Junos Segment Routing with SRv6 Micro-SIDs

COURSE OVERVIEW

This three-day, advanced-level course provides an in-depth introduction to segment routing (SR), otherwise known as Source Packet Routing in Networking (SPRING). The course focuses on using IS-IS and BGP to deploy Segment Routing for IPv6 (SRv6) micro-SIDs, which encode multiple instructions into a single IPv6 address in the data plane.

After exploring the features and use cases for SRv6 with micro-SIDs, students are introduced to the fundamentals of a segment-routed network, such as locator blocks, locator prefixes, and a variety of BGP service functions such as uDT4 and uDT6 segments. This also includes VPN configuration, with a focus on Layer 3 VPNs and the MPLS label transposition process.

Students are then taught how an SRv6 micro-SID network can encode multiple segments into a single address, and the segment popping process that takes place across a path. Students configure End and End.X transport segments to test this, which acts as a starting point to deploy a variety of backup paths with Topology-Independent Loop-Free Alternate (TI-LFA). A self-study section then follows that considers topics including classic SRv6, microloop avoidance, and the three flavor behaviors of SRv6 transport segments.

Students also briefly learn the most fundamental concepts of Segment Routing for MPLS (SR-MPLS). This knowledge enables students to compare and contrast the two SR methods.

This course is based on Junos OS Release 25.2R1.8.

COURSE LEVEL

Junos Segment Routing with SRv6 Micro-SIDs is an advanced-level course, but will also appeal to students who have strong intermediate knowledge.

AUDIENCE

- Individuals who work with routers that run Junos OS.
- Individuals involved in the service provider industry, the data center industry, or who work in large enterprise networks.
- Operators who use BGP and IS-IS, and who may previously have used MPLS to create transport paths across their networks.

PREREQUISITES

- Advanced routing knowledge; the Advanced Junos Service Provider Routing course or equivalent knowledge.
- Intermediate Junos CLI experience.
- Fundamental knowledge of MPLS transport functions, including LDP and RSVP, and the BGP prefix resolution process in such environments.
- Recommended:
  - Completion of the Junos MPLS Fundamentals course or equivalent knowledge.
  - Basic knowledge of Layer 3 VPNs in an MPLS environment.

RELATED JUNIPER PRODUCTS

ACX Series, Junos OS, MX Series, QFX Series, Juniper Paragon Pathfinder, PTX Series

RECOMMENDED NEXT COURSE

Junos Segment Routing with SR-MPLS

OBJECTIVES

- Explain the basic philosophy of segment routing.
- Describe some of the exciting features offered by segment routing.
- Explain some fundamentals segment routing concepts, such as segment IDs, global segments, and local segments.
- Demonstrate how SRv6 micro-SIDs can enable a BGP-free core.
- Demonstrate how to deploy and verify uSID locator blocks and locator prefixes in Junos OS.
- Describe the variety of function types you can deploy in an SRv6 network.
- Demonstrate how to configure internal and external BGP in preparation for generating SRv6 micro-SIDs.
- Demonstrate how to deploy uDT4, uDT6, and uDT46 micro-SIDs.
- Demonstrate how to override the default Junos OS micro-SID Local ID Block (LIB) range.

- Configure and verify Layer 3 VPNs in an SRv6 micro-SID network.
- Explain how a path with multiple precise hops can be encoded in a single SRv6 micro-SID address.
- Explain how adjacency segments can be used to define strict hops along a path.
- Explain how the Segment Routing Header (SRH) can carry multiple SRv6 addresses inside a single header.
- Explain how TI-LFA backup paths can radically reduce downtime during link or node failure.
- Demonstrate how to configure and verify TI-LFA link protection in a Junos OS SRv6 network.
- Demonstrate how to configure and verify TI-LFA node protection in a Junos OS SRv6 network.
- Explain the various ways that you can continue your SRv6 micro-SID studies once the course is completed.
- Describe the process by which Junos OS calculates a SID stack for TI-LFA backup paths.
- Explain how enabling microloop avoidance can solve problems that may occur during network convergence.
- Explain how to configure and verify a classic SRv6 deployment using Junos OS.
- Explain the behavior of the three flavors that can pop a Segment Routing Header or an IPv6 transport header.
- Review crucial MPLS concepts such as the label format, the inet.3 and mpls.0 tables, and BGP next-hop resolution.

COURSE CONTENTS

DAY 1

Module 01: Introducing Segment Routing

- Explain how a segment is like an instruction to forward or process a packet in a particular way
- Describe the high-level difference between SR-MPLS, classic SRv6, and micro-SIDs
- Demonstrate at a high level how segments are advertised inside your interior gateway protocol

Module 02: The Features Enabled by Segment Routing

- Explain how segment routing enables both shortest paths and traffic engineered paths
- Describe some exciting features offered by segment routing, such as Flex Algo and TI-LFA

Module 03: Segments in the Data Plane—SR-MPLS

- Describe how SR-MPLS creates stacks of segments
- Demonstrate how SR-MPLS encodes global and local segments with an MPLS label

Module 04: Segments in the Data Plane—SRv6 Micro-SIDs

- Explain how micro-SIDs compress one SID into a single IPv6 hextet
- Describe how the SRv6 locator enables shortest-path routing to a remote node
- Describe how the SRv6 function encodes an instruction for a local router to process

Module 05: SRv6 Micro-SID Locators—Configuration and Verification

- Explain the design of the test network used throughout this course
- Describe how to choose and deploy a micro-SID locator block
- Configure a micro-SID locator prefix in Junos OS
- Verify micro-SID locator blocks and locator prefixes in Junos OS

Lab 01: Enabling Locators and Shortest-Path Tunnels in an SRv6 Micro-SID Network

Module 06: SRv6 Micro-SID Functions

- Explain the purpose and meaning of End.DT4, End.DT6, and End.DT46 functions in SRv6
- Demonstrate the importance of maintaining separate blocks of micro-SID values for global and local segments

DAY 2

Module 07: SRv6 Micro-SIDs—Initial EBGP and IBGP Configuration

- Configure IPv6 EBGP sessions to advertise IPv4 prefixes with IPv4 next hops
- Configure IBGP to process SRv6 SIDs and to advertise IPv4 prefixes with IPv6 next hops
- Demonstrate how to verify that your IBGP network is ready to host micro-SIDs

Lab 02: Configuring the Underlying EBGP and IBGP Settings for SRv6 Micro-SIDs

Module 08: BGP Service Micro-SIDs—Configuration and Verification

- Configure uDT4, uDT6, and uDT46 micro-SIDs in the default Junos OS routing tables
- Verify BGP micro-SID prefix resolution on the Junos OS CLI

Lab 03: Tagging BGP Updates with uDT4 and uDT6 Micro-SIDs for IP Prefix Resolution

Module 09: Customizing the Micro-SID Local ID Block

- Configure Junos OS to allocate a range of micro-SID values for manual allocation
- Configure Junos OS to allocate a larger range of micro-SID values to the LIB

Lab 04: SRv6 Micro-SID Block Customization

Module 10: SRv6 Micro-SIDs and Layer 3 VPNs

- Describe the transposition process of using MPLS labels in BGP updates to efficiently advertise SRv6 SIDs
- Demonstrate how to deploy a Layer 3 VPN that uses the SRv6 micro-SID data plane
- Describe the function types required in a Layer 2 Ethernet VPN deployment

Lab 05: SRv6 Micro-SIDs and L3VPN Integration

Module 11: Micro-SID Stacks, Part 1—Micro-Node SIDs and SRv6 Traceroute

- Describe the hop-by-hop behavior of an SRv6 address that contains a stack of shortest-path micro-node SIDs
- Demonstrate how to use SRv6 traceroute to test and troubleshoot a micro-SID deployment

DAY 3

Module 12: Micro-SID Stacks, Part 2—Micro-Adjacency SIDs

- Configure and verify End.X micro-adjacency SIDs to enable precise SR paths
- Demonstrate how End.X micro-adjacency SIDs are processed in the data plane
- Explain the meaning of the formal RFC name of NEXT-CSID for micro-SIDs

Module 13: Micro-SID Stacks, Part 3—The Segment Routing Header

- Explain the format and behavior of the SRH along a path
- Describe how flavors offer additional permission for transport segments to pop the SRH and the IPv6 header
- Demonstrate how Junos OS represents the SRH in an SRv6 traceroute

Lab 06: Using SRv6 Traceroute to Troubleshoot Transport Micro-SIDs and the Segment Routing Header

Module 14: Topology-Independent Loop-Free Alternate—Theory

- Explain how TI-LFA creates loop-free backup paths with full topology coverage
- Explain the concepts of the pre-convergence and post-convergence topologies
- Describe the difference between link protection and node protection in TI-LFA

Module 15: TI-LFA Link Protection—Configuration

- Configure Junos OS for TI-LFA with link protection
- Explain how Junos calculates SRv6 TI-LFA SID stacks to route around pre-convergence loops
- Explain the three main methods of writing TI-LFA SIDs to a packet in an SRv6 micro-SID network
- Verify that Junos automatically offers TI-LFA protection to prefixes learned from BGP

Module 16: TI-LFA Node Protection—Configuration

- Configure Junos OS for TI-LFA with loose node protection
- Configure Junos OS for TI-LFA with strict node protection
- Explain what types of traffic are eligible for local repair

Lab 07: Topology-Independent Loop-Free Alternate

Module 17: Where Do You Go from Here?

- Describe some crucial topics for future self-study, including traffic engineering, locator prefix aggregation, and Flex Algo
- Explain the free study materials offered by Juniper Networks, including the certification program

SELF-STUDY MODULES

Module 18: Topology-Independent Loop-Free Alternate—The Micro-SID Stack

- Explain how P space and extended P space find loop-free backup paths
- Demonstrate how Q space can be used to tunnel traffic across topological loops on a backup path
- Describe how TI-LFA bridges gaps between P space and Q space

Module 19:Microloop Avoidance

- Describe how microloop avoidance can prevent temporary loops between two nodes during network convergence
- Configure and verify microloop avoidance in Junos OS

Module 20:Classic SRv6—An Introduction

- Demonstrate how to configure and verify a classic SRv6 locator prefix
- Describe the format and purpose of a classic SRv6 function value
- Demonstrate the way that SID stacks in classic SRv6 operate differently from micro-SIDs

Module 21:SRv6—Using Flavors to Pop the Segment Routing Header

- Explain the motivations behind the Penultimate Segment Pop flavor
- Describe the purpose of the flavor called Ultimate Segment Decapsulation
- Explain a theoretical use case for the Ultimate Segment Pop flavor
- Demonstrate how to verify the flavors of transport micro-SIDs on the Junos CLI

Module 22:Refresher—Using MPLS Tunnels to Resolve BGP Prefixes

- Explain the required prerequisite knowledge for this course
- Describe the IS-IS LSP message format, and describe how BGP resolves its protocol next-hops
- Demonstrate how MPLS can create tunnels between devices
- Define some crucial MPLS terminology

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