

## COURSE OVERVIEW

This three-day course is designed to provide students with the knowledge to configure and troubleshoot MPLS-based Layer 2 virtual private networks (VPN). The course includes an overview of MPLS Layer 2 VPN concepts, such as BGP Layer 2 VPNs, LDP Layer 2 circuits, forwarding equivalence class (FEC) 129, virtual private LAN service (VPLS), Ethernet VPN (EVPN), and Inter-AS MPLS VPNs. This course also covers Junos OS-specific implementations of Layer 2 VPN instances, VPLS, and EVPNs. This course is based on the Junos OS Release 21.4R1.12.

### COURSE LEVEL

Advanced

### AUDIENCE

Benefits individuals responsible for configuring and monitoring devices running the Junos OS in a service provider environment, in MPLS-based data centers, and in larger enterprises

### PREREQUISITES

- Intermediate-level networking knowledge;
- An understanding of OSPF, IS-IS, BGP, and Junos routing policy;
- Experience configuring MPLS label-switched paths using Junos;
- Completion of the following courses, or equivalent knowledge
  - [Introduction to the Junos Operating System](#)
  - [Junos Service Provider Switching](#)
  - [Junos Intermediate Routing](#)
  - [Junos MPLS Fundamentals](#)

### RELATED JUNIPER PRODUCTS

- EX Series switches
- MX Series routers
- QFX Series switches

### RELATED CERTIFICATION

[JNCIP-SP](#)

### RECOMMENDED NEXT COURSE

[JNCIE-SP Self-Study Bundle](#)

### CONTACT YOUR REGIONAL EDUCATION SERVICES TEAM:

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### OBJECTIVES

- Describe some of the different kinds of VPNs, their mechanics, and their use cases.
- Describe the types of MPLS VPN that operate at layer 2.
- Describe the mechanics of BGP-signaled pseudowires, also known as L2VPNs.
- Configure BGP-signaled L2VPNs with Ethernet and Ethernet-VLAN encapsulations.
- Demonstrate how to troubleshoot some of the most common BGP-signaled L2VPN configuration problems.
- Describe how BGP-signaled L2VPNs use a block of labels to bring efficiency to hub-and-spoke advertisements.
- Configure advanced BGP-signaled L2VPN features, such as multihoming, VLAN normalization, and route target constraint.
- Describe the mechanics of LDP-signaled pseudowires, also known as Layer 2 Circuits.
- Describe the causes and solutions of some of the most common L2Circuit configuration problems.
- Configure advanced LDP-signaled L2Circuit features, such as multihoming and local switching.
- Explain how the FEC 129 pseudowire method combines BGP for autodiscovery and LDP for signaling.
- Describe the purpose and mechanics of a VPLS.
- Create a VPLS instance that is signaled using BGP and demonstrate the commands that verify its status.
- Create VPLS instances that are signaled using LDP and FEC 129 and demonstrate the commands available to verify their status.
- Describe how mismatched VLAN tags are handled in a default VPLS configuration.
- Configure a VPLS to swap mismatched VLAN tags automatically, and to create multiple bridge domains inside a single VPLS instance.
- Configure the most important VPLS traffic management features, including flood protection, MAC limiting, IRB interfaces, and automated Site IDs.
- Configure hub-and-spoke VPLS topologies.
- Configure multihomed sites in a VPLS.
- Describe the features of Ethernet VPN, and the enhancements that EVPN brings over VPLS.
- Explain how EVPNs advertise MAC addresses, and how they request to receive flooded traffic within a bridge domain.
- Configure and verify a single-homed VLAN-based EVPN instance.
- Configure and verify a single-homed VLAN-aware bundle EVI.
- Configure a multihomed EVPN and explain the purpose of the EVPN Type 4 route.
- Describe the features provided by EVPN Type 1 routes.
- Describe how to use MAC Mobility and IRB interfaces in an EVPN.
- Explain how EVPNs can tightly integrate themselves into MPLS Layer 3 VPNs to provide highly efficient forwarding.

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## OBJECTIVES (continued)

- Describe and configure various solutions that create MPLS VPNs between service providers.
- Describe the circuit-cross connect pseudowire method and explain how this old method can still have value in modern networks.
- Describe how multisegment pseudowires can create layer 2 VPNs across autonomous system boundaries.

## COURSE CONTENTS

### DAY 1

1	<b>Course Introduction</b>
2	<b>Refresher—VPNs and MPLS</b> <ul style="list-style-type: none"> <li>• Explain the basic function and purpose of a VPN</li> <li>• Describe how MPLS uses labels to forward traffic</li> <li>• Explain the differences between MPLS layer 3 VPNs and MPLS layer 2 VPNs</li> </ul>
3	<b>The Different Flavors of Layer 2 VPN</b> <ul style="list-style-type: none"> <li>• Describe the purpose and creation of pseudowires</li> <li>• Define the different technical terms relating to pseudowires</li> <li>• Describe the purpose and creation of VPLS</li> <li>• Describe the purpose, creation, and advantages of EVPN</li> </ul>
4	<b>L2VPN, aka BGP-Signaled Pseudowires</b> <ul style="list-style-type: none"> <li>• Define the concept of an attachment circuit, and of pseudowire encapsulation</li> <li>• Explain the importance of route targets, route distinguishers, and Site IDs</li> <li>• Explain the control plane and data plane of an L2VPN</li> <li>• Describe the contents of an L2VPN BGP packet capture</li> </ul>
5	<b>L2VPN—Configuration</b> <ul style="list-style-type: none"> <li>• Configure an L2VPN that accepts all Ethernet traffic</li> <li>• Configure an L2VPN that accepts specific VLAN tags</li> </ul>
6	<b>L2VPN—Troubleshooting</b> <ul style="list-style-type: none"> <li>• Diagnose and fix L2VPN problems caused by missing LSPs, mismatched site information, and incorrect configuration</li> </ul>

## COURSE CONTENTS

### DAY 1 (continued)

7	<b>L2VPN—Site IDs, the Label Base, and Overprovisioning</b> <ul style="list-style-type: none"> <li>• Explain the purpose of the Site ID and the VPN label base</li> <li>• Configure an overprovisioned L2VPN with explicit remote Site IDs</li> <li>• Configure an overprovisioned L2VPN with implicit remote Site IDs</li> </ul> <b>Lab 1: BGP-Signaled Layer 2 VPNs</b>
8	<b>L2VPN—Advanced Concepts</b> <ul style="list-style-type: none"> <li>• Configure and verify L2VPN multihoming</li> <li>• Explain the purpose of Martini encapsulation</li> <li>• Configure VLAN normalization in an L2VPN</li> <li>• Configure out-of-band route reflection and route target constraint</li> </ul> <b>Lab 2: L2VPNs—Advanced Concepts</b>
9	<b>L2Circuit—LDP-Signaled Pseudowires</b> <ul style="list-style-type: none"> <li>• Explain the concept of targeted LDP sessions, and the elements that L2Circuits have in common with L2VPNs</li> <li>• Configure and verify an L2Circuit</li> <li>• Describe the contents of an LDP advertisement packet capture</li> </ul>
10	<b>L2Circuit—Troubleshooting</b> <ul style="list-style-type: none"> <li>• Configure the Pseudowire Status TLV</li> <li>• Explain the meaning of the most frequent L2Circuit error codes</li> </ul>
<b>DAY 2</b>	
11	<b>L2Circuit—Advanced Concepts</b> <ul style="list-style-type: none"> <li>• Describe the purpose and benefits of virtual circuit connectivity verification</li> <li>• Configure multihoming, local switching, and interworking</li> </ul> <b>Lab 3: LDP-Signaled L2Circuits</b>
12	<b>FEC 129 Pseudowires</b> <ul style="list-style-type: none"> <li>• Explain the way that FEC 129 autodiscovers remote PEs and signals pseudowires</li> <li>• Configure and verify a FEC 129 pseudowire</li> </ul> <b>Lab 4: FEC 129 Pseudowires (Optional)</b>

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## COURSE CONTENTS (continued)

### DAY 2 (continued)

13	<b>Virtual Private LAN Service—Introduction</b> <ul style="list-style-type: none"> <li>Describe how a VPLS is built, and how it compares to a regular pseudowire</li> <li>Explain how VPLS forwards traffic between multiple sites</li> <li>Describe the BGP and LDP methods of signaling a VPLS</li> </ul>
14	<b>VPLS—BGP Configuration and Verification</b> <ul style="list-style-type: none"> <li>Configure a BGP-signaled VPLS</li> <li>Verify a BGP-signaled VPLS</li> </ul>
15	<b>VPLS—LDP and FEC 129 Configuration and Verification</b> <ul style="list-style-type: none"> <li>Configure and verify an LDP-signaled VPLS</li> <li>Configure and verify a FEC 129 VPLS</li> </ul>
16	<b>VPLS—The Default VLAN Mode</b> <ul style="list-style-type: none"> <li>Define the four VLAN modes for VPLS</li> <li>Define the concept of a bridge domain, and verify the default VPLS VLAN mode</li> </ul>
17	<b>VPLS—VLAN Normalization, VLAN-Aware Instances, and Dual-Stacked VLANs</b> <ul style="list-style-type: none"> <li>Configure and verify VLAN-Aware mode</li> <li>Configure and verify VLAN-Normalizing mode and No-VLAN mode</li> <li>Configure and verify dual-stacked VLAN tags in VPLS</li> </ul>
18	<b>VPLS—Advanced Features and Troubleshooting</b> <ul style="list-style-type: none"> <li>Deploy automated BGP VPLS Site IDs</li> <li>Configure flood protection, MAC flap protection, and MAC limiting</li> <li>Explain how to add IRB interfaces to a VPLS, and configure efficient traffic flooding using multicast LSPs</li> <li>Describe the most important VPLS-specific troubleshooting techniques</li> </ul>
19	<b>VPLS—Multihoming</b> <ul style="list-style-type: none"> <li>Configure multihomed sites in a BGP-signaled VPLS</li> <li>Configure multihomed sites and single sites on the same PE in a BGP-signaled VPLS</li> <li>Configure best-site multihoming in a BGP-signaled VPLS</li> <li>Configure multihomed sites in an LDP-signaled VPLS</li> </ul> <p><b>Lab 5: VPLS</b></p>

### DAY 3

20	<b>EVPN—Introduction</b> <ul style="list-style-type: none"> <li>Explain the main disadvantages of a VPLS solution</li> <li>Explain how EVPN overcomes these disadvantages, and enables extra features</li> </ul>
21	<b>EVPN—Using BGP to Advertise MACs and to Flood Traffic</b> <ul style="list-style-type: none"> <li>Explain the meaning of an EVPN Instance</li> <li>Describe how EVPN Type 2 routes advertise MAC addresses and MAC/IP bindings</li> <li>Describe how EVPN Type 3 routes request to receive flooded traffic within a bridge domain</li> </ul>
22	<b>EVPN—Configuring a Single-Homed VLAN-Based EVI</b> <ul style="list-style-type: none"> <li>Configure a service provider network to host EVPN services</li> <li>Configure a single-homed VLAN-based EVI</li> <li>Verify a VLAN-based EVI</li> </ul>
23	<b>EVPN—Configuring a Single-Homed VLAN-Aware Bundle EVI</b> <ul style="list-style-type: none"> <li>Configure a VLAN-aware bundle EVI</li> <li>Verify a VLAN-aware bundle EVI</li> </ul>
24	<b>EVPN—Multihoming Configuration and Type 4 Routes</b> <ul style="list-style-type: none"> <li>Configure a CE and two PEs to take part in a multihomed EVPN</li> <li>Describe the contents of the Type 4 Ethernet Segment route</li> <li>Explain how the Type 4 route prevents layer 2 loops, using the designated forwarder election</li> </ul>
25	<b>EVPN—Multihoming Features Using Type 1 Routes</b> <ul style="list-style-type: none"> <li>Describe Type 1 Ethernet Auto-Discovery Per-Ethernet Segment routes</li> <li>Explain how Type 1 Per-Ethernet Segment routes prevent layer 2 loops</li> <li>Describe how Type 1 Per-EVI routes are different from Per-ES routes</li> </ul>
26	<b>EVPN—MAC Mobility and IRB Interfaces</b> <ul style="list-style-type: none"> <li>Configure and verify the EVPN MAC Mobility feature</li> <li>Configure and verify Automatic Gateway MAC-IP Synchronization</li> <li>Configure and verify Manual Gateway MAC-IP Synchronization</li> <li>Configure and verify EVPN Virtual Gateway Addresses</li> </ul> <p><b>Lab 6: EVPN</b></p>

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## COURSE CONTENTS (continued)

### SELF-STUDY MATERIALS

<b>A</b>	<b>EVPN—Integration with L3VPNs</b> <ul style="list-style-type: none"><li>Describe the basic functionality of an L3VPN</li><li>Explain how EVPNs and L3VPNs integrate for optimal routing</li><li>Describe how chained composite next hop brings efficiency to EVPN in the Packet Forwarding Engine</li></ul>
<b>B</b>	<b>Inter-AS MPLS VPNs</b> <ul style="list-style-type: none"><li>Describe the functionality of Interprovider Options A, B, and C</li><li>Configure and verify the Interprovider Option C method</li><li>Describe and configure carrier-of-carriers VPNs</li></ul>
<b>C</b>	<b>Circuit Cross-Connect</b> <ul style="list-style-type: none"><li>Use circuit cross-connect to stitch pseudowires together, and to signal pseudowires that have their own pair of dedicated RSVP LSPs</li></ul>
<b>D</b>	<b>Multisegment Pseudowires</b> <ul style="list-style-type: none"><li>Explain how a multisegment pseudowire is signaled</li><li>Configure and verify a multisegment pseudowire</li></ul> <b>Lab 7: Inter-AS L2VPNs</b>
<b>E</b>	<b>VPLS—Hub-and-Spoke Topologies</b> <ul style="list-style-type: none"><li>Configure a hub-and-spoke BGP VPLS using route targets</li><li>Configure a hub-and-spoke BGP VPLS using site ranges</li><li>Configure a hub-and-spoke LDP VPLS using hierarchical VPLS</li></ul>

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