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1.0 Layer 2 Technologies — 20%

1.1 LAN switching technologies

- 1.1.a Implement and troubleshoot switch administration
  - 1.1.a [i] Managing MAC address table
  - 1.1.a [ii] errdisable recovery
  - 1.1.a [iii] L2 MTU
- 1.1.b Implement and troubleshoot layer 2 protocols
  - 1.1.b [i] CDP, LLDP
  - 1.1.b [ii] UDLD
- 1.1.c Implement and troubleshoot VLAN
  - 1.1.c [i] access ports
  - 1.1.c [ii] VLAN database
  - 1.1.c [iii] normal, extended VLAN, voice VLAN
- 1.1.d Implement and troubleshoot trunking
  - 1.1.d [i] VTPv1, VTPv2, VTPv3, VTP pruning
  - 1.1.d [ii] dot1Q
  - 1.1.d [iii] Native VLAN
  - 1.1.d [iv] Manual pruning
- 1.1.e Implement and troubleshoot etherchannel
  - 1.1.e [i] LACP, PAgP, manual
  - 1.1.e [ii] layer 2, layer 3
  - 1.1.e [iii] load-balancing
  - 1.1.e [iv] etherchannel misconfiguration guard
- 1.1.f Implement and troubleshoot spanning-tree
  - 1.1.f [i] PVST+/RPVST+/MST
  - 1.1.f [ii] switch priority, port priority, path cost, STP timers
  - 1.1.f [iii] port fast, BPDUguard, BPDUfilter
  - 1.1.f [iv] loopguard, rootguard
- 1.1.g Implement and troubleshoot other LAN switching technologies
  - 1.1.g [i] SPAN, RSPAN, ERSPAN

1.2 Layer 2 Multicast

- 1.2.a Implement and troubleshoot IGMP
  - 1.2.a [I] IGMPv1, IGMPv2, IGMPv3
  - 1.2.a [ii] IGMP snooping
  - 1.2.a [iii] IGMP querier
  - 1.2.a [iv] IGMP filter
  - 1.2.a [v] IGMP proxy

1.3 Layer 2 WAN circuit technologies

- 1.3.a Implement and troubleshoot HDLC
- 1.3.b Implement and troubleshoot PPP
  - 1.3.b [i] authentication [PAP, CHAP]
  - 1.3.b [ii] PPPoE
  - 1.3.b [iii] MLPPP

1.4 Troubleshooting layer 2 technologies

- 1.4.a Use IOS troubleshooting tools
  - 1.4.a [i] debug, conditional debug
  - 1.4.a [ii] ping, traceroute with extended options
  - 1.4.a [iii] Embedded packet capture
- 1.4.b Apply troubleshooting methodologies
  - 1.4.b [i] Diagnose the root cause of networking issue [analyze symptoms, identify and describe root cause]
  - 1.4.b [ii] Design and implement valid solutions according to constraints
  - 1.4.b [iii] Verify and monitor resolution
- 1.4.c Interpret packet capture
  - 1.4.c [i] Using wireshark trace analyzer
  - 1.4.c [ii] Using IOS embedded packet capture

2.0 Layer 3 Technologies 40%

2.1 Addressing technologies

- 2.1.a Identify, implement and troubleshoot IPv4 addressing and sub-netting
  - 2.1.a [i] Address types, VLSM
  - 2.1.a [ii] ARP
- 2.1.b Identify, implement and troubleshoot IPv6 addressing and sub-netting
  - 2.1.b [i] Unicast, multicast
  - 2.1.b [ii] EUI-64
  - 2.1.b [iii] ND, RS/RA
  - 2.1.b [iv] Autoconfig/SLAAC temporary addresses [RFC4941]
  - 2.1.b [v] Global prefix configuration feature

2.2 Layer 3 Multicast

- 2.2.a Troubleshoot reverse path forwarding
  - 2.2.a [i] RPF failure
  - 2.2.a[ii] RPF failure with tunnel interface
- 2.2.b Implement and troubleshoot IPv4 protocol independent multicast
  - 2.2.b [i] PIM dense mode, sparse mode, sparse-dense mode
  - 2.2.b [ii] Static RP, auto-RP, BSR
  - 2.2.b [iii] Bidirectional PIM
  - 2.2.b [iv] Source-specific multicast
  - 2.2.b [v] Group to RP mapping
  - 2.2.b [vi] Multicast boundary
- 2.2.c Implement and troubleshoot multicast source discovery protocol
  - 2.2.c.[i] Intra-domain MSDP [anycast RP]
  - 2.2.c.[ii] SA filter

2.3 Fundamental routing concepts

- 2.3.a Implement and troubleshoot static routing
- 2.3.b Implement and troubleshoot default routing
- 2.3.c Compare routing protocol types
  - 2.3.c [i] distance vector
  - 2.3.c [ii] link state
  - 2.3.c [iii] path vector
- 2.3.d Implement, optimize and troubleshoot administrative distance
- 2.3.e Implement and troubleshoot passive interface
- 2.3.f Implement and troubleshoot VRF lite
- 2.3.g Implement, optimize and troubleshoot filtering with any routing protocol
- 2.3.h Implement, optimize and troubleshoot redistribution between any routing protocol
- 2.3.i Implement, optimize and troubleshoot manual and auto summarization with any routing protocol
- 2.3.j Implement, optimize and troubleshoot policy-based routing
- 2.3.k Identify and troubleshoot sub-optimal routing
- 2.3.l Implement and troubleshoot bidirectional forwarding detection
- 2.3.m Implement and troubleshoot loop prevention mechanisms
  - 2.3.m [i] Route tagging, filtering
  - 2.3.m [ii] Split horizon
  - 2.3.m [iii] Route poisoning
- 2.3.n Implement and troubleshoot routing protocol authentication
  - 2.3.n [i] MD5
  - 2.3.n [ii] key-chain
  - 2.3.n [iii] EIGRP HMAC SHA2-256bit
  - 2.3.n [iv] OSPFv2 SHA1-196bit
  - 2.3.n [v] OSPFv3 IPsec authentication

2.4 RIP v2

- 2.4.a Implement and troubleshoot RIPv2

2.5 EIGRP [for IPv4 and IPv6]

- 2.5.a Describe packet types
  - 2.5.a [i] Packet types [hello, query, update, and such]
  - 2.5.a [ii] Route types [internal, external]
- 2.5.b Implement and troubleshoot neighbor relationship
  - 2.5.b [i] Multicast, unicast EIGRP peering
- 2.5.c Implement and Troubleshoot Loop free path selection
  - 2.5.c [i] RD, FD, FC, successor, feasible successor
  - 2.5.c [ii] Classic metric
  - 2.5.c [iii] Wide metric
- 2.5.d Implement and troubleshoot operations
  - 2.5.d [i] General operations
  - 2.5.d [ii] Topology table, update, query, active, passive
  - 2.5.d [iii] Stuck in active
  - 2.5.d [iv] Graceful shutdown
- 2.5.e Implement and troubleshoot EIGRP stub
  - 2.5.e [i] stub
  - 2.5.e [ii] leak-map
- 2.5.f Implement and troubleshoot load-balancing
  - 2.5.f [i] equal-cost
  - 2.5.f [ii] unequal-cost
  - 2.5.f [iii] add-path
- 2.5.g Implement EIGRP [multi-address] named mode
  - 2.5.g [i] Types of families
  - 2.5.g [ii] IPv4 address-family
  - 2.5.g [iii] IPv6 address-family
- 2.5.h Implement, troubleshoot and optimize EIGRP convergence and scalability
  - 2.5.h [i] Describe fast convergence requirements
  - 2.5.h [ii] Control query boundaries
  - 2.5.h [iii] IP FRR/fast reroute [single hop]
  - 2.5.h [iv] Summary leak-map
  - 2.5.h [v] Summary metric

2.6 OSPF [v2 and v3]

- 2.6.a Describe packet types
  - 2.6.a [i] LSA types [1, 2, 3, 4, 5, 7, 9]
  - 2.6.a [ii] Route types [N1, N2, E1, E2]
- 2.6.b Implement and troubleshoot neighbor relationship
- 2.6.c Implement and troubleshoot OSPFv3 address-family support
  - 2.6.c [i] IPv4 address-family
  - 2.6.c [ii] IPv6 address-family

- 2.6.d Implement and troubleshoot network types, area types and router types
  - 2.6.d [i] Point-to-point, multipoint, broadcast, non-broadcast
  - 2.6.d [ii] LSA types, area type: backbone, normal, transit, stub, NSSA, totally stub
  - 2.6.d [iii] Internal router, ABR, ASBR
  - 2.6.d [iv] Virtual link
- 2.6.e Implement and troubleshoot path preference
- 2.6.f Implement and troubleshoot operations
  - 2.6.f [i] General operations
  - 2.6.f [ii] Graceful shutdown
  - 2.6.f [iii] GTSM [generic TTL security mechanism]
- 2.6.g Implement, troubleshoot and optimize OSPF convergence and scalability
  - 2.6.g [i] Metrics
  - 2.6.g [ii] LSA throttling, SPF tuning, fast hello
  - 2.6.g [iii] LSA propagation control [area types, ISPF]
  - 2.6.g [iv] IP FR/fast reroute [single hop]
  - 2.6.g [v] LFA/loop-free alternative [multi hop]
  - 2.6.g [vi] OSPFv3 prefix suppression

2.7 BGP

- 2.7.a Describe, implement and troubleshoot peer relationships
  - 2.7.a [i] Peer-group, template
  - 2.7.a [ii] Active, passive
  - 2.7.a [iii] States, timers
  - 2.7.a [iv] Dynamic neighbors
- 2.7.b Implement and troubleshoot IBGP and EBGP
  - 2.7.b [i] EBGP, IBGP
  - 2.7.b [ii] 4 bytes AS number
  - 2.7.b [iii] Private AS
- 2.7.c Explain attributes and best-path selection
- 2.7.d Implement, optimize and troubleshoot routing policies
  - 2.7.d [i] Attribute manipulation
  - 2.7.d [ii] Conditional advertisement
  - 2.7.d [iii] Outbound route filtering
  - 2.7.d [iv] Communities, extended communities
  - 2.7.d [v] Multi-homing
- 2.7.e Implement and troubleshoot scalability
  - 2.7.e [i] Route-reflector, cluster
  - 2.7.e [ii] Confederations
  - 2.7.e [iii] Aggregation, AS set
- 2.7.f Implement and troubleshoot multi-protocol BGP
  - 2.7.f [i] IPv4, IPv6, VPN address-family
- 2.7.g Implement and troubleshoot AS path manipulations
  - 2.7.g [i] Local AS, allow AS in, remove private AS

    - 2.7.g [ii] Prepend
    - 2.7.g [iii] Regexp
- 2.7.h Implement and Troubleshoot Other Features
    - 2.7.h [i] Multipath
    - 2.7.h [ii] BGP synchronization
    - 2.7.h [iii] Soft reconfiguration, route refresh

2.8 Troubleshooting layer 3 technologies

- 2.8.a Use IOS troubleshooting tools
    - 2.8.a [i] debug, conditional debug
    - 2.8.a [ii] ping, traceroute with extended options
    - 2.8.a [iii] Embedded packet capture
- 2.8.b Apply troubleshooting methodologies
    - 2.8.b [i] Diagnose the root cause of networking issue [analyze symptoms, identify and describe root cause]
    - 2.8.b [ii] Design and implement valid solutions according to constraints
    - 2.8.b [iii] Verify and monitor resolution
- 2.8.c Interpret packet capture
    - 2.8.c [i] Using wireshark trace analyzer
    - 2.8.c [ii] Using IOS embedded packet capture

3.0 VPN Technologies 20%

3.1 Tunneling

- 3.1.a Implement and troubleshoot MPLS operations
    - 3.1.a [i] Label stack, LSR, LSP
    - 3.1.a [ii] LDP
    - 3.1.a [iii] MPLS ping, MPLS traceroute
- 3.1.b Implement and troubleshoot basic MPLS L3VPN
    - 3.1.b [i] L3VPN, CE, PE, P
    - 3.1.b [ii] Extranet [route leaking]
- 3.1.c Implement and troubleshoot encapsulation
    - 3.1.c [i] GRE
    - 3.1.c [ii] Dynamic GRE
- 3.1.d Implement and troubleshoot DMVPN [single hub]
    - 3.1.d [i] NHRP
    - 3.1.d [ii] DMVPN with IPsec using preshared key
    - 3.1.d [iii] QoS profile
    - 3.1.d [iv] Pre-classify

3.2 Encryption

- 3.2.a Implement and troubleshoot IPsec with preshared key

- 3.2.a [i] IPv4 site to IPv4 site
- 3.2.a [ii] IPv6 in IPv4 tunnels
- 3.2.a [iii] Virtual tunneling interface [VTI]

3.3 Troubleshooting VPN technologies

- 3.3.a Use IOS troubleshooting tools
  - 3.3.a [i] debug, conditional debug
  - 3.3.a [ii] ping, traceroute with extended options
  - 3.3.a [iii] Embedded packet capture
- 3.3.b Apply troubleshooting methodologies
  - 3.3.b [i] Diagnose the root cause of networking issue [analyze symptoms, identify and describe root cause]
  - 3.3.b [ii] Design and implement valid solutions according to constraints
  - 3.3.b [iii] Verify and monitor resolution
- 3.3.c Interpret packet capture
  - 3.3.c [i] Using wireshark trace analyzer
  - 3.3.c [ii] Using IOS embedded packet capture

4.0 Infrastructure Security 5%

4.1 Device security

- 4.1.a Implement and troubleshoot IOS AAA using local database
- 4.1.b Implement and troubleshoot device access control
  - 4.1.b [i] Lines [VTY, AUX, console]
  - 4.1.b [ii] SNMP
  - 4.1.b [iii] Management plane protection
  - 4.1.b [iv] Password encryption
- 4.1.c Implement and troubleshoot control plane policing

4.2 Network security

- 4.2.a Implement and troubleshoot switch security features
  - 4.2.a [i] VACL, PACL
  - 4.2.a [ii] Stormcontrol
  - 4.2.a [iii] DHCP snooping
  - 4.2.a [iv] IP source-guard
  - 4.2.a [v] Dynamic ARP inspection
  - 4.2.a [vi] Port-security
  - 4.2.a [vii] Private VLAN
- 4.2.b Implement and troubleshoot router security features
  - 4.2.b [i] IPv4 access control lists [standard, extended, time-based]
  - 4.2.b [ii] IPv6 traffic filter
  - 4.2.b [iii] Unicast reverse path forwarding

- 4.2.c Implement and troubleshoot IPv6 first hop security
  - 4.2.c [i] RA guard
  - 4.2.c [ii] DHCP guard
  - 4.2.c [iii] Binding table
  - 4.2.c [iv] Device tracking
  - 4.2.c [v] ND inspection/snooping
  - 4.2.c [vi] Source guard
  - 4.2.c [vii] PACL

4.3 Troubleshooting infrastructure security

- 4.3.a Use IOS troubleshooting tools
  - 4.3.a [i] debug, conditional debug
  - 4.3.a [ii] ping, traceroute with extended options
  - 4.3.a [iii] Embedded packet capture
  - 4.3.b Apply troubleshooting methodologies
  - 4.3.b [i] Diagnose the root cause of networking issue [analyze symptoms, identify and describe root cause]
  - 4.3.b [ii] Design and implement valid solutions according to constraints
  - 4.3.b [iii] Verify and monitor resolution
- 4.3.c Interpret packet capture
  - 4.3.c [i] Using wireshark trace analyzer
  - 4.3.c [ii] Using IOS embedded packet capture

5.0 Infrastructure Services 15%

5.1 System management

- 5.1.a Implement and troubleshoot device management
  - 5.1.a [i] Console and VTY
  - 5.1.a [ii] telnet, HTTP, HTTPS, SSH, SCP
  - 5.1.a [iii] [T]FTP
- 5.1.b Implement and troubleshoot SNMP
  - 5.1.b [i] v2c, v3
- 5.1.c Implement and troubleshoot logging
  - 5.1.c [i] Local logging, syslog, debug, conditional debug
  - 5.1.c [ii] Timestamp

5.2 Quality of service

- 5.2.a Implement and troubleshoot end to end QoS
  - 5.2.a [i] CoS and DSCP mapping
- 5.2.b Implement, optimize and troubleshoot QoS using MQC
  - 5.2.b [i] Classification
  - 5.2.b [ii] Network based application recognition [NBAR]

    - 5.2.b [iii] Marking using IP precedence, DSCP, CoS, ECN
    - 5.2.b [iv] Policing, shaping
    - 5.2.b [v] Congestion management [queuing]
    - 5.2.b [vi] HQoS, sub-rate ethernet link
    - 5.2.b [vii] Congestion avoidance [WRED]

5.3 Network services

- 5.3.a Implement and troubleshoot first-hop redundancy protocols
    - 5.3.a [i] HSRP, GLBP, VRRP
    - 5.3.a [ii] Redundancy using IPv6 RS/RA
- 5.3.b Implement and troubleshoot network time protocol
    - 5.3.b [i] NTP master, client, version 3, version 4
    - 5.3.b [ii] NTP authentication
- 5.3.c Implement and troubleshoot IPv4 and IPv6 DHCP
    - 5.3.c [i] DHCP client, IOS DHCP server, DHCP relay
    - 5.3.c [ii] DHCP options
    - 5.3.c [iii] DHCP protocol operations
    - 5.3.c [iv] SLAAC/DHCPv6 interaction
    - 5.3.c [v] Stateful, stateless DHCPv6
    - 5.3.c [vi] DHCPv6 prefix delegation
- 5.3.d Implement and troubleshoot IPv4 network address translation
    - 5.3.d [i] Static NAT, dynamic NAT, policy-based NAT, PAT
    - 5.3.d [ii] NAT ALG

5.4 Network optimization

- 5.4.a Implement and troubleshoot IP SLA
    - 5.4.a [i] ICMP, UDP, jitter, VoIP
- 5.4.b Implement and troubleshoot tracking object
    - 5.4.b [i] Tracking object, tracking list
    - 5.4.b [ii] Tracking different entities [e.g. interfaces, routes, IPSLA, and such]
- 5.4.c Implement and troubleshoot netflow
    - 5.4.c [i] Netflow v5, v9
    - 5.4.c [ii] Local retrieval
    - 5.4.c [iii] Export [configuration only]
    - 5.4.d Implement and troubleshoot embedded event manager
    - 5.4.d [i] EEM policy using applet

5.5 Troubleshooting infrastructure services

- 5.5.a Use IOS troubleshooting tools
    - 5.5.a [i] debug, conditional debug
    - 5.5.a [ii] ping, traceroute with extended options
    - 5.5.a [iii] Embedded packet capture
- 5.5.b Apply troubleshooting methodologies

- 5.5.b [i] Diagnose the root cause of networking issue [analyze symptoms, identify and describe root cause]
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- 5.5.c Interpret packet capture
  - 5.5.c [i] Using wireshark trace analyzer
  - 5.5.c [ii] Using IOS embedded packet capture