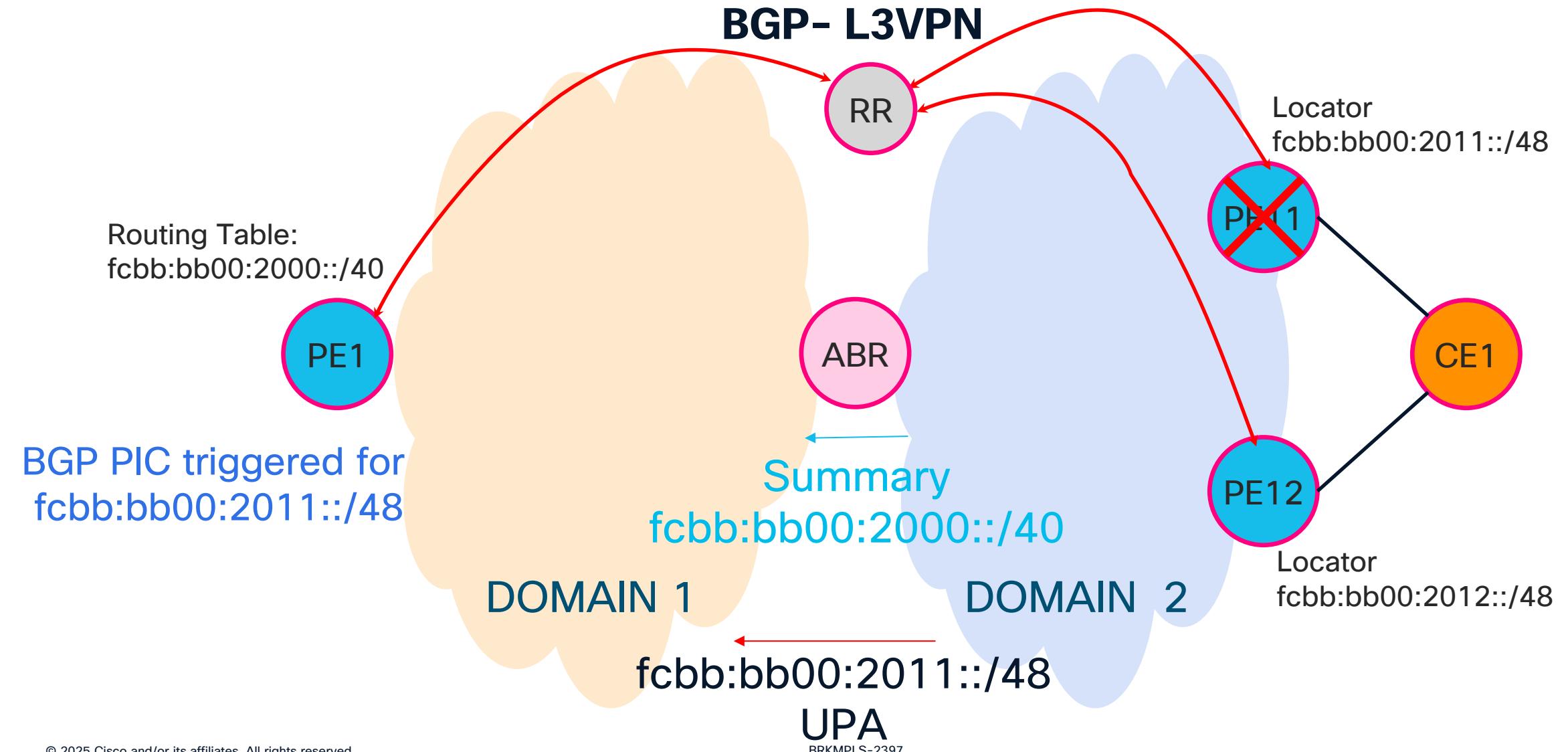
# Solution1: Closed Ring Architecture



# Solution2: Open Ring with Partition detection



# Convergence: Unreachable Prefix Announcement



# Loopback Options

## Option 1 - One New Loopback for SRv6 & BGP

Recommended

Locator :	FCBB:BB00:02::/48
Lo0 (Old) :	2001:ABCD:02::1/128
Lo1 (New) :	<b>FCBB:BB00:02::1/128</b>
Srv6 encaps source :	<b>FCBB:BB00:02::1</b>
BGP update source:	FCBB:BB00:02::1

### Pros -

Single locator block redistribution needed, improved IGP/FIB scale

Fate sharing in BGP for algo 0

SA and DA from same SRv6 space in service packet (eases service traffic security treatment)

### Cons -

No separation in infrastructure loopback address and SRv6 address space

## Option 2 - Use existing loopback for SRv6 & BGP

Locator :	FCBB:BB00:02::/48
Lo0 (Old) :	2001:ABCD:02::1/128
Srv6 encaps source :	2001:ABCD:02::1
BGP update source:	2001:ABCD:02::1

Use existing loopback (0) for SRv6 encaps source and BGP overlay

### Pros -

no need to configure additional loopbacks

Separation in infrastructure loopback address and SRv6 address space

### Cons -

SA and DA is different in SRv6 service packet (difficult service traffic security treatment)

Higher IGP/FIB scale requirements

## Option 3 - Hybrid model

Locator :	FCBB:BB00:02::/48
Lo0 (Old) :	2001:ABCD:02::1/128
Lo1 (New) :	<b>FCBB:BB00:02::1/128</b>
Srv6 encaps source :	<b>FCBB:BB00:02::1</b>
BGP update source:	2001:ABCD:02::1

New loopback (1) for SRv6 encaps source and existing loopback (0) for BGP overlay

### Pros -

Separation in infrastructure and SRv6 address space

SA and DA from same SRv6 space in service packet (eases service traffic security treatment)

### Cons -

Higher IGP/FIB scale requirements

Higher operational cost (allocation, propagation, ACLs)

# Other Recommendations

- Separate Route Reflector for SRv6
- MTU considerations : IPv6 (40b) + SRH (8b + nx16b) header
- Anycast SID for Resiliency, load balancing and Faster convergence



# Key SRv6 uSID advantages

- Simplicity: Less protocols, High Scale compared to MPLS networks.
  - Service compatibility
- Compact Header, highly programmable
- Classic IPv6 forwarding and source routing philosophy
  - Simplified troubleshooting with very few CLIs



# Key Takeaways

- Simplicity
  - Back to Basics
- Right tools
  - 3 step troubleshooting
- Design for Scalability



*“A problem well stated is a problem half solved.”*

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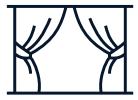


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# Acknowledgement



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Principal Engineer

Thank you

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