INW Final

Module 8

NTP (Network Time Protocol) - Purpose

- NTP is a protocol used to synchronize the clocks of devices on a network to a common time source
- Ensures all devices on a network agree on the correct time
- Helps in log file consistency (comparing timestamps across routers, switches, and servers), security, and troubleshooting

CDP (Cisco Discovery Protocol) - Purpose and Uses

- It is a layer 2 (Data Link Layer) protocol that allows Cisco devices to discover information about directly connected Cisco neighbors
- Purpose: CDP is used to discover and share information about directly connected Cisco devices, even if IP is not configured
- Uses: Neighbor discovery by identifying which Cisco device is connected to each interface, and network mapping, troubleshooting, verifying device types, and VoIP deployment, which helps switches recognize Cisco IP Phones

IP Phones - Using VLANs

- An IP phone is a telephone that uses the IP networks to make calls. It is basically a voice device that behaves like a networked computer
- We need to separate the IP Phone and the PC using VLANs as they are sharing one switch port

Routing Basics

- Routing is the process of moving packets from one network to another
    - Switches move data within a network (same subnet)
    - Routers move data between the different networks
- We need routing because most networks are broken into subnets, and devices in different subnets can't talk to each other without a router
- Static routing: Admin manually enters routes. Good for smaller networks
- Dynamic routing: Routers exchange routes using a protocol (e.g., OSPF or EIGRP). Automatically updates
- Routing table: Every router has a routing table. It tells the router, "If you want to reach this network, send the packet out this interface or to this next-hop IP."
- Routers work at the Layer 3 (Network)

The Routing Process - Packets and Frames

- Packets are in layer 3 - IP layer data, including source and destination IP addresses
- Frames are in layer 2 - Ethernet layer data, including source and destination MAC addresses
- Routers are a layer 3 device - Forward packets between different IP networks
- Routers remove the old Layer 2 header and add a new one before forwarding
- MAC addresses are only relevant within the local network segment

- IP addresses remain unchanged from source to destination
- The routing decision is based on the destination IP, not MAC

Module 9

ARP tables: IP to MAC address

- ARP (Address Resolution Protocol) - Translates an IP address into MAC address so a device can build a layer 2 frame
- ARP is needed because IP addresses are used at Layer 3 for routing, but MAC addresses are used at Layer 2 for frame delivery. Before a device can send a frame, it must know the MAC address that corresponds to the destination IP
- An ARP table is a list that stores and shows IP addresses and their associated MAC addresses

Static Routes

- A static route is a manually configured path that tells the router how to reach a specific network (Unlike dynamic routing, where routers talk to each other and update automatically)
- Better for smaller, simpler networks
- Command: # ip route [destination_network] [subnet_mask] [next_hop_ip

Routing tables: Connected vs Local

- When you type show ip route on a router you'll often see both Connected and Local routes
- Local Route (L)
    - This is the specific IP address assigned to the router's interface
    - It shows exactly what IP the router is using on a given interface
    - It helps the router know how to respond to traffic sent to itself
- Connected Route (C)
    - This is the entire subnet that is directly connected to one of the router's interfaces
    - It tells the router: "This entire network is reachable through this interface."

Router of last resort

- The router of last resort is the router (or next-hop IP) a router will send packets to when it has no better match in the routing table
- It is used when a router receives a packet with a destination IP that does not match any specific route in its routing table, and the router has a default route (0.0.0.0/0) configured
- Router(config)# ip route 0.0.0.0 0.0.0.0 [next-hop IP or exit interface]

IP addresses, A, B, C Classes

- IPv4 addresses are 32-bit numbers, usually written in dotted decimal format (e.g., 192.168.1.1)
- Class A:
    - First Octet: 1 - 126
    - Default Subnet Mask: /8
    - # of Networks: 126
    - Hosts per Network: 16,777,214
- Class B:

    - First Octet: 128 - 191
    - Default Subnet Mask: /16
    - # of Networks: 16,384
    - Hosts per Network: 65,534
- Class C:
    - First Octet: 192 - 223
    - Default Subnet Mask: /24
    - # of Networks: 2,097,152
    - Hosts per Network: 254
- 169.254.x.x is reserved for APIPA
- Subnet ID: First address in the block
- Broadcast: Last address in the block
- Usable hosts: Between the subnet ID +1 and broadcast -1

Module 10

Autonomous system

- A group of routers and networks under a single administrative domain that uses interior gateway protocols (IGPs) to route traffic within the system, and BGP to route traffic between systems
- Book definition: An Autonomous System is a collection of IP routing prefixes under the control of one or more network operators that presents a common routing policy to the Internet
- Interior routing: (IGP): OSPF, EIGRP, RIP routing with an autonomous system
- Exterior Routing (EGP): BGP (Border Gateway Protocol) routing between autonomous systems
- Each autonomous system is assigned a unique autonomous system number (ASN)
- BGP connects different autonomous systems

Interior vs exterior gateway protocols

- How routers exchange routing info (inside vs outside)
- Interior gateway protocols (IGPs): Used for routing within a single Autonomous System - typically inside one company or network
- IGPs
    - Used internally (Inside an Autonomous system)
    - Commonly used in enterprise networks
    - For example: RIP, EIGRP, OSPF, IS-IS
- Exterior Gateway Protocols (EGPs): Used to route between different Autonomous Systems, such as between two ISPs or between an enterprise and its ISP
- EGPs
    - Used externally (between Autonomous Systems)
    - Used for internet-wide routing
    - Only one EGP in use today: BGP (Border Gateway Protocol)
- EIGRP is a Cisco proprietary interior gateway protocol (IGP) that routes IP packets within an autonomous system

How dynamic routing works

- Dynamic Routing is when routers automatically exchange routing information using a routing protocol, instead of manually adding static routes
- This allos routers to discover remote networks, learn new paths, and detect failures and reroute traffic
- Examples of dynamic routing protocols: OSPF, EIGRP, RIP, BGP (for external routing)
- They send hello messages to discover nearby routers and once neighbors are found they exchange routing information
- Routers build and update their routing tables, evaluating bandwidth, hop count, and delay to use the best path
- Convergence: When routers have to recalculate routes if the network changes. For example if a failure is detected they remove the bad route and find a new one

Routing Metrics

- Value assigned to each route that helps routers determine the best path to a destination network
- Lower metric = better path

4 functiuon of dynamic routing

- Discover remote networks
- Maintain updated routing information
- Determine the best path to each network
- Find a new best path if the current path fails (Called convergence)

RIP

- RIP (Routing Information Protocol) in one of the oldest dynamic routing protocols. It is a distance vector protocol that uses hop count as its metric
- RIP shooses the path with the fewest number of routers to get to the destination, not the fastest or most reliable
- Max hop count of 15 (anything with 16 hops is considered unreachable

OSPF using Hello Messages

- OSPF (Open Shortest Path First) is a link state interior gateway protocol (IGP) used to exchange routing information within a single autonomous system
- Hello messages are special packets set to discover, establish, maintain neighbor adjacencies
- They are sent periodically out of each interface running OSPF

OSPF Areas

- An OSPF area is a logical grouping of routers that helps organize and optimize routing within an asutonomous system
- Areas help OSPF scale to large networks, reduce routing table size, and limit LSA flooding

Link-State

- A link state is a description of a router's interface (link) to the network, including its IP address, subnet mask, cost, neighbors, and status
- In OSPF, routers use these link-state descriptiuons to build a complete map of the network topology

Sharing gateway of last resort

- The gateway of last resort in the next-hop router a router will send packets to when it doesn't have a specific route for the destination
- In OSPF run default-information originate

BGP

- BGP (Border Gateway Protocol) in the only Exterior Gateway Protocol (EGP) used to exchange routing information between autonomous systems
- BGP is the protocol that connects the internet together. It tells routers how to reach networks outside their organization, across autonomous systems boundries

Subnet Planning

- Subnet planning is the process of dividing a lager IP network into smaller subnetworks to optimize IP address usage, improve routing efficiency, and enhance security

Configure serial cards as DCE vs DTE

- DCE (Data Communications Equipment) provides the clock rate (timing signal)
- DTE (Data Terminal Equipment) receives clocking from DCE
- On the DCE end run Router(config-if)# clock rate 64000