Networking

Network Troubleshooting

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- Guiding Question: How can understanding IP addressing, routing tables, and basic troubleshooting tools help diagnose and fix network connectivity problems?

- Students will:
  - Identify and resolve issues with IP address configurations, subnet masks, and default gateways.
  - Detect and troubleshoot duplicate IP addresses and address pool exhaustion.
  - Interpret routing tables and default route settings to ensure proper network pathing.
  - Explain how routing protocols, administrative distance, and route metrics influence route selection.
  - Use command-line tools such as ping, traceroute, show ip route, ipconfig, netstat, and nmap to verify and troubleshoot network connectivity.

Overview

- Understanding how packets are addressed and routed is critical when solving network problems.
- Networks rely on IP addresses, gateways, routing protocols, and tables.
- Problems in any of these areas can break communication.
- Command-line tools help find and fix network issues.

Incorrect IP Address

- Every device needs a correct IP address to find and talk to others.
- If the address is wrong, it’s like trying to call someone with the wrong phone number.
- A wrong IP address prevents devices from communicating.
- Use `ipconfig` (Windows) or `ifconfig` (Linux) to confirm settings.
- Make sure the device's IP fits into the correct network range.

Incorrect Subnet Mask

- Subnet masks group devices together, if the mask is wrong, devices that should see each other will think they're on different networks.
- A wrong subnet mask blocks communication between devices.
- A typical mask would look like: **`255.255.255.0 (/24)`**.
- Check using **`ipconfig`** or **`ifconfig`**.
- Use **`ping`** to test local communication or **`traceroute`** for distant devices.

Duplicate IP Address

- When two devices have the same address, it's like two houses sharing a mailbox.
- Messages get mixed up or lost entirely, leading to serious network disruptions.
- Duplicate IP addresses confuse the network and cause connection drops.
- Watch for error messages or use **`arp-scan`** to detect duplicates.
- Fix by manually changing the IP address or adjusting DHCP settings.

Address Pool Exhaustion

- If there are no free IPs, new devices can’t join.
- It’s like arriving at a full parking lot — you must wait for someone to leave or find a new place to park.
- Happens when DHCP has no more IPs to give out.
- Use show **`ip dhcp`** binding to monitor address usage.
- Solutions:
  - Expand the address pool.
  - Shorten lease times.
  - Add a new subnet.

Incorrect Default Gateway

- A default gateway links a device to outside networks.
- If a device is assigned the wrong gateway, users can't reach the internet.
- Check gateway with **`ipconfig`** or **`ip route`**.
- Test reachability with **`ping`** and **`traceroute`**.

Routing Table Basics

- The routing table is the router’s GPS.
- If it has wrong or missing information, packets won't reach their destination correctly, causing outages or slowdowns.
- A routing table stores paths to network destinations.
- View with **`show ip route`**.
- Watch for:
  - Missing routes.
  - Conflicting routes.

Default Routes

- Think of a default route as your 'fallback' option.
- If the router doesn’t know a better way to reach a destination, it uses this route to send the packet onward.
- A routing table will include a default route to be used when there is no specific route match.
- Should point to `0.0.0.0/0`.
- Check the next-hop IP is correct and reachable.

Route Selection

- Administrative Distance tells the router who to trust most.
- Metrics are like travel time estimates — the router wants the shortest or fastest route based on cost.
- Check routes using show **`ip route`**.
- Keep in mind how a router makes path decisions:
  - OSPF, EIGRP, and BGP routing protocols decide best paths – make sure router is configured with the right protocol for the type of network.
  - Lower Administrative Distance (AD) = more trusted route.
  - Lower Metric = more efficient path.

Key Command-Line Tools

- **`ping`**: Test if a device is reachable.
- **`traceroute/tracert`**: Show path and delays.
- **`nslookup/dig`**: Check DNS resolutions.
- **`netstat`**: View active connections.
- **`ipconfig/ifconfig`**: View network settings.
- **`arp`**: Check IP-to-MAC address mapping.
- **`nmap`**: Scan networks for active devices.
- **`Speedtest CLI`**: Software tool to measure network speed.

Networking Device Show Commands

- **`show mac-address-table`**: MAC address mappings.
- **`show ip route`**: Routing table.
- **`show interfaces`**: Interface status and errors.
- **`show running-config`**: Device setup.
- **`show arp`**: IP-to-MAC address table.
- **`show vlan`**: VLAN details.
- **`show power inline`**: PoE status.