



Configure Segment Routing over IPv6 (SRv6) with Micro-SIDs

Table 1: Feature History Table

| Feature Name | Release | Description |
|--------------------------------|---------------|---|
| SRv6 with Micro-Segment (uSID) | Release 7.5.2 | <p>This release introduces support for Segment Routing over IPv6 data plane using Micro SIDs (uSIDs).</p> <p>This feature allows the source router to encode multiple SRv6 uSID instructions within a single 128-bit SID address. Such functionality allows for efficient and compact SRv6 SID representation with a low MTU overhead</p> |

Segment Routing for IPv6 (SRv6) is the implementation of Segment Routing over the IPv6 dataplane.

In a Segment Routing over IPv6 (SRv6) network, an IPv6 address serves as the segment identifier (SID). The source router can encode multiple SRv6 uSID instructions within a single 128-bit SID address. Such a SID address is called a uSID Carrier.

SRv6 uSIDs provides low MTU overhead; for example, 6 uSIDs per uSID carrier results in 18 source-routing waypoints in only 40 bytes of overhead (in SRH).

- [Segment Routing over IPv6 Overview, on page 2](#)
- [SRv6 Micro-Segment \(uSID\), on page 4](#)
- [Usage Guidelines and Limitations, on page 16](#)
- [Configuring SRv6, on page 18](#)
- [Configuring SRv6 under IS-IS, on page 23](#)
- [Configuring SRv6 Flexible Algorithm under IS-IS, on page 23](#)
- [Configuring SRv6 Locator Prefix Summarization, on page 26](#)
- [Configuring TI-LFA with SRv6 IS-IS, on page 26](#)
- [Configuring SRv6 IS-IS Microloop Avoidance, on page 29](#)
- [SRv6 SID Information in BGP-LS Reporting, on page 29](#)

Segment Routing over IPv6 Overview

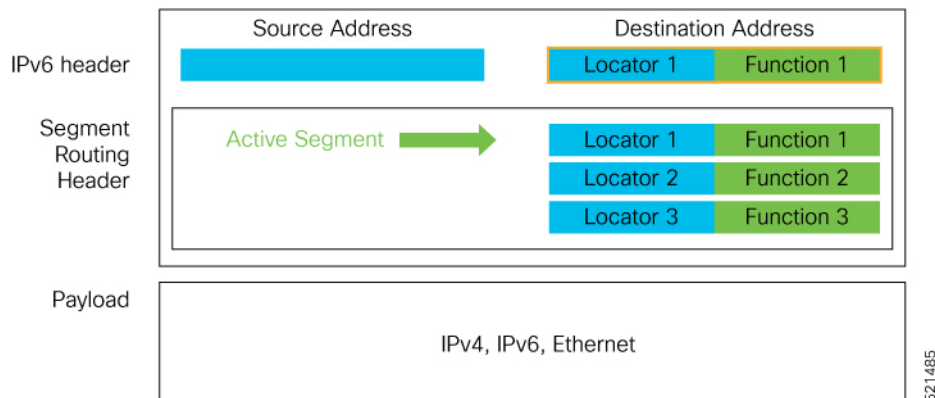
Segment Routing (SR) can be applied on both MPLS and IPv6 data planes. Segment Routing over IPv6 (SRv6) extends Segment Routing support with IPv6 data plane.

In an SR-MPLS enabled network, an MPLS label represents an instruction. The source nodes programs the path to a destination in the packet header as a stack of labels.

SRv6 introduces the Network Programming framework that enables a network operator or an application to specify a packet processing program by encoding a sequence of instructions in the IPv6 packet header. Each instruction is implemented on one or several nodes in the network and identified by an SRv6 Segment Identifier (SID) in the packet. The SRv6 Network Programming framework is defined in [IETF RFC 8986 SRv6 Network Programming](#).

In SRv6, an IPv6 address represents an instruction. SRv6 uses a new type of IPv6 Routing Extension Header, called the Segment Routing Header (SRH), in order to encode an ordered list of instructions. The active segment is indicated by the destination address of the packet, and the next segment is indicated by a pointer in the SRH.

Figure 1: Network Program in the Packet Header



The SRv6 SRH is documented in IETF RFC [IPv6 Segment Routing Header \(SRH\)](#).

The SRH is defined as follows:

[illegible]

```

|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|
|           Segment List[n] (128-bit IPv6 address)
|
|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
//
//           Optional Type Length Value objects (variable)
//
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

The following list explains the fields in SRH:

- Next header—Identifies the type of header immediately following the SRH.
- Hdr Ext Len (header extension length)—The length of the SRH in 8-octet units, not including the first 8 octets.
- Segments left—Specifies the number of route segments remaining. That means, the number of explicitly listed intermediate nodes still to be visited before reaching the final destination.
- Last Entry—Contains the index (zero based) of the last element of the segment list.
- Flags—Contains 8 bits of flags.
- Tag—Tag a packet as part of a class or group of packets like packets sharing the same set of properties.
- Segment list—128-bit IPv6 addresses representing the *n*th segment in the segment list. The segment list encoding starts from the last segment of the SR policy (path). That means the first element of the segment list (Segment list [0]) contains the last segment of the SR policy, the second element contains the penultimate segment of the SR policy and so on.

In SRv6, a SID represents a 128-bit value, consisting of the following three parts:

- Locator: This is the first part of the SID with most significant bits and represents an address of a specific SRv6 node.
- Function: This is the portion of the SID that is local to the owner node and designates a specific SRv6 function (network instruction) that is executed locally on a particular node, specified by the locator bits.
- Args: This field is optional and represents optional arguments to the function.

The locator part can be further divided into two parts:

- SID Block: This field is the SRv6 network designator and is a fixed or known address space for an SRv6 domain. This is the most significant bit (MSB) portion of a locator subnet.
- Node Id: This field is the node designator in an SRv6 network and is the least significant bit (LSB) portion of a locator subnet.

SRv6 Node Roles

Each node along the SRv6 packet path has a different functionality:

- Source node—A node that can generate an IPv6 packet with an SRH (an SRv6 packet), or an ingress node that can impose an SRH on an IPv6 packet.

- **Transit node**—A node along the path of the SRv6 packet (IPv6 packet and SRH). The transit node does not inspect the SRH. The destination address of the IPv6 packet does not correspond to the transit node.
- **Endpoint node**—A node in the SRv6 domain where the SRv6 segment is terminated. The destination address of the IPv6 packet with an SRH corresponds to the end point node. The segment endpoint node executes the function bound to the SID

SRv6 Micro-Segment (uSID)

Table 2: Feature History Table

| Feature Name | Release Information | Feature Description |
|---------------------------|---------------------|--|
| SRv6 Micro-Segment (uSID) | Release 7.3.1 | <p>This feature is an extension of the SRv6 architecture. It leverages the existing SRv6 Network Programming architecture to encode up to six SRv6 Micro-SID (uSID) instructions within a single 128-bit SID address. Such a SID address is called a uSID Carrier.</p> <p>In addition, this feature leverages the existing SRv6 data plane and control plane with no changes. It also provides low MTU overhead; for example, 6 uSIDs per uSID carrier results in 18 source-routing waypoints in only 40 bytes of overhead (in SRH).</p> |

The SRv6 micro-segment (uSID) is an extension of the SRv6 architecture. It leverages the SRv6 Network Programming architecture to encode several SRv6 Micro-SID (uSID) instructions within a single 128-bit SID address. Such a SID address is called a uSID Carrier.

SRv6 uSID is documented in the IETF drafts [Network Programming extension: SRv6 uSID instruction](#) and [Compressed SRv6 Segment List Encoding in SRH](#).

Throughout this chapter, we will refer to SRv6 micro-segment as “uSID”.

The SRv6 uSID provides the following benefits:

- Leverages the SRv6 Network Programming with no change. SRv6 uSID is a new pseudo code in the existing SRv6 network programming framework.
- Leverages the SRv6 data plane (SRH) with no change. Any SID in the destination address or SRH can be an SRv6 uSID carrier.
- Leverages the SRv6 control plane with no change.
- **Ultra-Scale**—Scalable number of globally unique nodes in the domain, for example:
 - 16-bit uSID ID size: 65k uSIDs per domain block

- 32-bit uSID ID size: 4.3M uSIDs per domain block
- Lowest MTU overhead
 - 6 uSIDs per uSID carrier
 - For example, 18 source-routing waypoints in only 40 bytes of overhead
- Hardware-friendliness:
 - Leverages mature hardware capabilities (inline IP Destination Address edit, IP Destination Address longest match).
 - Avoids any extra lookup in indexed mapping tables.
 - A micro-program with 6 or fewer uSIDs requires only legacy IP-in-IP encapsulation behavior.
- Scalable Control Plane:
 - Summarization at area/domain boundary provides massive scaling advantage.
 - No routing extension is required, a simple prefix advertisement suffices.
- Seamless Deployment:
 - A uSID may be used as a SID (the carrier holds a single uSID).
 - The inner structure of an SR Policy can stay opaque to the source. A carrier with uSIDs is just seen as a SID by the policy headend Security.
 - Leverages SRv6's native SR domain security.

SRv6 Head-End Behaviors

Table 3: Feature History Table

SR policies define the behavior of headend routers in managing and directing traffic through a network. The headend router is responsible for initiating and enforcing these policies. SR supports these headend behaviors.

- H.Encaps.Red—H.Encaps with Reduced Encapsulation

The SR Headend with Encapsulation behaviors are documented in the [IETF RFC 8986 SRv6 Network Programming](#).

The SR Headend with Insertion head-end behaviors are documented in the following IETF draft:

<https://datatracker.ietf.org/doc/draft-filsfils-spring-srv6-net-pgm-insertion/>

SRv6 Endpoint Behaviors

SRv6 Endpoint Behaviors

The SRv6 endpoint behaviors are documented in the [IETF RFC 8986 SRv6 Network Programming](#).

The following is a subset of defined SRv6 endpoint behaviors that can be associated with a SID.

- End—Endpoint function. The SRv6 instantiation of a Prefix SID [RFC8402].
- End.X—Endpoint with Layer-3 cross-connect. The SRv6 instantiation of an Adj SID [RFC8402].
- End.DX6—Endpoint with decapsulation and IPv6 cross-connect (IPv6-L3VPN - equivalent to per-CE VPN label).
- End.DX4—Endpoint with decapsulation and IPv4 cross-connect (IPv4-L3VPN - equivalent to per-CE VPN label).
- End.DT6—Endpoint with decapsulation and IPv6 table lookup (IPv6-L3VPN - equivalent to per-VRF VPN label).
- End.DT4—Endpoint with decapsulation and IPv4 table lookup (IPv4-L3VPN - equivalent to per-VRF VPN label).
- End.DX2—Endpoint with decapsulation and L2 cross-connect (L2VPN use-case).
- End.B6.Encaps—Endpoint bound to an SRv6 policy with encapsulation. SRv6 instantiation of a Binding SID.
- End.B6.Encaps.RED—End.B6.Encaps with reduced SRH. SRv6 instantiation of a Binding SID.

SRv6 Endpoint Behavior Variants

Depending on how the SRH is handled, different behavior variants are defined for the End and End.X behaviors. The End and End.X behaviors can support these variants, either individually or in combinations.

- **Penultimate Segment Pop (PSP) of the SRH variant**—An SR Segment Endpoint Node receives the IPv6 packet with the Destination Address field of the IPv6 Header equal to its SID address.

A penultimate SR Segment Endpoint Node is one that, as part of the SID processing, copies the last SID from the SRH into the IPv6 Destination Address and decrements the Segments Left value from one to zero.

The PSP operation takes place only at a penultimate SR Segment Endpoint Node and does not happen at non-penultimate endpoint nodes. When a SID of PSP-flavor is processed at a non-penultimate SR Segment Endpoint Node, the PSP behavior is not performed since Segments Left would not be zero.

The SR Segment Endpoint Nodes advertise the SIDs instantiated on them via control plane protocols. A PSP-flavored SID is used by the Source SR Node when it needs to instruct the penultimate SR Segment Endpoint Node listed in the SRH to remove the SRH from the IPv6 header.

- **Ultimate Segment Pop (USP) of the SRH variant**—The SRH processing of the End and End.X behaviors are modified as follows:

If Segments Left is 0, then:

1. Update the Next Header field in the preceding header to the Next Header value of the SRH
2. Decrease the IPv6 header Payload Length by $8 * (\text{Hdr Ext Len} + 1)$
3. Remove the SRH from the IPv6 extension header chain
4. Proceed to process the next header in the packet

One of the applications of the USP flavor is when a packet with an SRH is destined to an application on hosts with smartNICs implementing SRv6. The USP flavor is used to remove the consumed SRH from the extension header chain before sending the packet to the host.

- **Ultimate Segment Decapsulation (USD) variant**—The Upper-layer header processing of the End and End.X behaviors are modified as follows:
 - **End** behavior: If the Upper-layer Header type is 41 (IPv6), then:
 1. Remove the outer IPv6 Header with all its extension headers
 2. Submit the packet to the egress IPv6 FIB lookup and transmission to the new destination
 3. Else, if the Upper-layer Header type is 4 (IPv4)
 4. Remove the outer IPv6 Header with all its extension headers
 5. Submit the packet to the egress IPv4 FIB lookup and transmission to the new destination
 6. Else, process as per Section 4.1.1 (Upper-Layer Header) of [IETF RFC 8986 SRv6 Network Programming](#)
 - **End.X** behavior: If the Upper-layer Header type is 41 (IPv6) or 4 (IPv4), then:
 1. Remove the outer IPv6 Header with all its extension headers
 2. Forward the exposed IP packet to the L3 adjacency J
 3. Else, process as per Section 4.1.1 (Upper-Layer Header) of [IETF RFC 8986 SRv6 Network Programming](#)

One of the applications of the USD flavor is the case of TI-LFA in P routers with encapsulation with H.Encaps. The USD flavor allows the last Segment Endpoint Node in the repair path list to decapsulate the IPv6 header added at the TI-LFA Point of Local Repair and forward the inner packet.

SRv6 uSID Terminology

The SRv6 Network Programming is extended with the following terms:

- **uSID**—An identifier that specifies a micro-segment.
A uSID has an associated behavior that is the SRv6 function (for example, a node SID or Adjacency SID) associated with the given ID. The node at which an uSID is instantiated is called the “Parent” node.
- **uSID Carrier**—A 128-bit IPv6 address (carried in either in the packet destination address or in the SRH) in the following format:

```
<uSID-Block><Active-uSID><Next-uSID>...<Last-uSID><End-of-Carrier>...<End-of-Carrier>
```

 where:
 - **uSID Block**—An IPv6 prefix that defines a block of SRv6 uSIDs.
 - **Active uSID**—The first uSID that follows the uSID block.
 - **Next uSID**—The next uSID after the Active uSID.
 - **Last uSID**—The last uSID in the carrier before the End-of-Carrier uSID.
 - **End-of-Carrier**—A globally reserved uSID that marks the end of a uSID carrier. The End-of-Carrier ID is **0000**. All empty uSID carrier positions must be filled with the End-of-Carrier ID; therefore, a uSID carrier can have more than one End-of-Carrier.

The following is an example of an SRH with 3 Micro-SID carriers for a total of up to 18 micro-instructions:

| |
|--|
| Micro-SID Carrier1: {uInstruction1, uInstruction2... uInstruction6} |
| Micro-SID Carrier2: {uInstruction7, uInstruction8... uInstruction12} |
| Micro-SID Carrier3: {uInstruction13, uInstruction14... uInstruction18} |

SRv6 uSID Carrier Format

The uSID carrier format specifies the type of uSID carrier supported in an SRv6 network. The format specification includes Block size and ID size.

- **uSID Block**

The uSID block is an IPv6 prefix that defines a block of SRv6 uSIDs. This can be an IPv6 prefix allocated to the provider (for example, /22, /24, and so on.), or it can be any well-known IPv6 address block generally available for private use, such as the ULA space FC/8, as defined in IETF draft [RFC4193](#).

An SRv6 network may support more than a single uSID block.

The length of block [prefix] is defined in bits. From a hardware-friendliness perspective, it is expected to use sizes on byte boundaries (16, 24, 32, and so on).

- **uSID ID**

The length of uSID ID is defined in bits. From a hardware-friendliness perspective, it is expected to use sizes on byte boundaries (8, 16, 24, 32, and so on).

The uSID carrier format is specified using the notation "F**bbuu**", where "bb" is size of block and "uu" is size of ID. For example, "F3216" is a format with a 32-bit uSID block and 16-bit uSID IDs.

SRv6 uSID Allocation Within a uSID Block

Key Concepts and Terminologies

The architecture for uSID specifies both globally scoped and locally scoped uSIDs.

- **Global ID block (GIB):** The set of IDs available for globally scoped uSID allocation.

A globally scoped uSID is the type of uSID that provides reachability to a node. A globally scoped uSID typically identifies a shortest path to a node in the SR domain. An IP route (for example, /48) is advertised by the parent node to each of its globally scoped uSIDs, under the associated uSID block. The parent node executes a variant of the END behavior.

The "nodal" uSID (uN) is an example of a globally scoped behavior defined in uSID architecture.

A node can have multiple globally scoped uSIDs under the same uSID blocks (for example, one uSID per IGP flex-algorithm). Multiple nodes may share the same globally scoped uSID (Anycast).

- **Local ID block (LIB):** The set of IDs available for locally scoped uSID allocation.

A locally scoped uSID is associated to a local (end-point) behavior, and therefore *must* be preceded by a globally scoped uSID of the parent node when relying on routing to forward the packet.

A locally scoped uSID identifies a local micro-instruction on the parent node; for example, it may identify a cross-connect to a direct neighbor over a specific interface or a VPN context. Locally scoped uSIDs are not routeable.

For example, if N1 and N2 are two different physical nodes of the uSID domain and *L* is a locally scoped uSID value, then N1 and N2 may bind two different behaviors to *L*.

Example: uSID Allocation

The request to allocate locally scoped uSIDs comes from SRv6 clients (such as IS-IS or BGP). The request can be to allocate any available ID (dynamic allocation) or to allocate a specific ID (explicit allocation).

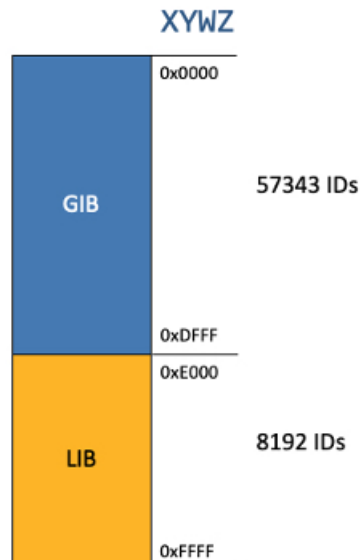
Consider the following example:

- uSID Locator Block length: 32 bits
- uSID Locator Block: FCBB:BB00::/32 (with B being a nibble value picked by operator)
- uSID length (Locator Node ID / Function ID): 16 bits
- uSID: FCBB:BB00:XYZW::/48 (with XYZW being variable nibbles)

A uSID FCBB:BB00:XYZW::/48 is said to be allocated from its block (FCBB:BB00::/32).

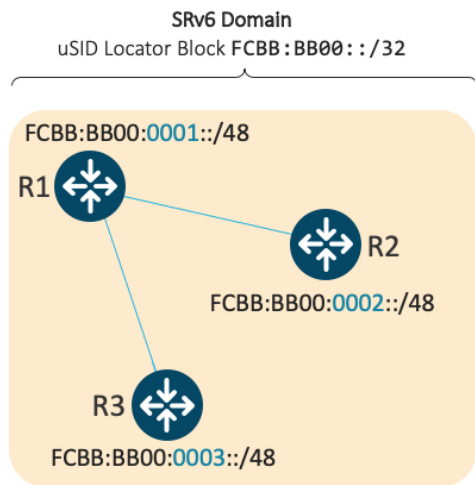
A uSID is allocated from the GIB or LIB of block FCBB:BB00::/32 depending on the value of the "X" nibble:

- GIB: nibble X from hex(0) to hex(D)
- LIB: nibble X hex(E) or hex(F)



With this allocation scheme, the uSID Block **FCBB:BB00::/32** supports up to 57343 global uSIDs (routers) with each router supporting up to 8192 local uSIDs.

For example, the following picture depicts the global uSIDs allocated for 3 nodes within the SRv6 domain.



Looking further into R1, this node also has Local uSIDs associated with uA end-point behaviors:

- Function ID 0xE000 – cross-connect to L3 neighbor R2
- Function ID 0xE001 – cross-connect to L3 neighbor R3

The underlay uSIDs present on R1 are:

- FCBB:BB00:0001::/48
- FCBB:BB00:0001:E000::/64
- FCBB:BB00:0001:E001::/64

SRv6 Endpoint Behaviors Associated with uSID

The SRv6 Network Programming is extended with new types of SRv6 SID endpoint behaviors:

- uN—A short notation for the NEXT-CSID (Compressed SID) End behavior with a pseudocode of shift-and-lookup, and PSP/USD flavors
- uA—A short notation for the NEXT-CSID End.X behavior with a pseudocode of shift-and-xconnect, and PSP/USD flavors
- uDT—A short notation for the NEXT-CSID End.DT behavior with the same pseudocode as End.DT4/End.DT6/End.DT2U/End.DT2M
- uDX—A short notation for the NEXT-CSID End.DX behavior with the same pseudocode as End.DX4/End.DX6/End.DX2

SRv6 uSID in Action - Example

This example highlights an integrated VPN and Traffic Engineering use-case leveraging SRv6 uSID.

VPNv4 site A connected to Node 1 sends packets to VPNv4 site B connected to Node 2 alongside a traffic engineered path via Node 8 and Node 7 using a single 128-bit SRv6 SID.

Node 1 is the ingress PE; Node 2 is the egress PE.

Nodes 3, 4, 5, and 6 are classic IPv6 nodes. Traffic received on these nodes use classic IP forwarding without changing the outer DA.

Nodes 1, 8, 7 and 2 are SRv6 capable configured with:

- 32-bit SRv6 block = fcbb:bb01
- 16-bit SRv6 ID

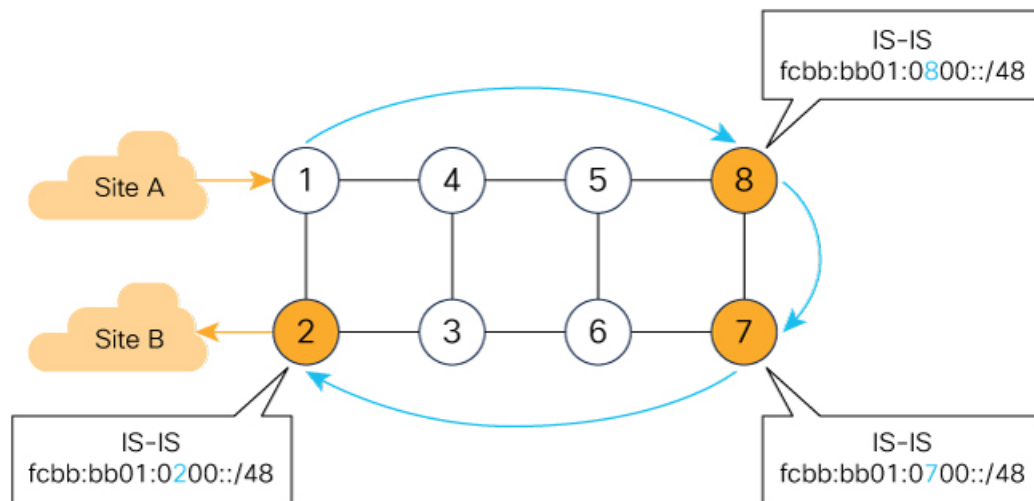
For example:

- Node 7 uN = fcbb:bb01:0700::/48
- Node 8 uN = fcbb:bb01:0800::/48

The following IGP routes are advertised:

- Node 8 advertises the IGP route fcbb:bb01:0800::/48
- Node 7 advertises the IGP route fcbb:bb01:0700::/48
- Node 2 advertises the IGP route fcbb:bb01:0200::/48

Figure 2: Integrated VPN and Traffic Engineering SRv6 uSID Use-case



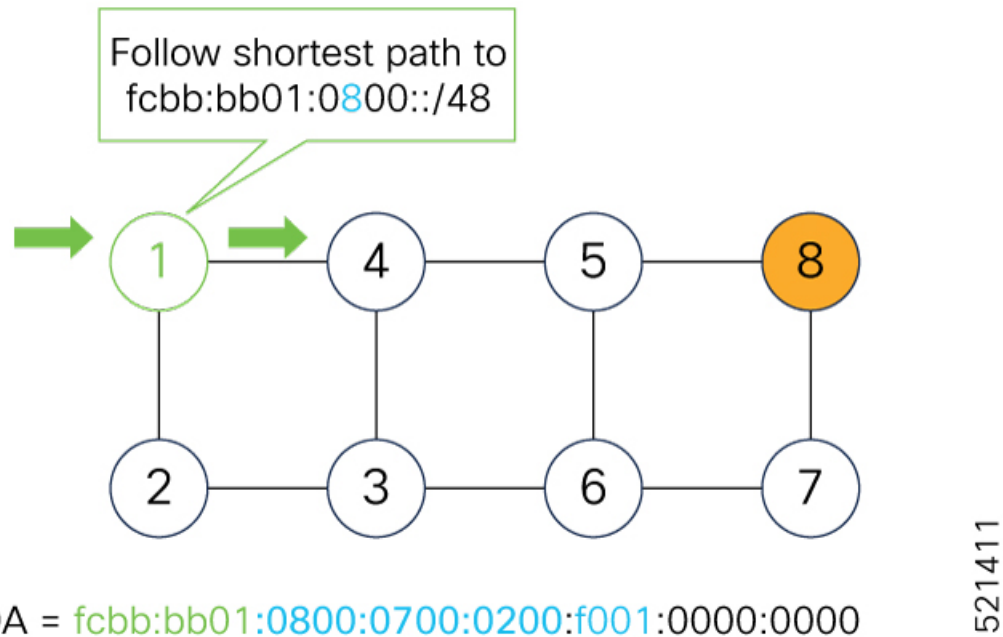
- Node 1 encapsulates IPv4 packet from Site A and sends an IPv6 packet with DA = fcbb:bb01:0800:0700:0200:f001:0000:0000
- Traffic engineered path via 8 and 7 using a single 128-bit SRv6 SID
- One single micro-program in the DA is enough

521410

Node 1 encapsulates an IPv4 packet from VPN Site A and sends an IPv6 packet with destination address fcbb:bb01:0800:0700:0200:f001:0000:0000. This is a uSID carrier, with a list of micro-instructions (uSIDs) (0800, 0700, 0200, f001, and 0000 – indicating the end of the instruction).

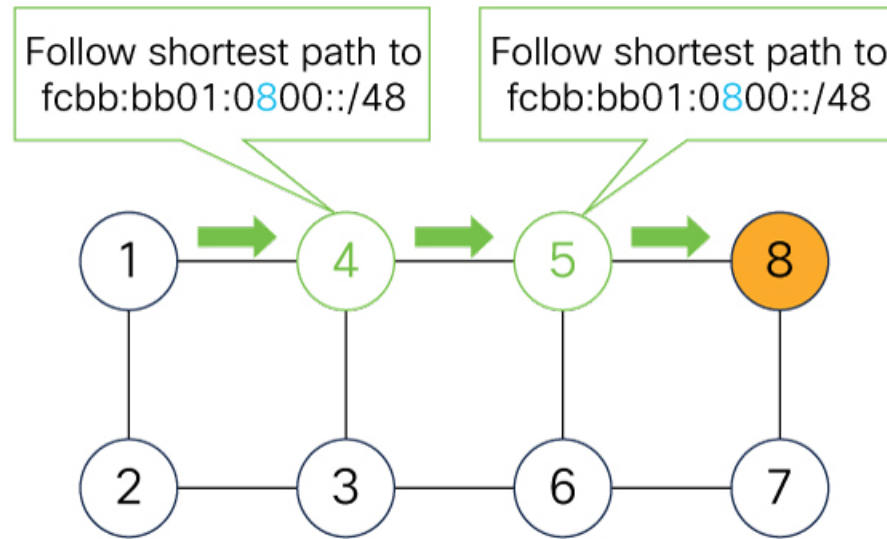
uSIDs (uNs) 0800, 0700, 0200 are used to realize the traffic engineering path to Node 2 with way points at Nodes 8 and 7. uSID f001 is the BGP-signalled instruction (uDT4) advertized by Node 2 for the VPNv4 service

Figure 3: Node 1: End.B6.Encaps Behavior



Nodes 4 and 5 simply forward the packet along the shortest path to Node 8, providing seamless deployment through classic IPv6 nodes.

Figure 4: Node 4 and Node 5: Classic IPv6 Nodes



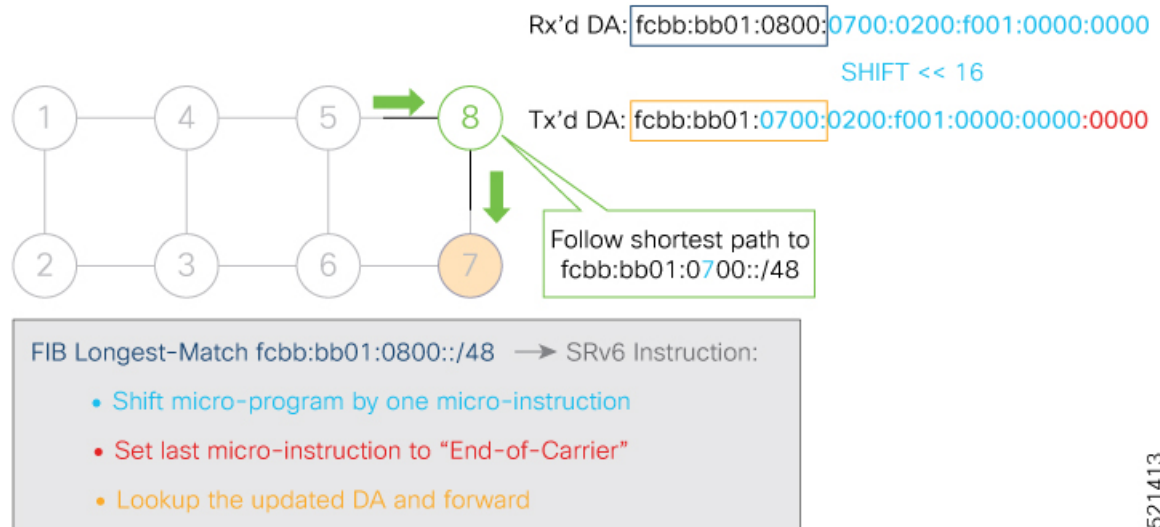
DA = fcbb:bb01:0800:0700:0200:f001:0000:0000

521412

When Node 8 receives the packet, it performs SRv6 uN behavior (shift-and-lookup with PSP/USD). It removes its outer DA (0800) and advances the micro program to the next micro instruction by doing the following:

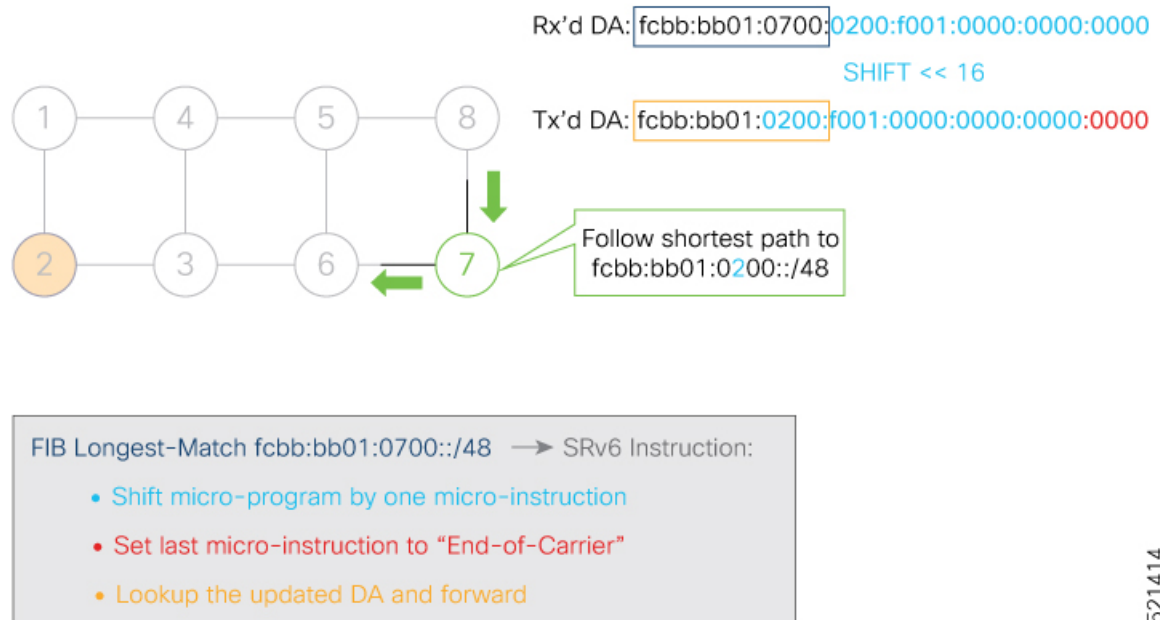
1. Pops its own uSID (0800)
2. **Shifts** the remaining DA by 16-bits to the left
3. Fills the remaining bits with 0000 (End-of-Carrier)
4. Performs a **lookup** for the shortest path to the next DA (fcbb:bb01:0700::/48)
5. Forwards it using the new DA fcbb:bb01:0700:0200:f001:0000:0000:0000

Figure 5: Node 8: SRv6 uN Behavior (Shift and Forward)



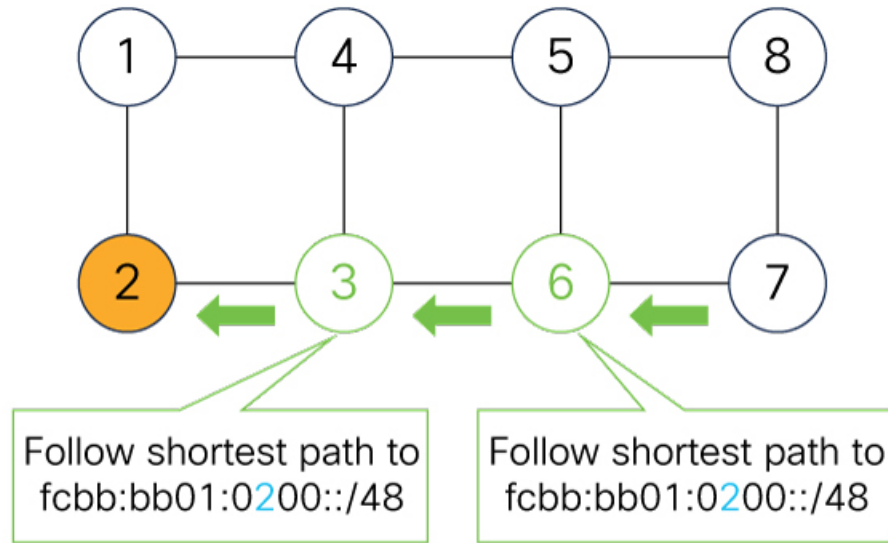
When Node 7 receives the packet, it performs the same SRv6 uN behavior (shift-and-lookup with PSP/USD), forwarding it using the new DA fcbb:bb01:0200::/48.

Figure 6: Node 7: SRv6 uN Behavior (Shift and Forward)



Nodes 6 and 3 simply forward the packet along the shortest path to Node 2, providing seamless deployment through classic IPv6 nodes.

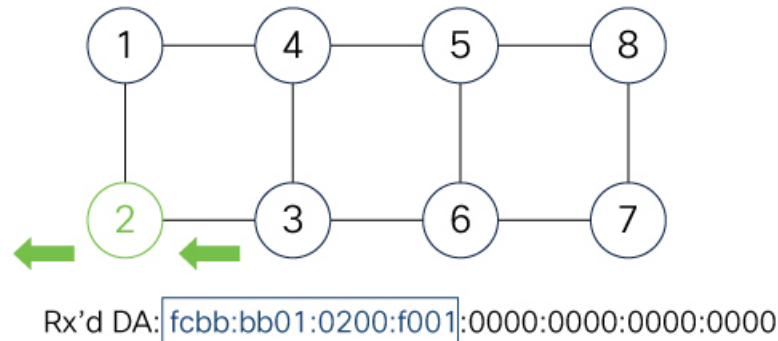
Figure 7: Node 6 and Node 3: Classic IPv6 Nodes



DA = **fcbb:bb01:0200:f001**:0000:0000:0000:0000

When Node 2 receives the packet, it performs an SRv6 uDT4 behavior (End.DT4—Endpoint with decapsulation and IPv4 table lookup) to VPNv4 Site B.

Figure 8: Node 2: SRv6 uDT4 Behavior



FIB Longest-Match **fcbb:bb01:0200:f001::/64** → SRv6 Instruction:

- Decapsulate and Lookup of inner IPv4 packet

To recap, this example showed an integrated VPN and Traffic Engineering use-case, where VPNv4 site A connected to Node 1 sent packets to VPNv4 site B connected to Node 2 alongside a traffic engineered path via Node 8 and Node 7 using a single 128-bit SRv6 SID:

- @1: inner packet P encapsulated with outer DA **fcbb:bb01:0800:0700:0200:f001:0000:0000**
- @4 & @5: classic IP forwarding, outer DA unchanged

- @8: SRv6 uN behavior: shift and lookup, outer DA becomes fcbb:bb01:**0700:0200**:f001:0000:0000:0000
- @7: SRv6 uN behavior: shift and lookup, outer DA becomes fcbb:bb01:**0200**:f001:0000:0000:0000:0000
- @6 & @3: classic IP forwarding, outer DA unchanged
- @2: SRv6 End.DT4: Decapsulate and IPv4 table lookup

Usage Guidelines and Limitations

General Guidelines and Limitations

- Cisco IOS XR supports uSIDs with 32-bit uSID block and 16-bit uSID IDs (3216).
A single UCF format must be used for uSID locators in a SRv6 uSID domain.
- Cisco IOS XR supports up to 16 uSID locator prefixes.
Multiple locator prefixes are used when configuring Anycast locators or SRv6 Flexible Algorithm instances, for example.
- Cisco IOS XR supports uSID locator prefixes from different uSID blocks.
Up to 256 uSID blocks can be used across all uSID locators in the network.
- SRv6 Underlay support includes:
 - IGP redistribution/leaking between levels
 - Prefix Summarization on ABR routers
 - IS-IS TI-LFA
 - Microloop Avoidance
 - Flex-algo
- SRv6 over GRE interface is not supported
- SRv6 over BVI interface is not supported

uSID Allocation Recommendation

We recommend allocating uSIDs from the private IPv6 space (IPv6 Unique Local Address [ULA] range). These addresses are not routable outside the domain and are therefore secure.

Allocation from the public IPv6 space (Global Unicast Addresses [GUA] range) is also possible but not recommended.

For example:

- Using /24 from FC::/8 ULA
- SRv6 Base Block = FCBB:BB::/24, with *B* indicating a nibble value picked by operator.
- SRv6 uSID Block = FCBB:BBVV/32, with *VV* indicating a nibble value picked by the operator.

- 256 /32 uSID blocks possible from this allocation, from block 0 (FCBB:BB00/32) to block 255(FCBB:BBFF/32)
- A network slice is assigned a /32 uSID block:
 - FCBB:BB00/32 for min-cost slice (shortest path based on minimum IS-IS cost)
 - FCBB:BB08/32 for min-delay slice (shortest path based on minimum latency using Flex Algo instance 128)

Platform-Specific Guidelines and Limitations

- SRv6 is supported on the following Cisco 8000 series Q200-based line cards and fixed-port routers:
 - Cisco 8800 with 88-LC0-36FH-M, 88-LC0-36FH, 88-LC0-34H14FH line cards
 - Cisco 8201-32FH
 - Cisco 8102-64H, 8101-32-FH
- SRv6 is not supported on Q100-based line cards and fixed-port routers.
- SRv6 is supported on Cisco 8000 series routers used as core routers (P-role).
- SRv6 is not supported on Cisco 8000 series routers used as edge routers (PE-role). Services over SRv6 are not supported.
- Egress marking on the outer header during SRv6 encapsulation operations (TI-LFA) is not supported.
- OAM: Ping and traceroute are supported.
- Cisco 8000 series routers support the following SRv6 uSID behaviors and variants:
 - **Endpoint behaviors:**
 - uN with PSP/USD
 - uA with PSP/USD
 - uDT4
 - uDT6
 - **Head-end behaviors:**
 - H.Encap.Red (1 uSID carrier with up to 6 uSIDs)

• Encapsulation Capabilities and Parameters

The following describes the Cisco 8000 series router capabilities for setting or propagating certain fields in the outer IPv6 header for SRv6 encapsulated packets:

- **Source address:** Cisco 8000 series routers support a single source address (SA) for SRv6 encapsulated packets. The SA is derived from the SRv6 global configuration; if not configured, it is derived from the IPv6 Loopback address.
- **Hop limit:**

- Overlay encapsulation

Default: propagate=No

The **hop-limit propagate** command enables propagation from inner header to outer header.

- Underlay encapsulation (TI-LFA) behavior is always in propagate mode, regardless of the CLI.

Manual configuration of the hop-limit value in the outer IPv6 header is not supported. See [#unique_17 unique_17_Connect_42_section_mw5_4w5_qtb](#).

- **Traffic-class:**

- Overlay encapsulation

Default: propagate=No

The **traffic-class propagate** command enables propagation from inner header to outer header.

- Underlay encapsulation (TI-LFA) behavior is always in propagate mode, regardless of the CLI.

Manual configuration of the traffic-class value in the outer IPv6 header is not supported. See [#unique_17 unique_17_Connect_42_section_mw5_4w5_qtb](#).

- **Flow Label:**

- Cisco 8000 series routers use the flow-label from the incoming IPv6 header. In case of USD operations, flow-label is used from the inner IPv6 header.
- During H.Encap.Red operations, if the inner packet has a flow label (non-zero value), the Cisco 8000 series routers propagate it to the outer IPv6 header. If the flow label is not present (zero), it is computed.

- **P role:**

- Underlay H-Encap: 6 sids (1 carrier with 6 sids per carrier)

- **PE role:**

- Underlay H-Insert: 3 sids (1 carrier with 3 sids per carrier)
- Overlay H-Encaps: 3 sids (1 carrier with 3 sids per carrier)

Configuring SRv6

Enabling SRv6 involves the following high-level configuration steps:

- Configure SRv6 locator(s)
- Enable SRv6 under IS-IS
- Enable SRv6 Services under BGP

Configure SRv6 Locator Name, Prefix, and uSID-Related Parameters

This section shows how to globally enable SRv6 and configure locator.

- **segment-routing srv6 locators locator** *locator*—Globally enable SRv6 and configure the locator.
- **segment-routing srv6 locators locator** *locator* **prefix** *ipv6_prefix/length*—Configure the locator prefix value.
- **segment-routing srv6 locators locator** *locator* **micro-segment behavior unode psp-usd**—Specifies the locator as a micro-segment (uSID) locator as well as specifies that IGP underlay uSID (uN/uA) variant is PSP-USD for this locator.

(Optional) Configure Algorithm Associated with Locator

- **segment-routing srv6 locators locator** *locator* **algorithm** *algo*—(Optional) Configure Algorithm associated with the locator. Valid values for *algo* are from 128 to 255.

For additional information about SRv6 Flexible Algorithm, see [Configuring SRv6 Flexible Algorithm under IS-IS, on page 23](#).

For detailed information about Flexible Algorithm, see [Enabling Segment Routing Flexible Algorithm](#).

(Optional) Configure Anycast Locator

An SRv6 Anycast locator is a type of locator that identifies a set of nodes (uN SIDs). SRv6 Anycast Locators and their associated uN SIDs may be provisioned at multiple places in a topology.

The set of nodes (Anycast group) is configured to advertise a shared Anycast locator and uN SID. Anycast routing enables the steering of traffic toward multiple advertising nodes. Packets addressed to an Anycast address are forwarded to the topologically nearest nodes.

One use case is to advertise Anycast uN SIDs at exit points from an SRv6 network. Any of the nodes that advertise the common uN SID could be used to forward traffic out of the SRv6 portion of the network to the topologically nearest node.

The following behaviors apply to Anycast Locator:

- Unlike a normal locator, IS-IS does not program or advertise uA SIDs associated with an Anycast locator.
- uN SIDs allocated from Anycast locators will not be used in constructing TI-LFA backup paths or Microloop Avoidance primary paths. TI-LFA backup and Microloop Avoidance paths for an Anycast locator prefix may terminate on any node advertising that locator, which may be different from the node terminating the original primary path.
- SRv6 anycast locators may have non-zero algorithm (Flexible Algorithm) values.

Use the following commands to configure the Anycast locator and advertise Anycast prefixes associated with an interface.

- **segment-routing srv6 locators locator** *locator* **anycast**—Configure the Anycast locator
- **router isis** *instance-id* **interface** *Loopback instance* **prefix-attributes anycast level** *level*—Advertise the Anycast prefixes associated with an interface.

Example 1:

The following example shows how to globally enable SRv6 and configure a locator.

```
Router(config)# segment-routing srv6
Router(config-srv6)# locators
Router(config-srv6-locators)# locator myLoc1
Router(config-srv6-locator)# micro-segment behavior unode psp-usd
Router(config-srv6-locator)# prefix 2001:0:8::/48
```

Example 2:

The following example shows how to configure Flexible Algorithm associated with locator.

```
Router(config)# segment-routing srv6
Router(config-srv6)# locators
Router(config-srv6-locators)# locator myLocAlgo128
Router(config-srv6-locator)# algorithm 128
Router(config-srv6-locator)# micro-segment behavior unode psp-usd
Router(config-srv6-locator)# prefix 2001:0:88::/48
```

Example 3:

The following example shows how to configure Anycast locator.

```
Router(config)# segment-routing srv6
Router(config-srv6)# locators
Router(config-srv6-locators)# locator myLocAnycast
Router(config-srv6-locator)# anycast
Router(config-srv6-locator)# micro-segment behavior unode psp-usd
Router(config-srv6-locator)# prefix 2001:0:100::/48
```

The following example shows how to advertise the Anycast prefixes associated with an interface.

```
Router(config)# router isis core
Router(config-isis)# interface Loopback100
Router(config-isis-if)# prefix-attributes anycast level 1
```

Example 4:

The following example shows how to configure SRv6-TE locator and binding SID (BSID) behavior.

```
Router#configure
Router(config)#segment-routing traffic-eng
Router(config-sr-te)#srv6 locator loc1 binding-sid dynamic behavior ub6-encaps-reduced
```

(Optional) Customize SRv6 Logging for Locator Status Changes

- **segment-routing srv6 logging locator status**—Enable the logging of locator status.

(Optional) Customize SRv6 SID Parameters

- **segment-routing srv6 sid holdtime *minutes***—The holdtime for a stale or freed SID. The range of *minutes* is from 0 (disabled) to 60 minutes.

Example 4:

The following example shows how to configure optional SRv6 parameters:

```
RP/0/RSP0/CPU0:Node1(config)# segment-routing srv6
RP/0/RSP0/CPU0:Node1(config-srv6)# logging locator status
RP/0/RSP0/CPU0:Node1(config-srv6)# sid holdtime 10
```

```
RP/0/RSP0/CPU0:Node1(config-srv6)#
```

Verifying SRv6 Manager

This example shows how to verify the overall SRv6 state from SRv6 Manager point of view. The output displays parameters in use, summary information, and platform specific capabilities.

```
Router# SF-D#sh segment-routing srv6 manager
Parameters:
  SRv6 Enabled: No
  SRv6 Operational Mode: None
  Encapsulation:
    Source Address:
      Configured: ::
      Default: 77::77
  Hop-Limit: Default
  Traffic-class: Default
  SID Formats:
    f3216 <32B/16NFA> (2)
  uSID LIB Range:
    LIB Start : 0xe000
    ELIB Start : 0xfe00
  uSID WLIB Range:
    EWLIB Start : 0xffff7
Summary:
  Number of Locators: 0 (0 operational)
  Number of SIDs: 0 (0 stale)
  Max SID resources: 24000
  Number of free SID resources: 24000
  OOR:
    Thresholds (resources): Green 1200, Warning 720
    Status: Resource Available
    History: (0 cleared, 0 warnings, 0 full)
Platform Capabilities:
  SRv6: Yes
  TILFA: Yes
  Microloop-Avoidance: Yes
  Endpoint behaviors:
    End.DT6
    End.DT4
    End.DT46
    End (PSP/USD)
    End.X (PSP/USD)
    uN (PSP/USD)
    uA (PSP/USD)
    uDT6
    uDT4
    uDT46
  Headend behaviors:
    H.Encaps.Red
Security rules:
  SEC-1
  SEC-2
  SEC-3
Counters:
  None
Signaled parameters:
  Max-SL : 3
  Max-End-Pop-SRH : 3
  Max-H-Insert : 0 sids
  Max-H-Encap : 2 sids
  Max-End-D : 5
```

```

Configurable parameters (under srv6):
  Ranges:
    LIB : Yes
    WLIB : Yes
  Encapsulation:
    Source Address: Yes
    Hop-Limit : value=No, propagate=Yes
    Traffic-class : value=No, propagate=Yes
  Default parameters (under srv6):
  Encapsulation:
    Hop-Limit : value=128, propagate=No
    Traffic-class : value=0, propagate=No
    Max Locators: 16
    Max SIDs: 24000
    SID Holdtime: 3 mins
Router# :SF-D#

```

Verifying SRv6 Locator

This example shows how to verify the locator configuration and its operational status.

```
Router# show segment-routing srv6 locator myLoc1 detail
```

| Name | ID | Algo | Prefix | Status | Flags |
|--------|----|------|---------------|--------|-------|
| myLoc1 | 3 | 0 | 2001:0:8::/48 | Up | U |

```

(U): Micro-segment (behavior: uN (PSP/USD))
Interface:
  Name: srv6-myLoc1
  IFH : 0x02000120
  IPv6 address: 2001:0:8::/48
Number of SIDs: 1
Created: Dec 10 21:26:54.407 (02:52:26 ago)

```

Verifying SRv6 SIDs

This example shows how to verify the allocation of SRv6 local SIDs off locator(s).

```
Router# show segment-routing srv6 locator myLoc1 sid
```

| SID | State | RW | Behavior | Context | Owner |
|------------|-------|----|--------------|-------------|--------|
| 2001:0:8:: | InUse | Y | uN (PSP/USD) | 'default':1 | sidmgr |

The following example shows how to display detail information regarding an allocated SRv6 local SID.

```
Router# show segment-routing srv6 locator myLoc1 sid 2001:0:8:: detail
```

| SID | State | RW | Behavior | Context | Owner |
|------------|-------|----|--------------|-------------|--------|
| 2001:0:8:: | InUse | Y | uN (PSP/USD) | 'default':8 | sidmgr |

```

SID Function: 0x8
SID context: { table-id=0xe0800000 ('default':IPv6/Unicast), opaque-id=8 }
Locator: 'myLoc1'
Allocation type: Dynamic
Created: Dec 10 22:10:51.596 (02:10:05 ago)

```

Similarly, you can display SID information across locators by using the **show segment-routing srv6 sid** command.

Configuring SRv6 under IS-IS

Intermediate System-to-Intermediate System (IS-IS) protocol already supports segment routing with MPLS dataplane (SR-MPLS). This feature enables extensions in IS-IS to support Segment Routing with IPv6 data plane (SRv6). The extensions include advertising the SRv6 capabilities of nodes and node and adjacency segments as SRv6 SIDs.

SRv6 IS-IS performs the following functionalities:

1. Interacts with SID Manager to learn local locator prefixes and announces the locator prefixes in the IGP domain.
2. Learns remote locator prefixes from other ISIS neighbor routers and installs the learned remote locator IPv6 prefix in RIB or FIB.
3. Allocate or learn prefix SID and adjacency SIDs, create local SID entries, and advertise them in the IGP domain.

Usage Guidelines and Restrictions

The following usage guidelines and restrictions apply for SRv6 IS-IS:

- An IS-IS address-family can support either SR-MPLS or SRv6, but both at the same time is not supported.

Configuring SRv6 IS-IS

To configure SRv6 IS-IS, use the **router isis** command. Enable SRv6 under the IS-IS IPv6 address-family and assign SRv6 locator(s) to it. Use the **level {1 | 2}** keywords to advertise the locator only in the specified IS-IS level.



Note If no level is specified, local locators will be advertised into all configured ISIS levels. Ensure that locators are included in the redistribution or propagation policy to prevent potential loops when redistributing between multiple instances or propagating between Level 2 and Level 1.

The following example shows how to configure SRv6 IS-IS.

```
Router(config)# router isis core
Router(config-isis)# address-family ipv6 unicast
Router(config-isis-af)# segment-routing srv6
Router(config-isis-srv6)# locator myLoc1
Router(config-isis-srv6-loc)# exit
```

Configuring SRv6 Flexible Algorithm under IS-IS

This feature introduces support for implementing Flexible Algorithm using IS-IS SRv6.

SRv6 Flexible Algorithm allows operators to customize IGP shortest path computation according to their own needs. An operator can assign custom SR prefix-SIDs to realize forwarding beyond link-cost-based SPF. As a result, Flexible Algorithm provides a traffic engineered path automatically computed by the IGP to any destination reachable by the IGP.

For detailed information about Flexible Algorithm, see [Enabling Segment Routing Flexible Algorithm](#).

Usage Guidelines and Restrictions

Observe the following usage guidelines and restrictions:

- You can configure up to 8 locators to support SRv6 Flexible Algorithm.
- The Flexible Algorithm locator prefix follows the same usage guidelines and restrictions of algo-0 locator prefixes. See [Usage Guidelines and Limitations](#), on page 16.
- The Locator Algorithm value range is 128 to 255.

Configuring SRv6 Flexible Algorithm under IS-IS

The following sections show you the steps to enable SRv6 Flexible Algorithm. The example highlights a delay-based Flexible Algorithm instance.

1. Configure SRv6 locators
2. Assign SRv6 locators under IS-IS
3. Configure Flexible Algorithm definition and associated metric (for example, delay)
4. Configure the delay probe under the interface. For more information on SR performance measurement, see [Configure Performance Measurement](#).

The following section shows how to configure two SRv6 locators: one associated with Algo 0, and the other associated with Algo 128.

```
Router(config)# segment-routing srv6
Router(config-srv6)# locators
Router(config-srv6-locators)# locator myLocBestEffort // best-effort locator
Router(config-srv6-locator)# micro-segment behavior unode psp-usd
Router(config-srv6-locator)# prefix 2001:0:1::/48
Router(config-srv6-locator)# exit

Router(config-srv6-locators)# locator myLocLowLat // low-latency (flex algo 128) locator
Router(config-srv6-locator)# micro-segment behavior unode psp-usd
Router(config-srv6-locator)# prefix 2001:0:2::/48
Router(config-srv6-locator)# algorithm 128
Router(config-srv6-locator)# exit
Router(config-srv6)# exit
```

The following section shows how to assign multiple SRv6 locators under IS-IS.

```
Router(config)# router isis core
Router(config-isis)# address-family ipv6 unicast
Router(config-isis-af)# segment-routing srv6
Router(config-isis-srv6)# locator myLocBestEffort
Router(config-isis-srv6-loc)# exit
Router(config-isis-srv6)# locator myLocLowLat
```



```
Router(config-isis-srv6-loc)# exit
```

The following section shows how to configure the Flexible Algorithm definition.

```
Router(config)# router isis core
Router(config-isis)# flex-algo 128
Router(config-isis-flex-algo)# metric-type delay
Router(config-isis-flex-algo)# exit
Router(config-isis)# interface GigabitEthernet0/0/0/0
Router(config-isis-if)# address-family ipv6 unicast
```

The following section shows how to configure the delay probe under the interface.

```
Router(config)# performance-measurement
Router(config-perf-meas)# interface GigabitEthernet0/0/0/0
Router(config-pm-intf)# delay-measurement
Router(config-pm-intf-dm)# commit
```

Verification

```
Router# show segment-routing srv6 locator
```

| Name | ID | Algo | Prefix | Status | Flags |
|-----------------|----|------|---------------|--------|-------|
| myLoc1 | 3 | 0 | 2001:0:8::/48 | Up | U |
| myLocBestEffort | 5 | 0 | 2001:0:1::/48 | Up | U |
| myLocLowLat | 4 | 128 | 2001:0:2::/48 | Up | U |

```
Router# show isis flex-algo 128
```

```
IS-IS core Flex-Algo Database
```

```
Flex-Algo 128:
```

```
Level-2:
```

```
Definition Priority: 128
Definition Source: Router.00, (Local)
Definition Equal to Local: Yes
Disabled: No
```

```
Level-1:
```

```
Definition Priority: 128
Definition Source: Router.00, (Local)
Definition Equal to Local: Yes
Disabled: No
```

```
Local Priority: 128
FRR Disabled: No
Microloop Avoidance Disabled: No
```

Configuring SRv6 Locator Prefix Summarization

SRv6 leverages longest-prefix-match IP forwarding. Massive-scale reachability can be achieved by summarizing locators at ABRs and ASBRs.

Use the **summary-prefix locator** [**algorithm algo**] [**explicit**] command in IS-IS address-family configuration mode to specify that only locators from the specified algorithm contribute to the summary. The **explicit** keyword limits the contributing prefixes to only those belonging to the same algorithm.

The following example shows how to configure SRv6 IS-IS Algorithm Summarization for regular algorithm and Flexible Algorithm (128).

```
Router(config)# router isis core
Router(config-isis)# address-family ipv6 unicast
Router(config-isis-af)# summary-prefix 2001:0:1::/48
Router(config-isis-af)# summary-prefix 2001:0:2::/48 algorithm 128 explicit
```

Configuring TI-LFA with SRv6 IS-IS

This feature introduces support for implementing Topology-Independent Loop-Free Alternate (TI-LFA) using SRv6 IS-IS.

TI-LFA provides link protection in topologies where other fast reroute techniques cannot provide protection. The goal of TI-LFA is to reduce the packet loss that results while routers converge after a topology change due to a link failure. TI-LFA leverages the post-convergence path which is planned to carry the traffic and ensures link and node protection within 50 milliseconds. TI-LFA with IS-IS SR-MPLS is already supported.

TI-LFA provides link, node, and Shared Risk Link Groups (SRLG) protection in any topology.

For more information, see [Configure Topology-Independent Loop-Free Alternate \(TI-LFA\)](#).

Usage Guidelines and Limitations

The following usage guidelines and limitations apply:

- TI-LFA provides link protection by default. Additional tiebreaker configuration is required to enable node or SRLG protection.
- Usage guidelines for node and SRLG protection:
 - TI-LFA node protection functionality provides protection from node failures. The neighbor node is excluded during the post convergence backup path calculation.
 - Shared Risk Link Groups (SRLG) refer to situations in which links in a network share a common fiber (or a common physical attribute). These links have a shared risk: when one link fails, other links in the group might also fail. TI-LFA SRLG protection attempts to find the post-convergence backup path that excludes the SRLG of the protected link. All local links that share any SRLG with the protecting link are excluded.
 - When you enable link protection, you can also enable node protection, SRLG protection, or both, and specify a tiebreaker priority in case there are multiple LFAs.

- Valid priority values are from 1 to 255. The lower the priority value, the higher the priority of the rule. Link protection always has a lower priority than node or SRLG protection.

Configuring SRv6 IS-IS TI-LFA

The following example shows how to configure different types of TI-LFA protection for SRv6 IS-IS.

```
Router(config)# router isis core
Router(config-isis)# interface bundle-ether 1201
Router(config-isis-if)# address-family ipv6 unicast
Router(config-isis-if-af)# fast-reroute per-prefix
Router(config-isis-if-af)# fast-reroute per-prefix ti-lfa
Router(config-isis-if-af)# exit
Router(config-isis-if)# exit
Router(config-isis)# interface bundle-ether 1301
Router(config-isis-if)# address-family ipv6 unicast
Router(config-isis-if-af)# fast-reroute per-prefix
Router(config-isis-if-af)# fast-reroute per-prefix ti-lfa
Router(config-isis-if-af)# fast-reroute per-prefix tiebreaker node-protecting index 100
Router(config-isis-if-af)# fast-reroute per-prefix tiebreaker srlg-disjoint index 200
Router(config-isis-if-af)# exit
```

Configuring SRv6 IS-IS TI-LFA with Flexible Algorithm

TI-LFA backup paths for particular Flexible Algorithm are computed using the same constraints as the calculation of the primary paths for such Flexible Algorithm. These paths use the locator prefix advertised specifically for such Flexible Algorithm in order to enforce a backup path.

By default, LFA/TI-LFA for SRv6 Flexible Algorithm uses the LFA/TI-LFA configuration of Algo 0.

Use the **fast-reroute disable** command to disable the LFA/TI-LFA calculation on a per-algorithm basis:

```
Router(config)# router isis core
Router(config-isis)# flex-algo 128
Router(config-isis-flex-algo)# fast-reroute disable
```

Verification

This example shows how to verify the SRv6 IS-IS TI-LFA configuration using the **show isis ipv6 fast-reroute ipv6-prefix detail** command.

```
Router# show isis ipv6 fast-reroute cafe:0:2::2/128 detail

L2 cafe:0:2::2/128 [20/115] Label: None, medium priority
  via fe80::e00:ff:fe3a:c700, HundredGigE0/0/0/0, Node2, Weight: 0
    Backup path: TI-LFA (link), via fe80::1600:ff:feec:fe00, HundredGigE0/0/0/1 Node3,
Weight: 0, Metric: 40
      P node: Node4.00 [cafe:0:4::4], SRv6 SID: cafe:0:4:: uN (PSP/USD)
      Backup-src: Node2.00
      P: No, TM: 40, LC: No, NP: No, D: No, SRLG: Yes
      src Node2.00-00, cafe:0:2::2
```

This example shows how to verify the SRv6 IS-IS TI-LFA configuration using the **show route ipv6 ipv6-prefix detail** command.

```
Router# show route ipv6 cafe:0:2::2/128 detail
Tue Feb 23 23:08:48.151 UTC
```

```

Routing entry for cafe:0:2::2/128
  Known via "isis 1", distance 115, metric 20, type level-2
  Installed Feb 23 22:57:38.900 for 00:11:09
  Routing Descriptor Blocks
    fe80::1600:ff:feec:fe00, from cafe:0:2::2, via HundredGigE0/0/0/1, Backup (TI-LFA)
      Repair Node(s): cafe:0:4::4
      Route metric is 40
      Label: None
      Tunnel ID: None
      Binding Label: None
      Extended communities count: 0
      Path id:65          Path ref count:1
      NHID:0x20002(Ref:19)
      SRv6 Headend: H.Encaps.Red, SID-list {cafe:0:4::}
    fe80::e00:ff:fe3a:c700, from cafe:0:2::2, via HundredGigE0/0/0/0, Protected
      Route metric is 20
      Label: None
      Tunnel ID: None
      Binding Label: None
      Extended communities count: 0
      Path id:1          Path ref count:0
      NHID:0x20001(Ref:19)
      Backup path id:65
  Route version is 0x4 (4)
  No local label
  IP Precedence: Not Set
  QoS Group ID: Not Set
  Flow-tag: Not Set
  Fwd-class: Not Set
  Route Priority: RIB_PRIORITY_NON_RECURSIVE_MEDIUM (7) SVD Type RIB_SVD_TYPE_LOCAL
  Download Priority 1, Download Version 66
  No advertising protos.

```

This example shows how to verify the SRv6 IS-IS TI-LFA configuration using the **show cef ipv6 ipv6-prefix detail location location** command.

```

Router# show cef ipv6 cafe:0:2::2/128 detail location 0/0/cpu0
Tue Feb 23 23:09:07.719 UTC
cafe:0:2::2/128, version 66, SRv6 Headend, internal 0x1000001 0x210 (ptr 0x8e96fd2c) [1],
0x0 (0x8e93fae0), 0x0 (0x8f7510a8)
Updated Feb 23 22:57:38.904
local adjacency to HundredGigE0/0/0/0

Prefix Len 128, traffic index 0, precedence n/a, priority 1
gateway array (0x8e7b5c78) reference count 1, flags 0x500000, source rib (7), 0 backups
[2 type 3 flags 0x8401 (0x8e86ea40) ext 0x0 (0x0)]
LW-LDI[type=3, refc=1, ptr=0x8e93fae0, sh-ldi=0x8e86ea40]
gateway array update type-time 1 Feb 23 22:57:38.904
LDI Update time Feb 23 22:57:38.913
LW-LDI-TS Feb 23 22:57:38.913
  via fe80::1600:ff:feec:fe00/128, HundredGigE0/0/0/1, 9 dependencies, weight 0, class 0,
  backup (TI-LFA) [flags 0xb00]
    path-idx 0 NHID 0x20002 [0x8f5850b0 0x0]
    next hop fe80::1600:ff:feec:fe00/128, Repair Node(s): cafe:0:4::4
    local adjacency
    SRv6 H.Encaps.Red SID-list {cafe:0:4::}
    via fe80::e00:ff:fe3a:c700/128, HundredGigE0/0/0/0, 6 dependencies, weight 0, class 0,
  protected [flags 0x400]
    path-idx 1 bkup-idx 0 NHID 0x20001 [0x8f8420b0 0x0]
    next hop fe80::e00:ff:fe3a:c700/128

Load distribution: 0 (refcount 2)

```

| Hash | OK | Interface | Address |
|------|----|--------------------|------------------------|
| 0 | Y | HundredGigE0/0/0/0 | fe80::e00:ff:fe3a:c700 |

Configuring SRv6 IS-IS Microloop Avoidance

This feature introduces support for implementing microloop avoidance using IS-IS SRv6.

Microloops are brief packet loops that occur in the network following a topology change (link down, link up, or metric change events). Microloops are caused by the non-simultaneous convergence of different nodes in the network. If nodes converge and send traffic to a neighbor node that has not converged yet, traffic may be looped between these two nodes, resulting in packet loss, jitter, and out-of-order packets.

The SRv6 Microloop Avoidance feature detects if microloops are possible following a topology change. If a node computes that a microloop could occur on the new topology, the node creates a loop-free SR-TE policy path to the destination using a list of segments. After the RIB update delay timer expires, the SR-TE policy is replaced with regular forwarding paths.

Usage Guidelines and Limitations

The following usage guidelines and limitations apply:

- The Routing Information Base (RIB) update delay value specifies the amount of time the node uses the microloop avoidance policy before updating its forwarding table. The *delay-time* range is from 1 to 60000 milliseconds; the default value is 5000.

Configuring SRv6 IS-IS Microloop Avoidance

The following example shows how to configure SRv6 IS-IS Microloop Avoidance and set the Routing Information Base (RIB) update delay value.



Note Complete the [Configuring SRv6, on page 18](#) before performing these steps.

```
Router(config)# router isis test-igp
Router(config-isis)# address-family ipv6 unicast
Router(config-isis-af)# microloop avoidance segment-routing
Router(config-isis-af)# microloop avoidance rib-update-delay 2000
Router(config-isis-af)# commit
```

SRv6 SID Information in BGP-LS Reporting

BGP Link-State (BGP-LS) is used to report the topology of the domain using nodes, links, and prefixes. This feature adds the capability to report SRv6 Segment Identifier (SID) Network Layer Reachability Information (NLRI).

The following NLRI has been added to the BGP-LS protocol to support SRv6:

- Node NLRI: SRv6 Capabilities, SRv6 MSD types

- Link NLRI: End.X, LAN End.X, and SRv6 MSD types
- Prefix NLRI: SRv6 Locator
- SRv6 SID NLRI (for SIDs associated with the node): Endpoint Function, BGP-EPE Peer Node/Set

This example shows how to distribute IS-IS SRv6 link-state data using BGP-LS:

```
Router(config)# router isis 200
Router(config-isis)# distribute link-state instance-id 200
```



Note It is still possible to ping or trace a SID:

- **ping** B:k:F::
- **traceroute** B:k:F::

It is possible to use a list of packed carriers to ping or trace a SID, to ping or trace route, use <destination SID> via srv6-carriers <list of packed carriers>
