CCIE 400-101 Routing and Switching Written Boot Camp - CCIE-W

Course Details

Course Outline

1. **Network Principles**
    a. **Network theory**
        - Describe basic software architecture differences between IOS and IOS XE
            - Control plane and Forwarding plane
            - Impact to troubleshooting and performances
            - Excluding specific platform's architecture
        - Identify Cisco express forwarding concepts
            - RIB, FIB, LFIB, Adjacency table
            - Load balancing Hash
            - Polarization concept and avoidance
        - Explain general network challenges
            - Unicast flooding
            - Out of order packets
            - Asymmetric routing
            - Impact of microburst
        - Explain IP operations
            - ICMP unreachable, redirect
            - IPv4 options, IPv6 extension headers
            - IPv4 and IPv6 fragmentation
            - TTL
            - IP MTU
        - Explain TCP operations
            - IPv4 and IPv6 PMTU
            - MSS
            - Latency
            - Windowing

- Bandwidth delay product
- Global synchronization
- Options

- Explain UDP operations
  - Starvation
  - Latency
  - RTP/RTCP concepts

b. Network implementation and operation

- Evaluate proposed changes to a network
  - Changes to routing protocol parameters
  - Migrate parts of a network to IPv6
  - Routing protocol migration
  - Adding multicast support
  - Migrate spanning tree protocol
  - Evaluate impact of new traffic on existing QoS design

c. Network troubleshooting

- Use IOS troubleshooting tools
- debug, conditional debug
  - ping, traceroute with extended options
  - Embedded packet capture
  - Performance monitor
- Apply troubleshooting methodologies
  - Diagnose the root cause of networking issue (analyze symptoms, identify and describe root cause)
  - Design and implement valid solutions according to constraints
  - Verify and monitor resolution
- Interpret packet capture
  - Using Wireshark trace analyzer
  - Using IOS embedded packet capture

2. Layer 2 Technologies

a. LAN switching technologies

- Implement and troubleshoot switch administration
  - Managing MAC address table
  - errdisable recovery
  - L2 MTU
- Implement and troubleshoot Layer 2 protocols
  - CDP, LLDP
  - UDLD
- Implement and troubleshoot VLAN
  - Access ports
  - VLAN database
  - Normal, extended VLAN, voice VLAN
- Implement and troubleshoot trunking
  - VTPv1, VTPv2, VTPv3, VTP pruning
  - dot1Q
  - Native VLAN
  - Manual pruning
- Implement and troubleshoot EtherChannel
  - LACP, PAgP, manual
  - Layer 2, Layer 3
  - Load-balancing
  - EtherChannel misconfiguration guard
- Implement and troubleshoot spanning-tree
  - PVST+/RPVST+/MST
  - Switch priority, port priority, path cost, STP timers
  - port fast, BPDUguard, BPDUfilter
  - loopguard, rootguard
- Implement and troubleshoot other LAN switching technologies
  - SPAN, RSPAN, ERSPAN
- Describe chassis virtualization and aggregation technologies
  - Multichassis
  - VSS concepts

- Alternative to STP
- Stackwise
- Excluding specific platform implementation

- Describe spanning-tree concepts
  - Compatibility between MST and RSTP
  - STP dispute, STP bridge assurance

b. Layer 2 multicast

- Implement and troubleshoot IGMP
  - IGMPv1, IGMPv2, IGMPv3
- IGMP snooping
  - IGMP querier
  - IGMP filter
  - IGMP proxy
- Explain MLD
- Explain PIM snooping

c. Layer 2 WAN circuit technologies

- Implement and troubleshoot HDLC
- Implement and troubleshoot PPP
  - Authentication (PAP, CHAP)
- PPPoE
- MLPPP
- Describe WAN rate-based Ethernet circuits
  - Metro and WAN Ethernet topologies
  - Use of rate-limited WAN Ethernet services

3. Layer 3 Technologies

a. Addressing technologies

- Identify, implement and troubleshoot IPv4 addressing and subnetting
- Address types, VLSM
  - ARP
- Identify, implement and troubleshoot IPv6 addressing and subnetting
- Unicast, multicast

- EUI-64
- ND, RS/RA
- Autoconfig/SLAAC, temporary addresses (RFC 4941)
    - Global prefix configuration feature
    - DHCP protocol operations
    - SLAAC/DHCPv6 interaction
    - Stateful, stateless DHCPv6
    - DHCPv6 prefix delegation

b. Layer 3 multicast

- Troubleshoot reverse path forwarding
    - RPF failure
    - RPF failure with tunnel interface
- Implement and troubleshoot IPv4 protocol independent multicast
    - PIM dense mode, sparse mode, sparse-dense mode
    - Static RP, auto-RP, BSR
    - Bi-directional PIM
    - Source-specific multicast
    - Group to RP mapping
    - Multicast boundary
- Implement and troubleshoot multicast source discovery protocol
    - Intra-domain MSDP (anycast RP)
    - SA filter
- Describe IPv6 multicast
    - IPv6 multicast addresses
    - PIMv6

c. Fundamental routing concepts

- Implement and troubleshoot static routing
- Implement and troubleshoot default routing
- Compare routing protocol types
    - Distance vector
    - Link state

- Path vector
- Implement, optimize and troubleshoot administrative distance
- Implement and troubleshoot passive interface
- Implement and troubleshoot VRF lite
- Implement, optimize and troubleshoot filtering with any routing protocol
- Implement, optimize and troubleshoot redistribution between any routing protocol
- Implement, optimize and troubleshoot manual and auto summarization with any routing protocol
- Implement, optimize and troubleshoot policy-based routing
- Identify and troubleshoot sub-optimal routing
- Implement and troubleshoot bidirectional forwarding detection
- Implement and troubleshoot loop prevention mechanisms
  - Route tagging, filtering
  - Split horizon
  - Route poisoning
- Implement and troubleshoot routing protocol authentication
  - MD5
  - Key-chain
  - EIGRP HMAC SHA2-256bit
  - OSPFv2 SHA1-196bit
  - OSPFv3 IPsec authentication

d. RIP (v2 and v6)

- Implement and troubleshoot RIPv2
- Describe RIPv6 (RIPng)

e. EIGRP (for IPv4 and IPv6)

- Describe packet types
  - Packet types (hello, query, update, and such)
  - Route types (internal, external)
- Implement and troubleshoot neighbor relationship
  - Multicast, unicast EIGRP peering
  - OTP point-to-point peering

- OTP route-reflector peering
- OTP multiple service providers scenario

- Implement and troubleshoot loop free path selection
  - RD, FD, FC, successor, feasible successor
  - Classic metric
  - Wide metric
- Implement and troubleshoot operations
  - General operations
  - Topology table, update, query, active, passive
  - Stuck in active
  - Graceful shutdown
- Implement and troubleshoot EIGRP stub
  - Stub
  - Leak-map
- Implement and troubleshoot load-balancing
  - equal-cost
  - unequal-cost
  - add-path
- Implement EIGRP (multi-address) named mode
  - Types of families
  - IPv4 address-family
  - IPv6 address-family
- Implement, troubleshoot and optimize EIGRP convergence and scalability
  - Describe fast convergence requirements
  - Control query boundaries
  - IP FRR/fast reroute (single hop)
  - Summary leak-map
  - Summary metric
  - OSPF (v2 and v3)
- Describe packet types
  - LSA types (1, 2, 3, 4, 5, 7, 9)

- Route types (N1, N2, E1, E2)
- Implement and troubleshoot neighbor relationship
- Implement and troubleshoot OSPFv3 address-family support
  - IPv4 address-family
  - IPv6 address-family
- Implement and troubleshoot network types, area types and router types
  - Point-to-point, multipoint, broadcast, non-broadcast
  - LSA types, area type: backbone, normal, transit, stub, NSSA, totally stub
  - Internal router, ABR, ASBR
  - Virtual link
- Implement and troubleshoot path preference
- Implement and troubleshoot operations
  - General operations
  - Graceful shutdown
  - GTSM (Generic TTL Security Mechanism)
- Implement, troubleshoot and optimize OSPF convergence and scalability
  - Metrics
  - LSA throttling, SPF tuning, fast hello
  - LSA propagation control (area types, ISPF)
  - IP FRR/fast reroute (single hop)
  - LFA/loop-free alternative (multi hop)
  - OSPFv3 prefix suppression
  - BGP
- Describe, implement and troubleshoot peer relationships
  - Peer-group, template
  - Active, passive
  - States, timers
  - Dynamic neighbors
- Implement and troubleshoot IBGP and EBGP
  - EBGP, IBGP
  - 4 bytes AS number

- Private AS
- Explain attributes and best-path selection
- Implement, optimize and troubleshoot routing policies
  - Attribute manipulation
  - Conditional advertisement
  - Outbound route filtering
  - Communities, extended communities
  - Multi-homing
- Implement and troubleshoot scalability
  - Route-reflector, cluster
  - Confederations
  - Aggregation, AS set
- Implement and troubleshoot multiprotocol BGP
  - IPv4, IPv6, VPN address-family
- Implement and troubleshoot AS path manipulations
  - Local AS, allow AS in, remove private AS
  - Prepend
  - Regexp
- Implement and troubleshoot other features
  - Multipath
  - BGP synchronization
  - Soft reconfiguration, route refresh
- Describe BGP fast convergence features
  - Prefix independent convergence
  - Add-path
  - Next-hop address tracking
  - ISIS (for IPv4 and IPv6)
- Describe basic ISIS network
  - Single area, single topology
- Describe neighbor relationship
- Describe network types, levels and router types

- NSAP addressing
- Point-to-point, broadcast

- Describe operations
- Describe optimization features
  - Metrics, wide metric

4. VPN Technologies

a. Tunneling

- Implement and troubleshoot MPLS operations
  - Label stack, LSR, LSP
  - LDP
  - MPLS ping, MPLS traceroute
- Implement and troubleshoot basic MPLS L3VPN
  - L3VPN, CE, PE, P
  - Extranet (route leaking)
- Implement and troubleshoot encapsulation
  - GRE
  - Dynamic GRE
  - LISP encapsulation principles supporting EIGRP OTP
- Implement and troubleshoot DMVPN (single hub)
  - NHRP
  - DMVPN with IPsec using preshared key
  - QoS profile
  - Pre-classify
- Describe IPv6 tunneling techniques
  - 6in4, 6to4
  - ISATAP
  - 6RD
  - 6PE/6VPE
- Describe basic Layer 2 VPN-wireline
  - L2TPv3 general principals
  - ATOM general principals

- Describe basic L2VPN-LAN services
  - MPLS-VPLS general principals
  - OTV general principals

b. Encryption

- Implement and troubleshoot IPsec with preshared key
  - IPv4 site to IPv4 site
  - IPv6 in IPv4 tunnels
  - Virtual tunneling Interface (VTI)
- Describe GET VPN

5. Infrastructure Security

a. Device security

- Implement and troubleshoot IOS AAA using local database
  - Implement and troubleshoot device access control
  - Lines (VTY, AUX, console)
  - SNMP
  - Management plane protection
  - Password encryption
- Implement and troubleshoot control plane policing
- Describe device security using IOS AAA with TACACS+ and RADIUS
  - AAA with TACACS+ and RADIUS
  - Local privilege authorization fallback
  - Network security
- Implement and troubleshoot switch security features
  - VACL, PACL
  - Storm control
  - DHCP snooping
  - IP source-guard
  - Dynamic ARP inspection
  - port-security
  - Private VLAN
- Implement and troubleshoot router security features

- IPv4 access control lists (standard, extended, time-based)
    - IPv6 traffic filter
    - Unicast reverse path forwarding
- Implement and troubleshoot IPv6 first hop security
    - RA guard
    - DHCP guard
    - Binding table
    - Device tracking
    - ND inspection/snooping
    - Source guard
    - PACL
- Describe 802.1X
    - 802.1X, EAP, RADIUS
    - MAC authentication bypass

6. **Infrastructure Services**
    a. **System management**
        - Implement and troubleshoot device management
            - Console and VTY
            - Telnet, HTTP, HTTPS, SSH, SCP
            - (T)FTP
        - Implement and troubleshoot SNMP
            - v2c, v3
        - Implement and troubleshoot logging
            - Local logging, syslog, debug, conditional debug
            - Timestamp

    b. **Quality of service**
        - Implement and troubleshoot end-to-end QoS
            - CoS and DSCP mapping
        - Implement, optimize and troubleshoot QoS using MQC
            - Classification
            - Network based application recognition (NBAR)

- Marking using IP precedence, DSCP, CoS, ECN
- Policing, shaping
- Congestion management (queuing)
- HQoS, sub-rate Ethernet link
- Congestion avoidance (WRED)

- Describe Layer 2 QoS
  - Queuing, scheduling
  - Classification, marking

c. Network services

- Implement and troubleshoot first-hop redundancy protocols
  - HSRP, GLBP, VRRP
  - Redundancy using IPv6 RS/RA
- Implement and troubleshoot network time protocol
  - NTP master, client, version 3, version 4
  - NTP Authentication
- Implement and troubleshoot IPv4 and IPv6 DHCP
  - DHCP client, IOS DHCP server, DHCP relay
  - DHCP options
  - DHCP protocol operations
  - SLAAC/DHCPv6 interaction
  - Stateful, stateless DHCPv6
  - DHCPv6 prefix delegation
- Implement and troubleshoot IPv4 network address translation
  - Static NAT, dynamic NAT, policy-based NAT, PAT
  - NAT ALG
- Describe IPv6 network address translation
  - NAT64
  - NPTv6

d. Network optimization

- Implement and troubleshoot IP SLA
  - ICMP, UDP, Jitter, VoIP

- Implement and troubleshoot tracking object
  - Tracking object, tracking list
  - Tracking different entities (e.g. interfaces, routes, IPSLA, and such)
- Implement and troubleshoot NetFlow
  - NetFlow v5, v9
  - Local retrieval
  - Export (configuration only)
- Implement and troubleshoot embedded event manager
  - EEM policy using applet
- Identify performance routing (PfR)
  - Basic load balancing
  - Voice optimization