

## CCIE Service Provider

### 1.0 Core Routing

25% 30%

#### 1.1. Interior Gateway Protocol

- 1.1.a. Describe, implement, and troubleshoot IS-IS
- 1.1.b. Describe, implement, and troubleshoot OSPFv2 and OSPFv3
- 1.1.c. Describe and optimize IGP scale and performance

#### 1.2. Border Gateway Protocol

- 1.2.a. Describe, implement, and troubleshoot IBGP, EBGP, and MP-BGP
- 1.2.b. Describe, implement, and troubleshoot BGP route policy enforcement
- 1.2.c. Describe BGP path attribute
- 1.2.d. Describe and optimize BGP scale and performance
- 1.2.e. Describe, implement, and troubleshoot advanced BGP features

#### 1.3. Multiprotocol Label Switching

- 1.3.a. Describe MPLS forwarding and control plane mechanisms
- 1.3.b. Describe, implement, and troubleshoot LDP
- 1.3.c. Describe and optimize LDP scale and performance

#### 1.4. MPLS Traffic Engineering

- 1.4.a. Describe, implement, and troubleshoot RSVP
- 1.4.b. Describe, implement, and troubleshoot ISIS and OSPF extensions
- 1.4.c. Describe, implement, and troubleshoot MPLS TE policy enforcement
- 1.4.d. Describe MPLS TE attributes
- 1.4.e. Describe and optimize MPLS TE scale and performance
- 1.4.f. Describe, implement, and troubleshoot MPLS advanced features, for example: Segment Routing and MPLS-TE Inter-AS

#### 1.5. Multicast

- 1.5.a. Describe, implement, and troubleshoot PIM (PIM-SM, PIM-SSM, and PIM-BIDIR)
- 1.5.b. Describe, implement, and troubleshoot RP (Auto-RP, BSR, Static, Anycast RP, and MSDP)
- 1.5.c. Describe, implement, and troubleshoot mVPN
- 1.5.d. Describe and optimize multicast scale and performance

#### 1.6. Quality of Service

- 1.6.a. Describe, implement, and troubleshoot classification and marking
- 1.6.b. Describe, implement, and troubleshoot congestion management and scheduling

- 1.6.c. Describe, implement, and troubleshoot congestion avoidance
- 1.6.d. Describe, implement, and troubleshoot MPLS QoS models (Pipe, Short Pipe, and Uniform)
- 1.6.e. Describe, implement, and troubleshoot MPLS TE QoS (MAM, RDM, CBTS, PBTS, and DS-TE)

## 2.0 Service Provider Architecture and Services

21% 22%

### 2.1. Service provider architecture concepts

- 2.1.a. Describe network architecture component and service provider network domains, for example: PE, P, CE, Metro Ethernet Core, Aggregation, RAN Backhaul, and eNodeB
- 2.1.b. Describe Cisco IOS, Cisco IOS-XE, and Cisco IOS-XR software architecture components, for example: XR Kernel, System Manager, and Interprocess communication

### 2.2. Virtualization concepts

- 2.2.a. Describe physical router virtualization, for example: SDR, Multiple-Logical-Routers, and Satellite Network Virtualization
- 2.2.b. Describe Network Function Virtualization architecture concepts, for example: Service Function Chaining, ESP, EPN, and NFVI

### 2.3. Carrier Ethernet

- 2.3.a. Describe, implement, and troubleshoot E-LINE, for example: VPWS
- 2.3.b. Describe, implement, and troubleshoot E-LAN and E-TREE, for example: VPLS and H-VPLS
- 2.3.c. Describe, implement, and troubleshoot EVPN
- 2.3.d. Describe IEEE 802.1ad (Q-in-Q), IEEE 802.1ah (Mac-in-Mac), and ITU G.8032 (REP)

### 2.4. L3VPN

- 2.4.a. Describe, implement, and troubleshoot L3VPN
- 2.4.b. Describe, implement, and troubleshoot Inter-AS L3VPN
- 2.4.c. Describe, implement, and troubleshoot multicast VPN
- 2.4.d. Describe, implement, and troubleshoot unified MPLS and CSC
- 2.4.e. Describe, implement, and troubleshoot shared services, for example: Extranet and Internet access

### 2.5. Overlay VPN

- 2.5.a. Describe, implement, and troubleshoot L2TPv3
- 2.5.b. Describe LISP

### 2.6. Internet service

- 2.6.a. Describe, implement, and troubleshoot IPv6 transition mechanism, for example: NAT44, NAT64, 6RD, MAP, and DS Lite
- 2.6.b. Describe, implement, and troubleshoot Internet peering route and transit policy enforcement

## 3.0 Access and Aggregation

18% 21%

### 3.1. Transport and encapsulation technologies

- 3.1.a. Describe transport technologies, for example: optical, xDSL, DOCSIS, TDM, and GPON
- 3.1.b. Describe Ethernet technologies

- 3.1.c. Describe, implement, and troubleshoot link aggregation techniques

### 3.2. PE-CE connectivity

- 3.2.a. Describe, implement, and troubleshoot PE-CE routing protocols, for example: static, OSPF, RIP, RIPng, EIGRP, ISIS, and BGP
- 3.2.b. Describe, implement, and troubleshoot route redistribution
- 3.2.c. Describe, implement, and troubleshoot route filtering
- 3.2.d. Describe, implement, and troubleshoot loop prevention techniques in multihomed environments
- 3.2.e. Describe, implement, and troubleshoot Multi-VRF CE

### 3.3. Quality of Service

- 3.3.a. Describe, implement, and troubleshoot classification and marking
- 3.3.b. Describe, implement, and troubleshoot congestion management and scheduling, for example: policing, shaping, and queuing
- 3.3.c. Describe, implement, and troubleshoot congestion avoidance

### 3.4. Multicast

- 3.4.a. Describe, implement, and troubleshoot IGMP and MLD
- 3.4.b. Describe, implement, and troubleshoot PIM
- 3.4.c. Describe, implement, and troubleshoot RP
- 3.4.d. Describe and optimize multicast scale and performance

## 4.0 High Availability and Fast Convergence

14% 15%

### 4.1. System level HA

- 4.1.a. Describe Multichassis/clustering HA
- 4.1.b. Describe, implement, and troubleshoot SS0/NSF, NSR, and GR
- 4.1.c. Describe, implement, and troubleshoot IGP-LDP Sync
- 4.1.d. Describe, implement, and troubleshoot LDP Session Protection

### 4.2. Layer 1/2/3 failure detection techniques

- 4.2.a. Describe Layer 1 failure detection
- 4.2.b. Describe, implement, and troubleshoot Layer 2 failure detection
- 4.2.c. Describe, implement, and troubleshoot Layer 3 failure detection

### 4.3. Routing/fast convergence

- 4.3.a. Describe, implement, and optimize IGP convergence
- 4.3.b. Describe, implement, and optimize BGP convergence
- 4.3.c. Describe, implement, and optimize IP FRR and MPLS TE FRR

## 5.0 Service Provider Security, Operation, and Management

12% 12%

### 5.1. Control plane security

- 5.1.a. Describe, implement, and troubleshoot control plane protection techniques, for example: LPTS and CoPP

- 5.1.b. Describe, implement, and troubleshoot routing protocol security, for example: BGP-TTL security and protocol authentication
  - 5.1.c. Describe, implement, and troubleshoot BGP prefix suppression
  - 5.1.d. Describe, implement, and troubleshoot LDP security, for example: authentication and label allocation filtering
  - 5.1.e. Describe, implement, and troubleshoot BGP prefix based filtering
  - 5.1.f. Describe, implement, and troubleshoot BGPsec
- 5.2. Management plane security
- 5.2.a. Describe, implement, and troubleshoot device management, for example: MPP, SSH, and VTY
  - 5.2.b. Describe, implement, and troubleshoot logging and SNMP security
  - 5.2.c. Describe backscatter Traceback
- 5.3. Infrastructure security
- 5.3.a. Describe, implement, and troubleshoot uRPF
  - 5.3.b. Describe Lawful-intercept
  - 5.3.c. Describe, implement, and troubleshoot iACL
  - 5.3.d. Describe, implement, and troubleshoot RTBH
  - 5.3.e. Describe, implement, and troubleshoot BGP Flowspec
  - 5.3.f. Describe DDoS mitigation techniques
- 5.4. Timing and synchronization
- 5.4.a. Describe timing protocol, for example: NTP, 1588v2, and SyncE
- 5.5. Network monitoring and troubleshooting
- 5.5.a. Describe, implement, and troubleshoot syslog and logging functions
  - 5.5.b. Describe, implement, and troubleshoot SNMP traps, RMON, EEM, and EPC
  - 5.5.c. Describe, implement, and troubleshoot NetFlow and IPFIX
  - 5.5.d. Describe, implement, and troubleshoot IP SLA
  - 5.5.e. Describe, implement, and troubleshoot MPLS OAM and Ethernet OAM
- 5.6. Network configuration and change management
- 5.6.a. Describe configuration change, implementation, and rollback

## 6.0 Evolving Technologies

10%

### 6.1 Cloud

- 6.1.a Compare and contrast Cloud deployment models
  - 6.1.a [i] Infrastructure, platform, and software services (XaaS)
  - 6.1.a [ii] Performance and reliability
  - 6.1.a [iii] Security and privacy
  - 6.1.a [iv] Scalability and interoperability
- 6.1.b Describe Cloud implementations and operations
  - 6.1.b [i] Automation and orchestration
  - 6.1.b [ii] Workload mobility

- 6.1.b [iii] Troubleshooting and management
- 6.1.b [iv] OpenStack components

## 6.2 Network Programmability (SDN)

- 6.2.a Describe functional elements of network programmability (SDN) and how they interact
  - 6.2.a [i] Controllers
  - 6.2.a [ii] APIs
  - 6.2.a [iii] Scripting
  - 6.2.a [iv] Agents
  - 6.2.a [v] Northbound vs. Southbound protocols
- 6.2.b Describe aspects of virtualization and automation in network environments
  - 6.2.b [i] DevOps methodologies, tools and workflows
  - 6.2.b [ii] Network/application function virtualization (NFV, AFV)
  - 6.2.b [iii] Service function chaining
  - 6.2.b [iv] Performance, availability, and scaling considerations

## 6.3 Internet of Things (IoT)

- 6.3.a Describe architectural framework and deployment considerations for Internet of Things
  - 6.3.a [i] Performance, reliability and scalability
  - 6.3.a [ii] Mobility
  - 6.3.a [iii] Security and privacy
  - 6.3.a [iv] Standards and compliance
  - 6.3.a [v] Migration
  - 6.3.a [vi] Environmental impacts on the network