642-902 Route: Implementing Cisco IP Routing

Course Introduction — 6m

Course Introduction

Module 01 - Planning Routing Services — 1h 39m

Lesson: Assessing Complex Enterprise Network Requirements

Cisco Enterprise Architectures
Cisco Hierarchical Network Model
Example: Hierarchical Campus Model
Example: Hierarchical Network Model WAN
Enterprise Composite Network Model Functional Areas
Enterprise Composite Network Model
Network Traffic Mix
Network Requirements
Example: Enterprise Network 1
Cisco SONA Framework
Cisco SONA Framework Layers
Intelligent Information Network
Example: Enterprise Network 2
Routing Protocols
Routing Protocol Comparison
Example: Enterprise Network 3
Summary

Lesson: Creating an Implementation Plan and Documenting the Implementation

Implementing Routing in the Network
Structured Approach
Models and Tools
Create the Implementation Plan 1
Identify the Required Network Information
Identify Other Requirements
Create the Implementation Plan 2
Implementation Plan Documentation
What to Document?
Example: Implementation Plan
Enterprise Network Topology Required
Identify Network Information and Requirements
Creation of the Implementation Plan
Demo - Network Planning
Summary
Module 01 Review

Module 02 - Implementing an EIGRP-Based Solution — 5h 32m

Lesson: Planning Routing Implementations with EIGRP

EIGRP Capabilities and Attributes
EIGRP Capabilities and Attributes (Cont.)
EIGRP Key Technologies
EIGRP Packets
Initial Route Discovery
EIGRP Neighbor Table
EIGRP Topology Table
EIGRP IP Routing Table
Example: EIGRP Tables
DUAL Terminology
DUAL Operation

Example: Advertised Distance (AD)
Example: Feasible Distance (FD)
Example: Successor and Feasible Successor
Example: Successor and Feasible Successor Solve Loop Issue
EIGRP Metric
EIGRP Metric Calculation
Example: EIGRP Metrics Calculation
Example: EIGRP Metrics Calculation (Cont.)
Planning for EIGRP
EIGRP Implementation Plan
Documenting EIGRP
Example: Planning for Basic EIGRP
Requirements for Basic EIGRP Configuration
Steps to Configure Basic EIGRP
Define EIGRP as a Routing Protocol
Define Networks Participating in EIGRP
Define Interface Bandwidth
Example: Basic EIGRP Configuration
Demo - EIGRP Overview
Summary

Lesson: Implementing and Verifying Basic EIGRP for the Enterprise LAN Architecture

EIGRP Deployment
Verifying EIGRP Neighbors
Verifying EIGRP Neighbors (Cont.)
Verifying EIGRP Routes
Verifying EIGRP Operation
Verifying EIGRP Operation (Cont.)
Using Passive Interfaces
Using Passive Interfaces (Cont.)
Verify Operation with Passive Interfaces
Using the ip default network Command with EIGRP
Using the ip default network Command with EIGRP (Cont.)
Verifying Default Network Information
Route Summarization
EIGRP Automatic Route Summarization
EIGRP Manual Route Summarization
Configuring Route Summarization
Verifying Route Summarization
Demo - Implementing EIGRP
Summary

Lesson: Configuring and Verifying EIGRP for the Enterprise WAN Architecture

Frame Relay Overview
EIGRP with Dynamic Mapping
EIGRP with Dynamic Mapping (Cont.)
EIGRP with Static Mapping
EIGRP with Static Mapping (Cont.)
Frame Relay Multipoint Subinterfaces
EIGRP over Multipoint Subinterfaces
EIGRP over Multipoint Subinterfaces (Cont.)
EIGRP Unicast Neighbor
EIGRP Unicast Neighbor (cont.)
Verifying EIGRP Unicast Neighbors
Frame Relay Point-to-Point Subinterfaces
EIGRP over Point-to-Point Subinterfaces
EIGRP over Point-to-Point Subinterfaces (Cont.)
EIGRP Load Balancing

EIGRP Load Balancing (Cont.)
EIGRP Unequal-Cost Load Balancing
EIGRP Unequal-Cost Load Balancing (Cont.)
Demo - Multipath
EIGRP Bandwidth Utilization over WAN
Bandwidth Utilization Issues
EIGRP Hub-and-Spoke WAN Utilization
EIGRP Multipoint WAN Utilization
EIGRP Hybrid Multipoint WAN Utilization (Cont.)
AToM Overview
Layer 2 and Layer 3 MPLS VPN Solutions
Layer 3 MPLS VPN Overview
Customer MPLS Perspective
Ethernet Port-to-Port Connectivity
Ethernet VLAN Connectivity
EIGRP over EoMPLS
EIGRP over Layer 3 MPLS VPN
Summary
Lesson: Implementing and Verifying EIGRP Authentication
Router Authentication
Router Authentication (Cont.)
Simple Password vs. MD5 Authentication
MD5 Authentication for EIGRP
Key Chain
Planning for EIGRP Authentication
Requirements for EIGRP Authentication
Steps to Configure EIGRP MD5 Authentication
Configure Authentication Mode
Configure the Key Chain
Configure the Lifetime of The Key or Keys
Enable Authentication of EIGRP Packets
Router R1 Configuration for MD5 Authentication
Verifying MD5 Authentication for EIGRP
Verifying MD5 Authentication for EIGRP (Cont.)
Misconfigured Key
Summary
Lesson: Advanced EIGRP Features in an Enterprise Network
Scalability in Large Networks
Factors that Influence EIGRP Scalability
EIGRP Design Challenges
EIGRP Query Process
EIGRP Query Process Stuck-in-Active
Active Process Enhancement
Updates and Queries Without an EIGRP Stub
Updates and Queries Using EIGRP Stub
EIGRP Stub
EIGRP Stub Configuration Planning
EIGRP Stub Options
Configuring eigrp stub connected
Configuring eigrp stub summary
Configuring eigrp stub static
Configuring eigrp stub receive-only
Configuring eigrp stub redistributed
Summary
Module 02 Review

Module 03 - Implementing a Scalable Multiarea Network OSPF-Based Solution

4h 52m

Lesson: Planning Routing Implementations with OSPF as the Scalable Routing Protocol

Link-State Protocols
Link-State Protocol Data Structures
OSPF Areas
Area Terminology and Router Types
OSPF Adjacencies
OSPF Calculation
OSPF Metric
Building the LSDB
Link-State Data Structures: LSA Operation
Defining the "More Recent" LSA
LSA Sequence Numbering
LSA Sequence Numbers and Maximum Age
Planning for OSPF
OSPF Implementation Plan
Documenting OSPF
Example: Planning for Basic OSPF
Summary

Lesson: How OSPF Packet Processes Work

OSPF Functions
OSPF Packet Header Format
OSPF Packet Types
Neighbor Relationship: The Hello Packet
OSPF Routing Update Packets
Establishing Bidirectional Communication
Discovering the Network Routes
Adding the Link-State Entries
OSPF Neighbor States
Flooding Changes in Topology
The debug ip ospf packet Command
Demo - OSPF Intro
Summary

Lesson: Improving Routing Performance in a Complex Enterprise Network

OSPF Network Types
Point-to-Point Links
Multiaccess Broadcast Network
OSPF Adjacency Over Metro Ethernet and EoMPLS
OSPF Adjacency Over MPLS VPN
Electing the DR and BDR
Setting the Priority for DR Election
Demo - DR BDR Election
NBMA Topology
DR Election in NBMA Topology
Frame Relay Topologies
OSPF over NBMA Topology Modes of Operation
Nonbroadcast Mode (NBMA Mode)
Steps to Configure NBMA Mode
Nonbroadcast Mode Operation
NBMA Configuration Example
The show ip ospf neighbor Command
Using Subinterfaces
Point-to-Point Subinterfaces
Point-to-Point Subinterface Example
Multipoint Subinterfaces

Multipoint Subinterface Example
Point-to-Point Mode
Point-to-Point Configuration Example
Point-to-Point Verification Example
Point-to-Multipoint Mode
Point-to-Multipoint Configuration Example
Point-to-Multipoint Verification Example
Point-to-Multipoint Nonbroadcast
OSPF over NBMA Topology Summary
Summary
Lesson: Configuring and Verifying OSPF Routing
Initializing Single-Area and Multiarea OSPF
Planning for OSPF
Steps to Configure Basic OSPF
Configuring OSPF for Multiple Areas
OSPF Router ID
Configuration of Loopback Interfaces
Setting OSPF Router ID
OSPF Router ID Verification
Steps to Verify Basic OSPF
Example: The show ip ospf Command
Example: The show ip ospf interface Command
Example: The show ip ospf neighbor Command
Example: The show ip route ospf Command
Example: The show ip protocols Command
LSA Types
LSA Type 1: Router LSA
LSA Type 2: Network LSA
LSA Type 3: Summary LSA
LSA Type 4: ASBR Summary LSA
LSA Type 5: External LSA
LSA Type 7: NSSA External LSA
Example of Different LSAs
OSPF LSDB: Intra-Area Routing
OSPF LSDB: Intra-Area Routing (Cont.)
OSPF LSDB: Interarea Routing
OSPF LSDB: Interarea Routing (Cont.)
OSPF LSDB: External Routes
OSPF LSDB: External Routes (Cont.)
OSPF LSDB: NSSA
OSPF LSDB: NSSA (Cont.)
OSPF LSDB: Virtual Link
OSPF LSDB: Virtual Link (Cont.)
The show ip route Command
Interpreting the Routing Table: Types of Routes
Calculating Costs for E1 and E2 Routes
OSPF LSDB: Overload Protection
OSPF Passive Interface
Design Limitations of OSPF
Virtual Links as a Solution
No Direct Physical Connection to Area 0
Discontiguous Area 0
OSPF Virtual Link Configuration
Virtual Link Verification
Virtual Link Verification in OSPF LSDB
OSPF Cost

Changing The Default OSPF Cost
Demo - OSPF LSA Types
Summary
Lesson: Configuring and Verifying OSPF Route Summarization
Summarization
Benefits of Route Summarization
Interarea Route Summarization
Using Route Summarization
Configure Interarea Route Summarization
Route Summarization Configuration Example at the ABR
External Route Summarization
Configure External Route Summarization
Route Summarization Configuration Example at ASBR
Default Routes in OSPF
Configure OSPF Default Route
Default Route Configuration Example
Summary
Lesson: Configuring and Verifying OSPF Special Area Types
OSPF Area Types and Structures
Types of Areas
OSPF Router and LSA Types
Stub and Totally Stub Area Rules
OSPF Stub Areas
Stub Area Configuration
OSPF Stub Area Configuration Example
OSPF Totally Stubby Areas
Totally Stubby Area Configuration
Totally Stubby Configuration Example
Routing Table in a Normal Area
Routing Table in a Stub Area
Routing Table in a Stub Area with Summarization
Routing Table in a Totally Stubby Area
OSPF Not-So-Stubby Areas (NSSAs)
OSPF Totally NSSA Areas
Totally NSSA Area Configuration
NSSA Configuration Example
Totally NSSA Configuration Example
Example of Different Areas
show Commands for Stub and NSSA
Demo - OSPF Stub Areas
Summary
Lesson: Configuring and Verifying OSPF Authentication
OSPF Authentication Types
Configure Simple Password Authentication for OSPF
Simple Password Authentication Configuration Example
Simple Password Authentication Configuration for Virtual Links
Verifying Simple Password Authentication
Configure OSPF MD5 Authentication
OSPF MD5 Authentication Configuration Example
Verifying MD5 Authentication
Authentication Verification
Successful Simple Password Authentication Verification
Troubleshooting Simple Password Authentication Problems
Successful MD5 Authentication Verification
Troubleshooting MD5 Authentication Problems
Summary

Module 03 Review

Module 04 - Implement an IPv4-Based Redistribution Solution 2h 26m

Lesson: Assessing Network Routing Performance and Security Issues

Common Factors Affecting Network Performance
Routing Updates
Filtering Routing Updates
Running Multiple Routing Protocols
Controlling Routing Updates
Using Route Filters
Controlling Routing Update Traffic Using Distribute Lists
Steps to Configure Distribute List Filters
Configuring a Distribute List Filter
Filtering Routing Updates with a Distribute List
Demo - Route Filtering
Controlling Redistribution with Distribute Lists
IP Prefix Filters
Controlling Redistribution with Prefix Lists
Prefix List Matching Rules
Prefix List Matching Without ge or le
Prefix List Matching With ge or le
Configuring Prefix Lists Examples
Configuring Prefix Lists Examples (Cont.)
Route Maps
Route Map Applications
Route Map Operation
Route Map Operation (Cont.)
Steps to Configure A Route Map
Configuring A Route Map
Attaching a Route Map to an Interface
Steps to Configure Redistribution with Route Maps
Route Map Redistribution Commands
Route Maps and Redistribution Commands Example
Filtering Routing Updates
Passive Interface
Using the passive-interface Command
Summary

Lesson: Operating a Network Using Multiple IP Routing Protocols

Complex Routing Scenarios
Using Multiple Routing Protocols
Using Multiple IP Routing Protocols
Redistribution
Redistribution Route Information
Using Seed Metrics
Default Seed Metrics
Redistribution with Seed Metric
One-Point Redistribution
Demo - One-Point Redistribution
One-Way and Two-Way Multipoint Redistribution
Redistribution Techniques
Redistribution Implementation Considerations
One-Way Redistribution Issue
One-Way Multipoint Redistribution Issue
Two-Way Multipoint Redistribution Issue
Summary

Lesson: Configuring and Verifying Route Redistribution

Redistribution Supports All Protocols
Steps to Configure Redistribution into RIP
Redistributing into RIP
Steps to Configure Redistribution into OSPF
Redistributing into OSPF
Steps to Configure Redistribution into EIGRP
Default Metric
Redistributing into EIGRP
Example: Redistributing into OSPF - Before Redistribution
Example: Configuring Redistribution at Router R2
Example: Routing Tables After Summarizing Routes and Redistributions
Administrative Distance
Administrative Distance Example
Steps to Configure Redistribution Using Administrative Distance
Modifying Administrative Distance
Modifying Administrative Distance (Cont.)
Example: Redistribution Using Administrative Distance
Example: Redistribution Using Administrative Distance (Cont.)
Redistribution to Prevent Routing Loops
Solution With Route Tagging
Redistribution With Tagging Verification
Redistribution With Tagging Verification (Cont.)
Summary
Module 04 Review

Module 05 - Implementing Path Control 58m

Lesson: Assessing Path Control Network Performance Issues

Assessing Path Control Network Performance
Path Selection Process Using Filters
Path Control Tools: Offset List
Path Control Tools: Offset List (Cont.)
Path Control Tools: Cisco IOS IP Service Level Agreement
Cisco IOS IP SLA Example
Cisco IOS IP SLA Example (Cont.)
Policy-Based Routing
Policy-Based Routing Benefits
Steps to Implement Path Control
Requirements for Policy Based Routing
Steps to Configure and Verify Policy-Based Routing
Matching the Traffic
Policy Routing set Commands
Policy Routing set Commands (Cont.)
Apply Route Maps for PBR
Demo - Policy Based Routing
Enable Fast-Switched PBR or PBR Switched by Cisco Express Forwarding
Verifying Policy-Based Routing
Verifying Policy-Based Routing (Cont.)
Example: PBR Equal Access
Example: PBR Equal Access (Cont.)
Verifying Policy-Based Routing: Examples
Verifying Policy-Based Routing: Examples (Cont.)
Summary
Module 05 Review

Module 06 - Connecting an Enterprise Network to an ISP Network 3h 57m

Lesson: Planning the Enterprise-to-ISP Connection

Session Origin Initiation
Enterprise Network-to-ISP Connectivity Requirements
Reachability
Using Circuit Emulation
Using Static Routes
Using MPLS VPN
Using BGP
Enterprise Network-to-ISP Connection Options
Single-homed ISP Connectivity
Dual-homed ISP Connectivity
Multihomed ISP Connectivity
Dual-multihomed ISP Connectivity
Summary

Lesson: Considering the Advantages of Using BGP

BGP Terminology
Multihoming Options
Default Routes from Providers
Default Routes from Providers (cont.)
Default Routes and Partial Table from Providers
Default Routes and Partial Table from Providers (cont.)
Full Internet Routing from Providers
Autonomous System
BGP Routing Between Autonomous Systems
Path Vector Functionality
BGP Routing Policies
Features of BGP
When to Use BGP
BGP Databases
BGP Message Types
Summary

Lesson: Comparing the Functions and Uses of EBGP and IBGP

BGP Neighbors
External BGP Neighbors
Requirements for EBGP
Internal BGP Neighbors
Summary

Lesson: Configuring and Verifying Basic BGP Operations

Planning for BGP
Requirements for Basic BGP Configuration
Steps to Configure Basic EBGP
Define BGP Process and Activate EBGP Session
Advertise Networks
BGP network Command Details
Basic EBGP Configuration
Basic IBGP and EBGP Configuration in the Customer A Network
Demo - Basic BGP Configuration
Shutting Down a BGP Neighbor
IBGP Peering Issue
BGP Issues with Source IP Address
IBGP Using Loopback Addresses
Demo - Internal BGP
IBGP Next-Hop Behavior
BGP neighbor next-hop-self Command
Demo - next-hop-self

BGP States
BGP Established and Idle States
Example: show ip bgp neighbors Command
BGP Active State Verification
Example: BGP Active State Verification
Example: BGP Peering
BGP Neighbor Authentication
Example: BGP Neighbor Authentication
Example: BGP Configuration
Example: show ip bgp Command
Example: show ip bgp rib-failure Command
Clearing the BGP Session
Hard Reset of BGP Sessions
Soft Reset Outbound
Inbound Soft Reset
Route Refresh: Dynamic Inbound Soft Reset
Monitoring Soft Reconfiguration
debug ip bgp updates Command
Summary
Lesson: BGP Attributes and Path Selection Process
BGP Path Selection
Routing Table Manager
Route Selection Decision Process
Weight Attribute
Set Weight with Route Map
Using Route Maps for Path Selection
Set Weight with Route Map Example
Local Preference Attribute
Set Local Preference with Route Map
Set Local Preference with Route Map (Cont.)
Set AS Path with Route Map
Set AS Path with Route Map (Cont.)
MED Attribute
Set MED with Route Map
Route Map for Router R1
Route Map for Router R2
Demo - Routing Policy
Steps to Configure BGP Route Filtering Using IP Prefix Lists
Configuring Filtering of BGP Routing Updates
Verify Filtering of BGP Routing Updates
Steps to Configure Route Filtering with a Route Map
Using Route Maps for Filtering Routing Updates
Using Route Maps as BGP Filters
Filtering Routing Updates
Summary
Module 06 Review
Bonus Content - IPv6
IPv6 Addressing
Why IPv6
Differences Between IPv4 and IPv6
Address Format
Address Types
Address Types Continued
Configuring Cisco Routers for IPv6 Addresses
IPv6 Routing Protocols
RIPng

RIPng Configuration
OSPFv3
OSPFv3 Configuration
OSPFv3 Configuration Continued
EIGRP Configuration
EIGRP Configuration Continued
MP-BGP
MP-BGP Continued
IPv6 Transition Techniques
Dual Stack Option
Cisco IOS Dual Stack
Dual-Stack Operation
Tunnel Options for Transition
Tunnel Options for Transition Continued
Example of IPv6-in-IPv4 Tunnel
NAT and PAT with IPv6
Course Closure

Total Duration: 20 hrs 12 min