Junos Segment Routing for MPLS

COURSE OVERVIEW

This four-day, advanced-level course provides an in-depth introduction to MPLS segment routing (SR), otherwise known as Source Packet Routing in Networking (SPRING). It also includes two additional day's worth of self-study material.

The course focuses on the configuration of Juniper Networks routing and switching devices to support MPLS segment routing.

After exploring the features and use cases for SR-MPLS, students are introduced to the building blocks of a segment-routed network (namely, adjacency segment identifiers (SIDs), node SIDs, prefix SIDs and anycast SIDs). The course includes these features for both IS-IS and OSPF.

Students then learn how to use these SIDs to create label-switched paths (LSPs) and tunnels within an MPLS network. This includes the creation of shortest-path LSPs, traffic-engineered SR policies with static paths, SR policies with dynamically calculated paths using distributed Constrained Shortest Path First (CSPF), color-based SR policies with Classful Transport resolution, backup paths with Topology-Independent Loop-Free Alternate (TI-LFA), and multitopology designs with Flex Algo.

This course also features a number of self-study modules, including a deeper dive into TI-LFA label stacks, and five modules on SRv6, including coverage on classic SRv6 SIDs and micro SIDs.

This course is based on Junos OS Release 23.4R1.10.

COURSE LEVEL

Junos Segment Routing is an advanced-level course

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 MPLS, BGP, and either IS-IS or OSPF to transport traffic across their network

PREREQUISITES

- Advanced routing knowledge the *Advanced Junos Service Provider Routing* course or equivalent knowledge is recommended
- Intermediate knowledge of MPLS transport functions, including LDP and RSVP
- The *Junos MPLS Fundamentals* course or equivalent knowledge is strongly recommended
- Intermediate to advanced Junos CLI experience

RELATED CERTIFICATION

JNCIE-SP JNCIP-SP

RELATED JUNIPER PRODUCTS

Junos OS, ACX Series, MX Series, QFX Series, PYX Series, Network Design, Paragon Pathfinder

OBJECTIVES

- Review crucial MPLS concepts such as the label format, the inet.3 and mpls.0 tables, and BGP next-hop resolution.
- Demonstrate the building blocks of segment routing, such as adjacency SIDs and node SIDs.
- Describe some of the many features and benefits offered by SR-MPLS.
- Demonstrate how to enable and verify adjacency segments in IS-IS.
- Demonstrate how to enable and verify adjacency segments in OSPF.
- Demonstrate how to enable node SIDs in IS-IS to create a full mesh of shortest-path LSPs.
- Demonstrate how to enable node SIDs in OSPF to create a full mesh of shortest-path LSPs.
- Demonstrate the configuration and use cases for prefix SIDs and anycast SIDs.

- Configure SR traffic engineering policies that contain paths with an explicit SID stack.
- Describe how Seamless Bidirectional Forwarding Detection (S-BFD) can monitor an SR policy.
- Configure and verify SR policies with paths that contain explicit IP hops and binding SIDs.
- Demonstrate how SR policies can dynamically calculate a path based on your traffic engineering constraints.
- Describe the configuration for an SR policy that calculates its path dynamically.
- Demonstrate SR policy features such as computed segment lists and dynamic tunnels.
- Explain how TI-LFA backup paths can radically reduce downtime during link or node failure.
- Demonstrate how to configure and verify TI-LFA in a Junos OS network.
- Explain how the BGP color community can automatically map prefixes to a specific SR policy.
- Describe how Junos transport classes offer advantages in a network with color-based traffic engineering.
- Describe the advantages and operation of Flex Algo for SR-MPLS.
- Demonstrate how to configure and verify Flex Algo on a Junos OS device.
- Describe the process by which Junos OS calculates a label stack for TI-LFA backup paths in SR-MPLS.
- Explain how enabling microloop avoidance can solve problems that may occur during network convergence.
- Demonstrate some advanced SR policy concepts, including load balancing and external controllers.
- Demonstrate how to resolve color-tagged prefixes to SR policies using the legacy inetcolor method of resolution.
- Explain how SRv6 operates in contrast to SR-MPLS.
- Explain how SRv6 functions are a local instruction for a segment endpoint.
- Demonstrate how a stack of SRv6 SIDs is carried in the data plane.
- Explain how micro SIDs can compress multiple SIDs into a single SRv6 address.
- Demonstrate how to deploy local micro-segments such as uDT SIDs and uA SIDs.

COURSE CONTENTS

DAY 1

Module 1: Refresher—MPLS, RSVP, and LDP

- Describe how BGP resolves its protocol next-hops
- Demonstrate how MPLS can create tunnels between devices
- Define some crucial MPLS terminology

Module 2: An Introduction to Segment Routing

- Describe how segment routing combines segments to create an end-to-end-path
- Explain how segment routing efficiently advertises MPLS labels for shortest-path forwarding

Module 3: The Use Cases for SR-MPLS

- Explain the benefits of shortest-path LSPs and traffic-engineered LSPs
- Describe some exciting features offered by segment routing, such as Flex Algo and TI-LFA
- Explain the difference between SR-MPLS and SRv6

Module 4: Adjacency SIDs, Part 1—IS-IS

- Explain the consistent topology and the IP scheme used throughout this course
- Configure and verify SR-MPLS adjacency SIDs in IS-IS

Module 5: Adjacency SIDs, Part 2—OSPF

- Configure and verify SR-MPLS adjacency SIDs in OSPF

Lab 1: Adjacency SIDs in SR-MPLS

Module 6: Node SIDs and Shortest-Path Routing, Part 1—IS-IS

- Describe how the SRGB defines a block of MPLS labels for shortest-path forwarding
- Configure and verify node SIDs in IS-IS
- Enable explicit-null behavior for node and prefix SIDs

Module 7: Node SIDs and Shortest-Path Routing, Part 2—OSPF

- Configure and verify node SIDs in OSPF
- Describe the link-state advertisements used by OSPF to advertise node SID information

Lab 2: Node SIDs in IS-IS and OSPF

DAY 2

Module 8: Prefix SIDs and Anycast SIDs

- Configure and verify prefix SIDs and anycast SIDs in IS-IS and OSPF
- Enable BGP to use anycast SIDs in its protocol next-hops

Lab 3: Prefix SIDs and Anycast SIDs

Module 9: Traffic Engineering—Static SR Policies with Explicit Label Stacks

- Describe how explicit and dynamic SR policies can create tunnels that take a precise path of your choosing
- Configure persistent adjacency SIDs
- Configure a CLI-based SR policy with an explicit SID stack

Module 10: Traffic Engineering—Static SR Policies with S-BFD

- Demonstrate how S-BFD can monitor the status of an SR policy
- Configure and verify S-BFD on an SR policy in Junos OS

Lab 4: Traffic Engineering—Static SR Policies with Explicit Label Stacks

Module 11: Traffic Engineering—Static SR Policies with Explicit IP Hops

- Configure a CLI-based SR policy with an explicitly configured path of IP addresses
- Explain the purpose of the traffic engineering database
- Demonstrate how binding SIDs can swap one incoming label for a stack of outgoing labels

Lab 5: Traffic Engineering—Static SR Policies with Explicit IP Hops

DAY 3

Module 12: Traffic Engineering—Dynamic SR Policies with CSPF, Part 1

- Explain the purpose of CSPF and admin groups
- Demonstrate how to configure and verify admin groups

Module 13: Traffic Engineering—Dynamic SR Policies with CSPF, Part 2

- Configure and verify a basic SR policy that calculates a dynamic path using TE metrics
- Deploy an SR policy with a compute-profile that contains traffic engineering constraints of your choosing

Lab 6: SR Policies with Dynamic Paths, Part 1

Module 14: Traffic Engineering—Dynamic SR Policies with CSPF, Part 3

- Deploy an SR policy with a compute-profile that also references a segment-list path
- Configure On-Demand Next-Hops that automatically build SR policies to BGP next-hops

Lab 7: SR Policies with Dynamic Paths, Part 2

Module 15: Topology-Independent Loop-Free Alternate—Theory

- Explain how TI-LFA creates loop-free backup paths with full topology coverage
- Describe the difference between link protection and node protection in TI-LFA

Module 16: Topology-Independent Loop-Free Alternate—Configuration

- Configure Junos OS for TI-LFA with link protection
- 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 8: Topology-Independent Loop-Free Alternate

DAY 4

Module 17: Color-Based Traffic Engineering and the BGP Color Community

- Describe the format of the BGP color community
- Demonstrate how to configure an SR policy with a color
- Explain why Junos offers two different methods of enabling color-aware prefix resolution

Module 18: Color-Based Traffic Engineering with Classful Transport

- Explain the advantages of resolving color-tagged prefixes using the Classful Transport method
- Configure automatic and manual transport classes
- Verify whether IP unicast prefixes have resolved using a transport class
- Verify whether VPN prefixes have resolved using a transport class

Lab 9: Resolving Color-Aware LSPs with Classful Transport

Module 19: Flex Algo, Part 1

- Explain the advantage of using Flex Algo to create multiple topologies with their own unique SPF metric
- Explain the meaning of algos 0, 1, and 128 to 255
- Configure the elements used to build a unique flexible algorithm definition

Module 20: Flex Algo, Part 2

- Configure a Flex Algo topology using the Classful Transport method of resolution
- Verify and troubleshoot a Junos OS Flex Algo deployment
- Describe some important design considerations when deploying Flex Algo

Lab 10: Flex Algo

Module 21: Where Do You Go from Here?

- Describe some of the ways that you can continue your SR-MPLS studies once you've completed this course
- Explain how to continue getting hands-on practice with Junos OS once the course is complete
- Describe the Juniper Networks certification track

SELF-STUDY MODULE

Module 22: Topology-Independent Loop-Free Alternate—The Label Stack

- Explain how P space and extended P space find loop-free backup paths
- Demonstrate how Q space can be used to tunnel backup paths across topological loops
- Describe how adj-SIDs can bridge gaps between P space and Q space

Module 23: 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 24: SR-MPLS—Additional Concepts

- Describe how SR policies can use multiple primary paths and a backup secondary path
- Explain how interface sets can offer unequal-cost load balancing

- Demonstrate how to create an anycast SR policy
- Describe how external controllers like Paragon Pathfinder use BGP-LS and PCEP to deploy LSPs across your entire network estate
- Explain why anycast SIDs require a consistent SRGB

Module 25: Color-Based Traffic Engineering with the inetcolor.0 Table

- Describe how the inetcolor.0 table resolves color-tagged BGP unicast prefixes
- Explain how to resolve BGP-based MPLS VPN prefixes in the inetcolor.0 table

Module 26: SRv6—The Data Plane and Locators

- Demonstrate the data plane differences between SRv6 and SR-MPLS
- Describe the locator, function, and argument elements of an SRv6 SID
- Configure and verify locator prefixes in Junos OS

Module 27: SRv6—End.DT4 and End.DT6 Functions

- Describe how End.DT4 and End.DT6 SIDs bind a packet to a routing table
- Configure End.DT4 and End.DT6 SIDs
- Verify End.DT4 and End.DT6 SIDs

Lab 11: Enabling Locators, End.DT4 SIDs, and End.DT6 SIDs in a Classic SRv6 Network

Module 28: SRv6—TI-LFA, End SIDs, and the Segment Routing Header

- Explain the purpose and behavior of the Segment Routing Header
- Demonstrate the hop-by-hop operation of the Segment Routing Header
- Describe the purpose of PSP, USP, and USD flavors for End SID and End.X SIDs
- Configure and verify End SIDs and End.X SIDs

Module 29: SRv6 Micro SIDs—SID Compression and Locators

- Demonstrate how uSIDs solve the problem of packets with a large SRH
- Explain how uSIDs are popped and shifted in a TE and TI-LFA network
- Configure and verify micro-SID blocks, locators, and uN SIDs

Module 30: SRv6 Micro SIDs—Local Segments and uDT SIDs

- Explain why global and local C-SID blocks must be consistent on all devices
- Configure and verify uDT4 and uDT6 SIDs for BGP prefixes
- Demonstrate how to customize uSID blocks and uA SID values

Lab 12: Enabling SRv6 Micro SIDs to Power a BGP-Free Core

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