Module 4: Introduction to Network Services

Why DNS?
-enables administrative changes without reflecting it on user experience
-helps with regional routing for faster access to websites
Why DNS Uses UDP:
-UDP is connectionless, reducing traffic overhead
-A full DNS lookup via TCP requires **44 packets**, while UDP needs only **8 packets**
When DNS Uses TCP:
If a DNS response is too large for a UDP datagram, the lookup switches to TCP.

A **fully qualified domain name (FQDN)** includes all these parts. Domains must follow specific rules: each section can be up to 63 characters, and the entire FQDN cannot exceed 255 characters. While DNS supports up to 127 levels of domains, most FQDNs are simple. Domains are registered through **registrars**, companies authorized by ICANN to sell unregistered domain names.

Why DHCP(Dynamic Host Configuration Protocol)?
-automates IP address assignment and reduces manual configuration AVOIDS IP CONFLICTS

- ☐ **Dynamic Allocation** – IPs are assigned from a pool and may change on reconnect.
- ☐ **Automatic Allocation** – Assigns the same IP to a device if possible.
- ☐ **Fixed Allocation** – Pre-configured MAC-to-IP mapping for security.

Network Address Translation (NAT)
-commonly used for **security** and **preserving IPv4 addresses**.
-basically A **router/firewall** rewrites the **source IP** of outgoing packets and keeps track of original IP to translate responses back.

Types of NAT

- **IP Masquerading**: Hides internal IPs from external networks.
- **One-to-Many NAT**: Multiple devices share a single public IP.

Module 5: Introduction to Connecting to the Internet.

Early Networking: Before Ethernet, TCP/IP, early networks focused on connecting nearby devices.

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Usenet: Built by Duke University students using **Public Switched Telephone Network (PSTN)** to exchange messages.

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Dial-Up Connections: Used **Plain Old Telephone Service (POTS)** to transmit data by dialing a phone number.

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Modems (Modulator-Demodulator): Converted digital data into audible signals for transmission over phone lines.

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Dial-Up Decline: Replaced by **broadband** but still used in rural areas.

Baud Rate: Measured data transmission speed:

- **1950s:** ~110 bps
- **Usenet era:** ~300 bps
- **1990s dial-up:** 14.4 kbps → Increased over time

Broadband

Always on, high-speed internet
WANs rely on broadband technologies to connect multiple locations over long distances.
Broadband powers WANs, providing high-speed Internet connections for remote office integration.

WANs use ISP-managed broadband links (e.g., fiber, leased lines) to connect multiple locations.
Local Loop: The section of the broadband network connecting a business to the ISP's core infrastructure.
Demarcation Point: The boundary where **business networking ends** and **ISP control begins**.
WANs utilize **specialized data link layer protocols** different from Ethernet to transmit data over broadband connections.

WANs are fast but expensive hence, **Point-to-Point VPNs (Site-to-Site VPNs)** offer a **cheaper alternative as Cloud Adoption Reduces WAN Needs**

Wireless Networking

Types of Wireless Networks

- **Ad-hoc Networks** – Devices communicate **directly** without infrastructure; used in **file sharing, industrial setups, and disaster recovery**.
- **Wireless LANs (WLANs)** – Most common; **access points (APs) bridge wireless devices to a wired network** for Internet access.
- **Mesh Networks** – Hybrid setup where **APs connect wirelessly**, extending network coverage **without additional cabling**.

Channels: Smaller sections of a frequency band that help reduce **collision domains** in wireless networks.

WPA3 enhances security against **cybercriminals** exploiting older encryption.

Module 6: Introduction to Troubleshooting and the Future of Networking

Verifying connectivity

Common Network Issues: **Misconfigurations, hardware failures, system incompatibilities** can disrupt connectivity.

ICMP (Internet Control Message Protocol)

- Used for **error reporting** (e.g., unreachable destination, expired TTL).
- ICMP messages contain **error type, code, checksum, and data payload**.

Ping Command

- Sends **ICMP Echo Requests** to check if a device is **reachable**.
- Displays **round-trip time (RTT)** and **packet loss**.
- **Windows**: Sends **4 pings** by default.

Traceroute (tracert on Windows)

- Identifies the **path between two devices**, showing **each router hop**.
- Uses **TTL manipulation** to track where packets are being dropped.

Port Connectivity Tools

Netcat (nc) (Linux/macOS): Tests if a **port is open** on a server.

  - `nc google.com 80` → Tries to connect to **Google on port 80**.
  - `nc -z -v google.com 80` → **Checks port status** in **verbose mode**.

Test-NetConnection (Windows): Similar to Netcat but with **detailed output**.

  - `Test-NetConnection -ComputerName google.com -Port 80` → **Tests port connectivity**.

mtr/pathping provide **real-time network path analysis**.

Digging into DNS

Domain Registration

-Domains must be **unique & registered** via a **registrar**.
-Can be transferred via **TXT record authentication**.
-Expiring domains can be re-registered by others.

Host Files

-Manually maps hostnames to IPs (used before DNS).
-Located on **every OS**, still used for **loopback (127.0.0.1 & ::1)**.
-**Checked before DNS**, can be used for **troubleshooting or malware exploits**.

The Cloud

a **computing model** that provides shared resources, services, and infrastructure over the Internet.

Hypervisors manage virtual machines and allocate computing resources dynamically.

- ➔ **Cost-effective**
- ➔ **Scalability**
- ➔ **Accessibility**
- ➔ **Automatic Updates**
- ➔ **Security & Redundancy**