Cisco Training - HD Telepresence

MPLS: Implementing Cisco MPLS V3.0

From the technology basics to advanced VPN configuration.

$3,995.00

• 5 Days

Upcoming Dates

Sep 30 - Oct 04
Dec 09 - Dec 13

Course Description

Multiprotocol Label Switching integrates the performance and traffic-management capabilities of data link Layer 2 with the scalability and flexibility of network Layer 3 routing. So, when used in conjunction with other standard technologies, MPLS gives the ability to support value-added features and service offerings.

Implementing Cisco MPLS (MPLS) v4.0 is a 5-day instructor-led class providing students with in-depth knowledge of MPLS and MPLS VPNs design, implementation and configuration skills for new features and functions in an existing routed environment. This class uses IoS (15.2)

Course Outline

Module 1: MPLS Concepts
Lesson 1: Introducing Basic MPLS Concepts

• Foundations of Traditional IP Routing
• Basic MPLS Features
• Benefits of MPLS
• MPLS Terminology: Label Switch Router
• MPLS Terminology: Label-Switched Path
• MPLS Terminology: Upstream and Downstream
• MPLS Architecture Components
• Architecture of Ingress Edge LSRs
• Architecture of Intermediate LSRs
• Architecture of Egress Edge LSRs
• Summary

Lesson 2: Introducing MPLS Labels and Label Stack

• MPLS Labels
• FEC and MPLS Forwarding
• MPLS Label Format
• MPLS Label Imposition
Lesson 3: Identifying MPLS Applications

- MPLS Services
- MPLS Unicast IP Routing
- MPLS Multicast IP Routing
- MPLS VPNs
- MPLS Traffic Engineering
- MPLS Quality of Service
- Any Transport over MPLS
- Interactions Between MPLS Services
- Summary

Lesson 4: Module Summary

Lesson 5: Module Self-Check

Module 2: Label Assignment and Distribution
Lesson 1: Discovering LDP Neighbors

- Label-Distributing Protocols
- LDP Neighbor Session Establishment
- LDP Link Hello Message
- LDP Negotiating Label Space
- Discovering LDP Neighbors
- Negotiating LDP Sessions
- Summary

Lesson 2: Introducing Typical Label Distribution in Frame-Mode MPLS

- Propagating Labels Across a Network
- Building Blocks for IP Forwarding
- Using the FIB Table to Forward Packets
- Using LDP to Forward Packets
- Label-Switched Path
- Propagating Labels by Using PHP
- Impact of IP Aggregation on LSPs
- Label Allocation in a Frame-Mode MPLS Network
- Label Distribution and Advertisement
- Receiving Label Advertisement
- Liberal Label Retention
- Further Label Allocation
- Frame-Mode Loop Detection Using the MPLS TTL Field
- Normal TTL Operation
- Disabling TTL Propagation
- Summary

Lesson 3: Introducing Convergence in Frame-Mode MPLS

- MPLS Steady-State Operation
- Link Failure State
- Routing Protocol Convergence After a Link Failure
- MPLS Convergence After a Link Failure
- Link Recovery Actions
- Summary

Lesson 4: Module Summary
Lesson 5: Module Self-Check

Module 3: Frame-Mode MPLS Implementation on Cisco IOS Platforms
Lesson 1: Introducing CEF Switching

- Cisco IOS Platform-Switching Mechanisms
- Using Standard IP Switching
- Cisco Express Forwarding Switching Architecture
- Configuring IP Cisco Express Forwarding
- Monitoring IP Cisco Express Forwarding
- Summary

Lesson 2: Configuring Frame-Mode MPLS on Cisco IOS Platforms

- MPLS Configuration Tasks
- Configuring the MPLS ID on a Router
- Configuring MPLS on a Frame-Mode Interface
- Configuring IP TTL Propagation
- Configuring Conditional Label Distribution
- Summary

Lesson 3: Monitoring Frame-Mode MPLS on Cisco IOS Platforms

- Monitoring MPLS
- Monitoring LDP
- Monitoring Label Switching
- Debugging MPLS and LDP
- Summary

Lesson 4: Troubleshooting Frame-Mode MPLS on Cisco IOS Platforms

- Common Frame-Mode MPLS Issues
- Solving LDP Session Startup Issues
- Solving Label Allocation Issues
- Solving Label Distribution Issues
- Solving Packet-Labeling Issues
- Solving Intermittent MPLS Failures
- Solving Packet Propagation Issues
- Summary

Lesson 5: Module Summary

Lesson 6: Module Self-Check

Module 4: MPLS Virtual Private Network Technology
Lesson 1: Introducing Virtual Private Networks

- Basic VPN Overview
- VPN Implementation Models
- Overlay VPN Technologies
- Peer-to-Peer VPN Technologies
- Benefits of VPNs
- Drawbacks of VPNs
- Summary

Lesson 2: Introducing MPLS VPN Architecture

- MPLS VPN Architecture
- PE Router Architecture
- VRF Overview
Methods of Propagating Routing Information Across the P-Network
- Route Distinguishers
- RD Format
- RD Operation in MPLS VPN
- RD Process Flow
- Route Targets
- RT Operation
- RT and RD Process Flow
- Summary

Lesson 3: Introducing the MPLS VPN Routing Model
- MPLS VPN Routing
- CE Router MPLS VPN Routing
- P Router MPLS VPN Routing
- PE Router MPLS VPN Routing
- Support for Internet Routing
- Routing Tables on PE Routers
- Identifying End-to-End Routing Update Flow
- Summary

Lesson 4: Forwarding MPLS VPN Packets
- End-to-End VPN Forwarding Mechanisms
- VPN Penultimate Hop Popping
- Propagating VPN Labels Between PE Routers
- Effects of MPLS VPNs on Label Propagation
- Effects of MPLS VPNs on Packet Forwarding
- Summary

Lesson 5: Module Summary

Lesson 6: Module Self-Check

Module 5: MPLS VPN Implementation
Lesson 1: Using MPLS VPN Mechanisms of Cisco IOS Platforms
- VRF Table
- Need for Routing Protocol Contexts
- VPN-Aware Routing Protocols
- Using VRF Tables
- Propagating BGP Routes—Outbound Example
- Propagating Non-BGP Routes—Outbound Example
- Propagating BGP Routes—Inbound Example
- Propagating Non-BGP Routes—Inbound Example
- Summary

Lesson 2: Configuring an MP-BGP Session Between PE Routers
- Configuring BGP Address Families
- Enabling BGP Neighbors
- Configuring MP-BGP
- Configuring MP-IBGP
- Summary

Lesson 3: Configuring VRF Tables
- VRF Configuration Tasks
- Creating VRF Tables and Assigning RDs
- Specifying Export and Import RTs
Lesson 4: Configuring Small-Scale Routing Protocols Between PE and CE Routers

- Configuring PE-CE Routing Protocols
- Selecting the VRF Routing Context for BGP
- Configuring Per-VRF Static Routes
- Configuring RIP PE-CE Routing
- Configuring EIGRP PE-CE Routing
- Configuring SOO for EIGRP PE-CE Loop Prevention
- Summary

Lesson 5: Monitoring MPLS VPN Operations

- Monitoring VRFs
- Monitoring VRF Routing
- Monitoring MP-BGP Sessions
- Monitoring an MP-BGP VPNv4 Table
- Monitoring Per-VRF Cisco Express Forwarding and LFIB Structures
- Monitoring Labels Associated with VPNv4 Routes
- Identifying MPLS VPN Diagnostic Commands
- Summary

Lesson 6: Configuring OSPF as the Routing Protocol Between PE and CE Routers

- OSPF Hierarchical Model
- OSPF in an MPLS VPN Routing Model
- OSPF Superbackbone—OSPF-BGP Hierarchy Issue
- OSPF in MPLS VPNs—Goals
- OSPF Superbackbone—Route Propagation Example
- OSPF Superbackbone—Rules
- OSPF Superbackbone—Implementation
- OSPF Superbackbone—External Routes
- OSPF Superbackbone—Mixing Routing Protocols
- Configuring PE-CE OSPF Routing
- Routing Loops Between MP-BGP and OSPF
- OSPF Down Bit—Loop Prevention
  - Optimizing of Packet Forwarding Across the MPLS VPN Backbone
- Routing Loops Across OSPF Domains
- OSPF Tag Field—Operation
- OSPF Tag Field—Usage Guidelines
- OSPF Tag Field—Routing Loop Prevention
- Sham Link
- Summary

Lesson 7: Configuring BGP as the Routing Protocol Between PE and CE Routers

- Configuring a Per-VRF BGP Routing Context
- Reasons for Limiting the Number of Routes in a VRF
- Limiting the Number of Prefixes Received from a BGP Neighbor
- Limiting the Total Number of VRF Routes
- Identifying AS-Override Issues
- AS-Override Implementation
- AS-Path Prepending
- Discovery 9: Configure BGP as a PE-CE Routing Protocol
- Identifying the Allow-AS Issue
- Allow-AS-In Implementation
- Implementing SOO for Loop Prevention
Lesson 8: Troubleshooting MPLS VPNs

- Identifying Preliminary Steps in MPLS VPN Troubleshooting
- Verifying the Routing Information Flow
- Validating CE-to-PE Routing Information Flow
- Validating PE-to-PE Routing Information Flow
- Validating PE-to-CE Routing Information Flow
- Identifying the Issues When Verifying the Data Flow
- Validating Cisco Express Forwarding Status
- Validating the End-to-End LSP
- Validating the LFIB Status
- MPLS VPN Troubleshooting Command Summary

Lesson 9: Module Summary

Lesson 10: Module Self-Check

Module 6: Complex MPLS VPNs

Lesson 1: Introducing Overlapping VPNs

- Participants in Overlapping VPNs
- Typical Overlapping VPN Usages
- Overlapping VPN Routing
- Overlapping VPN Data Flow
- Configuring Overlapping VPNs

Lesson 2: Introducing Central Services VPNs

- Central Services VPN
- Central Services VPN Routing
- Central Services VPN Data Flow Model
- Discovery 10: Configure a Central Services VPN
- Central Services VPN and Overlapping VPN Requirements
- Configuring RDs and RTs in a Central Services VPN and Overlapping VPN Advanced VRF Features
- Configuring Selective VRF Import
- Configuring Selective VRF Export

Lesson 3: Introducing the Managed CE Routers Service

- Managed CE Routers
- VRF Creation and RD Overview
- Configuring Managed CE Routers

Lesson 4: Module Summary

Lesson 5: Module Self-Check

Module 7: Internet Access and MPLS VPNs

Lesson 1: Combining Internet Access and MPLS VPNs

- Customer Internet Connectivity Scenarios Overview
- Classical Internet Access
- Multisite Internet Access
- Wholesale Internet Access
Lesson 2: Implementing Internet Access in the MPLS VPN Environment

- Classical Internet Access for a VPN Customer
- Implementing Classical Internet Access for a VPN Customer
- Using Separate Subinterfaces
- Implementing Internet Access from Every Customer Site
- Internet Access as a Separate VPN
- Redundant Internet Access
- Implementing Wholesale Internet Access
- Separate Internet Access Benefits and Limitations
- Running an Internet Backbone in a VPN: Benefits and Limitations
- Summary

Lesson 3: Module Summary

Lesson 4: Module Self-Check

Module 8: MPLS Traffic Engineering Overview
Lesson 1: Introducing MPLS Traffic Engineering Components

- Traffic Engineering Concepts
- Traffic Engineering Motivations
- Business Drivers for Traffic Engineering
- Congestion Avoidance and Traffic Engineering
- Traffic Engineering with a Layer 2 Overlay Model
- Traffic Engineering with a Layer 2 Overlay Model: Example
- Drawbacks of the Layer 2 Overlay Solution
- Layer 3 Routing Model Without Traffic Engineering
- Traffic Engineering with a Layer 3 Routing Model
- Traffic Engineering with the MPLS TE Model
- MPLS TE Traffic Tunnels
- Traffic Tunnels: Attributes
- Link Resource Attributes
- Constraint-Based Path Computation
- Example of Constraint-Based Path Computation (Bandwidth)
- MPLS TE Process
- Role of RSVP in Path Setup Procedures
- Path Setup and Admission Control with RSVP
- Forwarding Traffic to a Tunnel
- Autoroute
- Autoroute Example
- Summary

Lesson 2: MPLS Traffic Engineering Operations

- Attributes Used by Constraint-Based Path Computation
- MPLS TE Link-Resource Attributes
- MPLS TE Link Resource Attributes: Maximum Bandwidth and Maximum Reservable Bandwidth
- MPLS TE Link-Resource Attributes: Link-Resource Class
- MPLS TE Link-Resource Attributes: Constraint-Based Specific Link Metric (Administrative Weight)
- MPLS TE Tunnel Attributes
- MPLS TE Tunnel Attributes: Traffic Parameter and Path Selection and Management
Lesson 3: Configuring MPLS Traffic Engineering on Cisco IOS Platforms

- MPLS TE Configuration Flowchart
- Enabling Device-Level MPLS TE Support
- Enabling MPLS TE Support in IS-IS
- Enabling MPLS TE Support in OSPF
- Enabling Basic MPLS TE on an Interface
- Creating and Configuring a Traffic Tunnel
- Mapping Traffic into Tunnels with Autoroute
- Summary

Lesson 4: Monitoring Basic MPLS TE on Cisco IOS Platforms

- Monitoring MPLS TE Tunnels
- Show ip rsvp interface Command
- Show mpls traffic-eng tunnels brief Command
- Monitoring MPLS TE
- Show mpls traffic-eng autoroute Command
- Show ip cef Command
- Summary

Lesson 5: Module Summary

Lesson 6: Module Self-Check

LABS:
Discovery 1: Verifying CEF Switching
Discovery 2: Enabling MPLS
Discovery 3: Change IP TTL Propagation
Discovery 4: Configure MP-iBGP
Discovery 5: Configure the VRF Instances
Discovery 6: Configure RIP as a PE-CE Routing Protocol
Discovery 7: Configure EIGRP as a PE-CE Routing Protocol
Discovery 8: Configure OSPF as a PE-CE Routing Protocol
Discovery 9: Configure BGP as a PE-CE Routing Protocol
Discovery 10: Configure a Central Services VPN
Discovery 11: Configure MPLS Traffic Engineering

Challenge 1: Implement the Service Provider’s and Customer’s IP Addressing and IGP Routing
Challenge 2: Implement the Core MPLS Environment in the Service Provider Network
Challenge 3: Implement EIGRP Based VPNs
Challenge 4: Implement OSPF Based MPLS VPNs
Challenge 5: Implement BGP Based MPLS VPNs
Challenge 6: Implement MPLS Traffic Engineering

Audience

Primary target audience:

• This course is intended primarily for network administrators, network engineers, network managers and systems engineers who would like to implement MPLS and MPLS Traffic Engineering.

Secondary target audience:

• This course is intended for network designers and project managers. The course is also recommended to all individuals preparing for MPLS exam.

Prerequisites

To fully benefit from this course, students should have the following prerequisite skills and knowledge:

• Intermediate to advanced knowledge of Cisco IOS Software configuration
• Configuring and troubleshooting EIGRP, OSPF, IS-IS and BGP

Skills and knowledge equivalent to those learned in:

• Interconnecting Cisco Networking Devices v2.0, Part 1 (ICND1) v2.0 and Part 2 (ICND2) v2.0, or
• Interconnecting Cisco Networking Devices: Accelerated Version 2.0 (CCNAX) v2.0
• Implementing Cisco IP Routing (ROUTE) v2.0
• Configuring BGP on Cisco Routers (BGP) v4.0
• Building Cisco Service Provider Next-Generation Networks Part 1 (SPNGN1) v1.2
• Building Cisco Service Provider Next-Generation Networks Part 2 (SPNGN2) v1.2
• Deploying Cisco Service Provider Network Routing (SPROUTE) v1.2
• Deploying Cisco Service Provider Advanced Network Routing (SPADVROUTE) v1.2

What You Will Learn

After completion of this course, students will be able to...

• Describe the features of MPLS
• Describe how MPLS labels are assigned and distributed
• Configure and troubleshoot frame-mode MPLS on Cisco IOS platforms
• Describe the MPLS peer-to-peer architecture and explain the routing and packet-forwarding model in this architecture
• Configure, monitor, and troubleshoot VPN operations
• Describe how the MPLS VPN model can be used to implement managed services and Internet access
• Describe the various Internet access implementations that are available and the benefits and drawbacks of each model
• Describe the tasks and commands that are necessary to implement MPLS TE