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About Segment Routing

Segment routing is a technique by which the path followed by a packet is encoded in the packet itself, similar to source routing. A node steers a packet through a controlled set of instructions, called segments, by prepending the packet with a segment routing header. Each segment is identified by a segment ID (SID) consisting of a flat unsigned 32-bit integer.

Border Gateway Protocol (BGP) segments, a subclass of segments, identify a BGP forwarding instruction. There are two groups of BGP segments: prefix segments and adjacency segments. Prefix segments steer packets along the shortest path to the destination, using all available equal-cost multi-path (ECMP) paths.

Adjacency segments steer packets onto a specific link to a neighbor.

The segment routing architecture is applied directly to the MPLS data plane.

Segment Routing Application Module

Segment Routing Application (SR-APP) module is used to configure the segment routing functionality. Segment Routing Application (SR-APP) is a separate internal process that handles all the CLIs related to segment routing. It is responsible for reserving the SRGB range and for notifying the clients about it. It is also responsible for maintaining the prefix to SID mappings. The SR-APP support is also available for the BGP, IS-IS, and OSPF protocols.

The SR-APP module maintains the following information:

- Segment routing operation state
- Segment routing global block label ranges
- Prefix SID mappings

For more information, see Configuring Segment Routing.

NetFlow for MPLS

NetFlow identifies packet flows for ingress IP packets and provides statistics that are based on these packet flows. NetFlow does not require any change to either the packets themselves or to any networking device. You can export the data that NetFlow gathers for your flow by using a flow exporter and export this data to a remote NetFlow Collector, such as Cisco Stealthwatch. Cisco NX-OS exports flow as part of a NetFlow export User Datagram Protocol (UDP) datagram. You can export the data that NetFlow gathers for your flow by using a flow exporter and export this data to a remote NetFlow Collector, such as Cisco Stealthwatch. Cisco NX-OS exports a flow as part of a NetFlow export User Datagram Protocol (UDP) datagram.

Beginning with Cisco NX-OS Release 9.3(1), NetFlow Collector over segment routing is supported on Cisco Nexus 9300-EX, 9300-FX, 9300-FX2, 9500-EX, and 9500-FX platform switches.

Beginning with Cisco NX-OS Release 9.3(5), NetFlow Collector over segment routing is supported on Cisco Nexus 9300-FX3 platform switches.

NetFlow is not supported on Cisco Nexus 9300-GX platform switches..

NetFlow Collector supports both, single and double MPLS labels. Both, default and the non-default VRF in the exporter destination configurations is supported. NetFlow does not support an MPLS data path.

Since segment routing does not support a single label, you must configure the **address-family ipv4 labeled-unicast** command under BGP neighbor and the **allocate-label** command under the bgp configuration.

sFlow Collector

Sampled flow (sFlow) allows you to monitor real-time traffic in data networks that contain switches and routers. It uses the sampling mechanism in the sFlow agent software on switches and routers to monitor traffic and to forward the sample data to the central data collector.

Beginning with Cisco NX-OS Release 9.3(1), sFlow collector over segment routing is supported on Cisco Nexus 9300-EX, 9300-FX, 9300-FX2, 9500-EX, and 9500-FX platform switches.

Beginning Cisco NX-OS Release 9.3(5), sFlow collector over segment routing is supported on Cisco Nexus 9300-FX3 platform switches.

sFlow is not supported on Cisco Nexus 9364C-GX, Cisco Nexus 9316D-GX, and Cisco Nexus 93600CD-GX switches.

For information on configuring sFlow, see the *Configuring sFlow* section in the *Cisco Nexus 9000 Series NX-OS System Management Configuration Guide, Release 9.3(x)*.

Guidelines and Limitations for Segment Routing

Segment routing has the following guidelines and limitations:

- MPLS segment routing is not supported for FEX modules.
- Beginning with Cisco NX-OS Release 9.3(1), the **segment-routing mpls** command has changed to **segment-routing**.
- When you enable MPLS segment routing on Cisco Nexus 9504 and 9508 platform switches with a -R series line card, there can be instances of the BFD sessions going down and coming back. BGP peerings, if configured with BFD, also go down and come back up. When a BGP session goes down, it withdraws

routes from the hardware. This results in packet loss until the BGP session is re-established and routes are re-installed. However, once the BFD comes up, no additional flaps occurs.

- You can run segment routing under IGP(like OSPF) or by AF labeled unicast in BGP.
- Segment Routing is supported on Cisco Nexus 9300-FX platform switches and the Cisco Nexus N9K-X9736C-FX line cards.
- Segment routing and SR-EVPN are supported on Cisco Nexus C31108PC-V, C31108TC-V, and C3132Q-V switches.
- Beginning with Cisco NX-OS Release 9.3(3), you can configure Layer 3 VPNs on Cisco Nexus 9300-GX platform switches.
- Beginning with Cisco NX-OS Release 9.3(3), segment routing and SR-EVPN is supported on Cisco Nexus 9364C-GX, Cisco Nexus 9316D-GX, and Cisco Nexus 93600CD-GX platform switches.
- Beginning with Cisco NX-OS Release 9.3(3), adjacency SIDs on OSPF are supported on Cisco Nexus 9364C-GX, Cisco Nexus 9316D-GX, and Cisco Nexus 93600CD-GX platform switches.
- Beginning with Cisco NX-OS Release 9.3(3), segment routing with OSPF, IS-IS underlay, and BGP labeled unicast is supported on Cisco Nexus 9364C-GX, Cisco Nexus 9316D-GX, and Cisco Nexus 93600CD-GX platform switches.
- BGP allocates the SRGB label for iBGP route-reflector clients only when next-hop-self is in effect (for example, the prefix is advertised with the next hop being one of the local IP/IPv6 addresses on RR). When you have configured next-hop-self on an RR, the next hop is changed for the routes that are being affected (subject to route-map filtering).
- A nondisruptive ISSU is not supported with MPLS features for Cisco Nexus 9300-EX and 9300-FX platform switches.
- Static MPLS, MPLS segment routing, and MPLS stripping cannot be enabled at the same time.
- Beginning with Cisco NX-OS Release 9.3(5), MPLS stripping is supported on Cisco Nexus 9300-GX platform switches and the following guidelines are applicable:
  - For the MPLS strip feature to work, both the **mpls strip** and the **hardware acl tap-agg** commands should be configured after the switches are reloaded.
  - When the MPLS strip is enabled on the Cisco Nexus 9300-GX platform switches, the ACL log process is not displayed.
  - MPLS strip with dot1q VLAN is not supported.
  - For all double VLAN tags, the second VLAN range should be between 2-510.
  - MPLS strip with dot1q is not supported.
  - For PACL redirect support, you must use the **mode tap-aggregation** command on the ingress TAP interface.
- Because static MPLS, MPLS segment routing, and MPLS stripping are mutually exclusive, the only segment routing underlay for multi-hop BGP is single-hop BGP. iBGP multi-hop topologies with eBGP running as an overlay are not supported.

- MPLS pop followed by a forward to a specific interface is not supported. The penultimate hop pop (PHP) is avoided by installing the Explicit NULL label as the outlabel in the label FIB (LFIB) even when the control plane installs an IPv4 Implicit NULL label.
- BGP labeled unicast and BGP segment routing are not supported for IPv6 prefixes.
- BGP labeled unicast and BGP segment routing are not supported over tunnel interfaces (including GRE and VXLAN) or with vPC access interfaces.
- MTU path discovery (RFC 2923) is not supported over MPLS label switched paths (LSPs) or segment routed paths.
- For the Cisco Nexus 9200 Series switches, adjacency statistics are not maintained for Layer 3 or MPLS adjacencies.
- For the Cisco Nexus 9500 Series switches, MPLS LSPs and segment routed paths are not supported on subinterfaces (either port channels or normal Layer 3 ports).
- For the Cisco Nexus 9500 platform switches, segment routing is supported only in the nonhierarchical routing mode.
- The BGP configuration commands **neighbor-down fib-accelerate** and **suppress-fib-pending** are not supported for MPLS prefixes.
- The uniform model as defined in RFC 2973 and RFC 3270 is not supported. Therefore, the IP DSCP bits are not copied into the imposed MPLS header.
- You must ensure that the Segment Routing Global Block (SRGB) is configured before setting up protocols such as BGP that utilize labels. You must follow this configuration order to prevent allocation issues and ensure the SRGB is correctly initialized without interference from existing label allocations.
- Reconfiguration of the segment routing global block (SRGB) results in an automatic restart of the BGP process to update the existing URIB and ULIB entries. Traffic loss occurs for a few seconds, so you should not reconfigure the SRGB in production.
- If the segment routing global block (SRGB) is set to a range but the route-map label-index delta value is outside of the configured range, the allocated label is dynamically generated. For example, if the SRGB is set to range of 16000-23999 when a route-map label-index is set to 9000, the label is dynamically allocated.
- For network scalability, Cisco recommends using a hierarchical routing design with multi-hop BGP for advertising the attached prefixes from a top-of-rack (ToR) or border leaf switch.
- BGP sessions are not supported over MPLS LSPs or segment routed paths.
- The Layer 3 forwarding consistency checker is not supported for MPLS routes.
- You can configure segment routing traffic engineering with on-demand next hop on Cisco Nexus 9000 Series switches.
- Layer 3 VPN and Layer 3 EVPN stitching for segment routing is supported on Cisco Nexus 9000 Series switches.
- Beginning with Cisco NX-OS Release 9.3(3), Layer 3 VPN and Layer 3 EVPN stitching for segment routing is supported on 9300-GX platform switches.
- You can configure OSPFv2 as an IGP control plane for segment routing on Cisco Nexus 9000 Series switches.

- Layer 3 VPN and Layer 3 EVPN Stitching for segment routing is not supported on Cisco Nexus 9364C, 9200, 9300-EX, and 9500 platform switches with the -EX line cards.
- The OSPF segment routing command and segment-routing traffic engineering with on-demand next hop is not supported on Cisco Nexus 9364C switches.
- Segment Routing is supported on Cisco Nexus 9300-FX2 and 9300-FX3 platform switches.
- Layer 3 VPN and Layer 3 EVPN Stitching for Segment Routing, the OSPF segment routing command, and the segment-routing traffic engineering with on-demand next hop is supported on Cisco Nexus 9364C switches.
- Layer 3 VPN over Segment Routing is supported on Cisco Nexus 3100, 3200, 9200, 9300, 9300-EX/FX/FX2/FX3 platform switches and Cisco Nexus 9500 platform switches with -EX/FX and -R line cards.
- Deleting the segment routing configuration removes all the related segment routing configurations including the MPLS and the traffic engineering configurations.
- If you downgrade the Cisco Nexus device from Cisco NX-OS Release 9.3(1) to the previous NX-OS releases by setting the boot variables and reloading the switch, all earlier configurations of the segment-routing MPLS are lost.
- Before performing an ISSD from Cisco NX-OS Release 9.3(1), you must disable the segment routing configuration. Failure to do so will result in the loss of the existing segment routing configurations.
- Segment routing MPLS adjacency statistics are collected based on the out label stack and the next hop on the intermediate nodes. However, in the PHP mode, the statistics are shown on all adjacencies because the same stack is shared on all the FECs.
- If segment routing is enabled on a switch, Q-in-Q tagging on a dot1Q tagged MPLS packet is not supported, packets egress with only the outer tag.

  For example: Consider an ingress port in access dot1q tunnel mode, with VLAN 100. Incoming MPLS traffic has a dot1Q tag of 200. Typically, the traffic should egress with an outer tag of 100, and inner tag of 200 (same as the tag of the incoming packet). However, the packet egresses with an outer tag and loses the inner tag.
- When an incoming MPLS packet is untagged and the ingress port is in access VLAN mode, packets egress without any tag, if segment routing is enabled.
- We recommend that you do not configure segment routing using BGP, OSPF, and IS-IS underlay simultaneously.
- Beginning with Cisco NX-OS Release 10.2(1q)F, SR-MPLS is supported on the N9K-C9332D-GX2B platform switches. However, SR PBR and MPLS strip dot1q features are not yet supported on GX2 switches.
- Beginning with Cisco NX-OS Release 10.4(1)F , SR-MPLS is supported on the N9K-C9332D-H2R platform switches.
- Beginning with Cisco NX-OS Release 10.4(2)F , SR-MPLS is supported on the N9K-C93400LD-H1 platform switches.
- Beginning with Cisco NX-OS Release 10.4(3)F, the Segment Routing Layer 3 VPN feature with SR-MPLS underlay is supported on Cisco Nexus 9800 Series modular chassis (N9K-C9808, N9K-C9804) with X98900CD-A and X9836DM-A line cards. These are the guidelines and limitations:

- The chassis can be positioned as either a LEAF or a SPINE switch in the SR-MPLS fabric.
- SR-MPLS underlay is supported with BGP-LU, OSPF, and ISIS underlay protocols.
- L3VPN and L3 EVPN overlays over SR-MPLS underlay are supported using eBGP.
- The implementation supports Node-SID, Prefix-SID, and Adj-SID.
- SR-MPLS features are supported on L3 physical, L3 sub-interface, L3 Port-channel (PO), and L3 PO sub-interface types.
- Hierarchical ECMP (Level-1 and Level-2) is supported for SR-MPLS paths.
- MPLS TTL propagation operates in Uniform Mode.
- DSCP-EXP handling is Uniform during encapsulation and Pipe during decapsulation (tentative).
- Per-VRF VPN label encapsulation is supported.
- Default load-sharing for SR-MPLS traffic is based on Label + IP (up to 5-tuple).
- MPLS Decap Statistics are supported for VPN label termination.
- Switched Virtual Interfaces (SVIs) are not supported for SR-MPLS.