Computer Networking Notes

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# 1. TCP (Transmission Control Protocol)

TCP is a connection-oriented protocol at the Transport Layer. It ensures reliable data transfer using acknowledgments, retransmissions, and flow control. Key features: reliability, ordered delivery, and error detection (via checksum).

# 2. UDP (User Datagram Protocol)

UDP is a connectionless protocol at the Transport Layer. It is faster but unreliable, as it does not guarantee delivery, order, or error correction. Used in applications like video streaming, VoIP, and online gaming.

# 3. HTTP (Hypertext Transfer Protocol)

HTTP is an application-layer protocol for communication between web browsers and servers. It uses TCP as the transport protocol. Common versions: HTTP/1.1, HTTP/2, and HTTP/3.

# 4. Ports

Ports are virtual communication endpoints used to distinguish multiple services on a single device. Examples: HTTP (80), HTTPS (443), FTP (21), DNS (53).

# 5. SONET (Synchronous Optical Network)

SONET is a standardized digital communication protocol that transmits large amounts of data over optical fiber. It is widely used for high-speed backbone networks.

# 6. Modem & Router

Modem: Converts digital signals into analog for transmission over telephone lines and vice versa.  
Router: Connects multiple networks, forwards data packets, and directs traffic based on IP addresses.

# 7. OSI Model

The OSI (Open Systems Interconnection) model has 7 layers:   
1. Physical, 2. Data Link, 3. Network, 4. Transport, 5. Session, 6. Presentation, 7. Application.  
It standardizes how different systems communicate.

# 8. TCP/IP Model

The TCP/IP model has 4 layers:   
1. Network Interface, 2. Internet, 3. Transport, 4. Application.  
It is the foundation of the modern Internet.

# 9. Client-Server Architecture

In client-server architecture, clients request services and servers provide responses. Examples: web browsing, email access.

# 10. Peer-to-Peer Architecture

In P2P, devices (peers) act as both clients and servers, sharing resources directly. Examples: BitTorrent, blockchain networks.

# 11. HTTP Methods

Common HTTP methods: GET (retrieve), POST (send data), PUT (update), DELETE (remove).

# 12. Error/Status Codes

HTTP status codes:   
1xx – Informational, 2xx – Success, 3xx – Redirection, 4xx – Client errors, 5xx – Server errors.

# 13. Cookies

Cookies are small data files stored on the client side by web servers. They help maintain sessions, preferences, and user authentication.

# 14. How Email Works

Email uses SMTP (sending), POP3/IMAP (retrieving). Client → SMTP → Mail server → Recipient server → POP3/IMAP → Recipient client.

# 15. Post Office Protocol (POP3)

POP3 retrieves emails from a mail server and downloads them to the client. Once downloaded, emails are usually deleted from the server.

# 16. DNS (Domain Name System)

DNS translates human-readable domain names (like google.com) into IP addresses. It uses a hierarchical structure: Root → TLD → Authoritative servers.

# 17. Transport Layer

The Transport Layer ensures end-to-end communication, reliability, flow control, and error detection. Protocols: TCP and UDP.

# 18. Transport Layer in TCP/IP

In the TCP/IP model, the Transport Layer maps directly with TCP/UDP to provide communication between applications.

# 19. Checksum

Checksum is an error-detection method where a numeric value is computed from data. Sender and receiver compare checksums to detect errors.

# 20. Timer

A timer is used in TCP to handle retransmission of lost packets and manage connection reliability.

# 21. 3-Way Handshake

The TCP 3-way handshake establishes a reliable connection:  
1. SYN → 2. SYN-ACK → 3. ACK.

# 22. Network Layer

The Network Layer handles logical addressing (IP addresses), routing, and forwarding of packets. Protocols: IP, ICMP, ARP.

# 23. Routers

Routers are network devices that forward data packets between networks using routing tables and algorithms.

# 24. Control Plane

The control plane is the part of a router or switch that makes decisions about how to forward traffic (e.g., routing protocols, building routing tables).

# 25. Middleboxes

Middleboxes are devices that sit between end hosts to manage traffic beyond simple packet forwarding. Examples: firewalls, load balancers, NAT devices, proxies.

# 26. Data Link Layer

The Data Link Layer ensures reliable transmission over the physical medium. Functions: framing, error detection (CRC), and MAC addressing. Devices: Switches, bridges.