



## 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

- MPLS Label Stack
- Summary

### **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

- Using MPLS VPN IDs
- Summary

#### **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

- Summary

### **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
- 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
- Summary

### **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
- Summary

### **Lesson 3: Introducing the Managed CE Routers Service**

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

### **Lesson 4: Module Summary**

Lesson 5: Module Self-Check

Module 7: Internet Access and MPLS VPNs

Lesson 1: Combining Internet Access with MPLS VPNs

- Customer Internet Connectivity Scenarios Overview
- Classical Internet Access
- Multisite Internet Access
- Wholesale Internet Access

- Internet Design Models for Service Providers
- Internet Access Through Global Routing
- Internet Access Through a Separate VPN Service
- Internet Access Through Route Leaking
- Summary

## **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

- MPLS TE Tunnel Attributes: Tunnel Resource Class Affinity
- MPLS TE Tunnel Attributes: Adaptability, Priority, Pre-emption
- MPLS TE Tunnel Attributes: Resilience
- Implementing TE Policies with Affinity Bits
- Using Affinity Bits in TE Policies
- Propagating MPLS TE Link Attributes with Link-State Routing Protocol
- Constraint-Based Path Computation
- Constraint-Based Path Computation: Path Selection
- Example of Constraint-Based Path Computation (Resource Affinity) Path Setup
- RSVP Usage in Path Setup
- Hop-by-Hop Path Setup with RSVP
- Tunnel and Link Admission Control
- Path Rerouting
- Path Reoptimization
- Path Rerouting: Link Failure
- Assigning Traffic to Traffic Tunnels
- Using Static Routing to Assign Traffic to Traffic Tunnel
- Autoroute
- Autoroute: Path Selection Rules
- Autoroute: Default Metric
- Autoroute: Relative and Absolute Metric
- Forwarding Adjacency
- Forwarding Adjacency Traffic Flows
- Summary

### **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

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## 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