Advanced HPE Networking Junos OS service provider routing

Course overview

This five-day, advanced-level course provides an in-depth coverage of three crucial protocols that service provider network engineers and network architects encounter in production networks—IS-IS, OSPF, and BGP.

The course uses a consistent 10-router service provider network topology in both the instructor-led modules and in the hands-on labs. Each concept is taught in the context of a topology change that is implemented and verified by the student. Each topology change is covered with detailed configuration and verification steps. This approach enables network engineers to quickly read and understand CLI output when implementing configuration changes and troubleshooting.

The course begins with IS-IS. First, the course covers single-level, single-area IS-IS concepts in a dual-stack network, before progressing through to multi-area and multilevel operation, routing policies, route summarization, and IS-IS security and maintenance features.

Students then study OSPF with a similar depth, covering OSPF packet types, OSPF area types, and routing policies. Then, students learn the similarities and differences between OSPFv2 and OSPFv3, with a focus on the new link-state advertisement (LSA) types used in OSPFv3 and how they transport OSPFv3 information.

Finally, the course covers advanced BGP topics that are commonly used in service provider networks. Students configure and verify internal BGP (IBGP) and external BGP (EBGP) in a real-world service provider network that uses route reflection and that has multiple external peers. The network in this course has four BGP peering connections: two links to a Tier 2 Internet transit provider, a link to a Tier 1 Internet transit provider, and a link to a private peer. This course covers how to manipulate BGP attributes such as local preference, AS path, multi-exit discriminator (MED), and communities to traffic steering out of an autonomous system (AS) and between ASs. Other key topics include Add-Path, advanced route reflection designs, BGP session protection, multipath load balancing, resource public key infrastructure (RPKI), remotely triggered black hole (RTBH), and a summary of the capabilities that different Multiprotocol BGP address families can enable.

Through demonstrations and hands-on labs, students gain experience configuring, monitoring, and troubleshooting these protocols on HPE Juniper Networking devices. This course uses MX Routers for the hands-on component, but the lab environment does not preclude the course from being applicable to other Juniper hardware platforms running HPE Networking Junos Operating System. This course is based on Junos OS Release 25.2R1.

Finally, students can continue their study of IS-IS and OSPF topics outside of the class, through the self-study modules included in this course. For IS-IS, students can study the different types of IS-IS designs they might encounter in production and multitopology IS-IS. For OSPF, students can learn topics such as the overload option in OSPF, the different types of OSPF authentication, multi-area adjacency, and virtual links. Both IS-IS and OSPF are compared side-by-side, by analyzing a few of their link-state protocol characteristics.

Course level

- Advanced level

Intended audience

- Individuals who work with routers that run Junos OS and have an interest in service provider technologies.
- Individuals who are involved in the service provider industry, in any capacity ranging from support, architecture, or technical sales roles.

- Individuals who plan to make a career shift into the service provider industry.

Prerequisites

- Intermediate-level networking knowledge and an understanding of the OSI model and the TCP/IP protocol suite.
- Knowledge of OSPF, IS-IS, and BGP fundamental concepts, such as adjacency formation, packet types, and basic protocol operation
- Completion of the *Introduction to the Junos Operating System* and *Junos Intermediate Routing* courses, or equivalent experience.

Related certifications

- JNCIP-SP

Related products

- HPE Juniper Networking ACX Routers
- Junos OS
- MX Routers
- HPE Juniper Networking PTX Routers

Course contents

Day 1

Module 01: Service provider networks and the protocols that enable them

- Describe the services that run over service provider networks and how the IGP and BGP work together to make them possible
- Explain why service providers need both an IGP and BGP, and what each protocol is responsible for

Module 02: IS-IS Hello PDUs

- Describe the IS-IS configuration used in your network topology
- Describe the purpose of Hello PDUs and the type of information they contain
- Demonstrate how to read the contents of Hello PDUs in Wireshark
- Demonstrate how to view Hello PDUs on the Junos OS CLI

Module 03: Link-state PDUs and sequence number PDUs

- Describe the structure of a link-state PDU and some of the more common TLVs
- Demonstrate how to view link-state PDU information on the Junos OS CLI
- Describe the structure of CSNPs and PSNPs and how to view them on the Junos OS CLI

Lab 01: IIHs, LSPs, and SNPs

Module 04: Multilevel and multi-area IS-IS operation, Part 1

- Describe the difference between IS-IS levels and IS-IS areas
- Explain how LSP flooding works in multilevel IS-IS and how it enables reachability between levels

Module 05: Multilevel and multi-area IS-IS configuration

- Explain how to configure IS-IS areas and levels and what impact this configuration has
- Describe how to disable IS-IS levels per interface
- Explain how to verify a multilevel multi-area IS-IS network

Lab 02: Configuring a Level 1 domain in a different area

Day 2

Module 06: Multilevel and multi-area IS-IS operation, Part 2

- Explain the ATT bit behavior in a multi-area and single-area IS-IS network
- Describe some of the advantages and trade-offs of multilevel, multi-area networks

Lab 03: Verifying and troubleshooting an IS-IS network with three Level 1 domains and two areas

Module 07: IS-IS import and export policies

- Describe how export policies work in IS-IS and what their use cases are
- Describe how to use export policies to leak routes from L2 to L1
- Describe how import policies work in IS-IS and what their use cases are

Lab 04: IS-IS import and export policies

Module 08: Exporting routes into IS-IS and route summarization

- Describe how IPv4 and IPv6 external prefixes are treated in IS-IS
- Explain how to export and tag IPv4 and IPv6 external prefixes in IS-IS
- Explain how route summarization works and how to implement it in Junos OS

Lab 05: Exporting routes into IS-IS and route summarization

Module 09: Maintaining and securing IS-IS networks

- Describe how to use IS-IS metrics and the overload bit to steer traffic during maintenance

- Explain IS-IS authentication methods and configure MD5 authentication
- Configure hitless key rollover authentication and demonstrate how to troubleshoot IS-IS authentication

Day 3

Module 10: OSPF packets

- Describe the single-area OSPF configuration used in the network topology in this module
- Analyze the fields carried in OSPF Hello packets and verify them on the CLI
- Interpret DBD packets during adjacency formation and database exchange
- Analyze LSU packets and identify the LSAs they carry

Lab 06: OSPF packets

Module 11: OSPF standard areas—Operation and configuration

- Explain single-area OSPF limitations and how multi-area OSPF can mitigate them
- Demonstrate how to configure a standard OSPF area and describe the LSA types and routing behavior in a standard OSPF area
- Explain how LSAs are transported in an OSPF network with multiple standard areas

Lab 07: OSPF standard areas—Operation and configuration

Module 12: OSPF import and export policies

- Explain how external routes are exported into OSPF from other protocols
- Configure an export policy in OSPF and verify how Type 5 LSAs are advertised across the OSPF domain
- Describe how import policies work in OSPF and what their use cases are

Lab 08: OSPF import and export policies

Module 13: Different types of OSPF areas—Operation and configuration

- Describe how LSA flooding works in different OSPF area types
- Explain how stub areas and totally stubby areas work and how to configure and verify them in Junos OS
- Explain how NSSAs and totally NSSAs work and how to configure and verify them in Junos OS
- Describe how route summarization works and how to configure it in Junos OS

Lab 09: Different types of OSPF areas—Operation and configuration

Day 4

Module 14: OSPFv3—Operation and configuration

- Compare OSPFv2 and OSPFv3 operation in a multi-area service provider topology
- Trace internal and external OSPFv3 prefixes across the OSPFv3 multi-area domain
- Configure and verify OSPFv3 IPv4 realms

Lab 10: OSPFv3—Operation and configuration

Module 15: BGP-4 and Multiprotocol BGP—An overview

- Describe the core service provider BGP topology and peering design used across the BGP modules
- Describe the pieces of information sent by BGP-4 and Multiprotocol BGP in UPDATE and OPEN messages

Module 16: BGP route processing and next-hop behavior

- Describe the BGP RIBs and BGP next-hop resolution
- Diagnose hidden routes caused by next-hop resolution failures
- Explain the problems that arise from advertising IPv6 routes over IPv4 IBGP sessions and IPv4 routes over IPv6 IBGP sessions and list some common solutions

Lab 11: BGP route processing and next-hop behavior

Module 17: BGP path selection and local preference

- Describe the path that BGP traffic takes to a destination using the default attributes in a network configured with route reflection
- Configure local preference to control exit point selection out of an AS

Lab 12: BGP path selection and local preference

Module 18: Route filtering and traffic steering with BGP communities

- Describe BGP communities and the different community operations you can perform using routing policies
- Configure communities to classify traffic and ensure your AS is not providing unintended transit
- Demonstrate how to use local preference and your ISP communities to manipulate inbound traffic over multiple links from a single AS
- Describe commonly used well-known communities and their use cases, such as no-export and graceful-shutdown

Lab 13: Route filtering and traffic steering with BGP communities

Day 5

Module 19: Inbound traffic steering with AS path and MED

- Demonstrate how to use AS path prepending to steer inbound traffic across multiple ASs
- Describe some of the available AS path operations used by service providers
- Explain how to use MED to steer inbound traffic from a single AS across multiple links

Lab 14: Inbound traffic steering with AS Path and MED

Module 20: Advanced route reflection and BGP path optimization options

- Describe how the cluster list and the originator ID are used for loop prevention
- Configure and verify a redundant route reflector design
- Configure and verify Add-Path
- Configure and verify ORR
- Describe hierarchical route reflection and OOB route reflectors

Lab 15: Advanced route reflection and BGP path optimization options

Module 21: BGP session protection and load balancing

- Configure and verify BGP authentication using TCP-AO
- Explain how to protect a BGP session with GTSM and BGP prefix limits
- Configure per-flow load balancing for equal-cost load balancing across multiple paths
- Configure BGP multipath for load balancing across multiple BGP exits

Module 22: Securing BGP and protecting the internet

- Describe RPKI origin validation and the validation states it uses
- Explain RTBH as a community-based DDoS mitigation technique and describe BGP FlowSpec for fine-grained traffic filtering through BGP

Module 23: Where do you go from here?

- Describe some crucial topics for future self-study, such as L3VPN, EVPN, BGP-LS, and TE extensions for IS-IS and OSPF
- Explain the free study materials offered by HPE Networking, including the certification program

Self-Study Modules

Module 24: IS-IS multilevel and multi-area designs and features

- Explain some of the multilevel and multi-area IS-IS network designs that are possible
- Explain the purpose of configuring multiple areas on a router and describe how to merge two L1 domains with no downtime
- Describe the concept of unnumbered IS-IS networks, IPv6 link-local only IS-IS networks, and how to fix split L2 domains

Module 25: Multitopology IS-IS

- Describe the limitations of a single-topology dual-stack network and how multitopology IS-IS can resolve these limitations
- Explain how multitopology IS-IS works and describe some of the use cases for multiple topologies
- Configure and verify multitopology IS-IS in a Junos OS network
- Describe how to migrate from an IPv4-only IS-IS network to a dual-stack multitopology IS-IS network

Module 26: Maintaining and securing OSPF networks

- Describe how to use OSPF metrics and overload to steer traffic during maintenance
- Configure and verify different types of authentication for OSPF

Module 27: Link-state protocols—Advanced concepts

- Explain when LSAs and LSPs are generated, flooded, refreshed, aged, purged, and fragmented
- Explain how the SPF algorithm chooses the shortest path for each prefix
- Describe some of the SPF timers that can be changed for link-state protocols
- Configure and verify IS-IS timers
- Configure and verify OSPF timers

Module 28: Multi-area OSPF designs—Virtual links and multi-area adjacency

- Configure and verify virtual links in a multi-area OSPF network with a split backbone
- Explain how to configure a single interface to be a part of multiple OSPF areas

Module 29: Logical systems

- Describe the logical system lab topology and how logical systems work

Resources

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