Networking & Data Communication

Short Notes based on ***Exit Exam***

Zemzem labs

1. Basics of Data Communication

Elements of Communication System

1. **Sender**
2. **Receiver**
3. **Transmission Medium (link)**
4. **Message**
5. **Protocol**

Data Types

- **Analog**: continuous signals
- **Digital**: discrete values (0/1)

Transmission Modes

- **Simplex** – one direction
- **Half-duplex** – both directions, but not at the same time
- **Full-duplex** – both directions simultaneously

2. Transmission Media

Guided Media

- **Twisted Pair** (UTP/STP)
  - Cheap, common (Ethernet)
- **Coaxial Cable**
  - TV, early Ethernet
- **Fiber Optic Cable**
  - Highest bandwidth
  - Very secure
  - Immune to EMI

Unguided Media

- **Radio Waves**
- **Microwaves**
- **Infrared**
  Used in Wi-Fi, Bluetooth, satellite communication.

3. Switching Techniques

1. Circuit Switching

- Dedicated path
- Used in traditional telephone networks
- Good for real-time traffic

2. Packet Switching

- Data split into packets
- No dedicated path
- Types:
    - **Datagram** (Internet)
    - **Virtual Circuit** (Frame Relay)

3. Message Switching

- Store-and-forward
- Entire message sent as one unit
- No dedicated path

4. OSI Reference Model (7 Layers)

1. **Physical** – bits, cables, modulation
2. **Data Link** – frames, MAC, error detection (Ethernet)
3. **Network** – routing, IP addresses (IP)
4. **Transport** – end-to-end connection (TCP/UDP)
5. **Session** – dialogs between sessions
6. **Presentation** – encoding, encryption
7. **Application** – HTTP, FTP, DNS, SMTP

5. TCP/IP Model

1. Link Layer
2. Internet Layer (IP)
3. Transport Layer (TCP/UDP)
4. Application Layer

6. IP Addressing

IPv4

- 32-bit
- Format: a.b.c.d
- Classes: A, B, C, D, E (legacy)
- Private IPs:
  - 10.0.0.0/8
  - 172.16.0.0/12
  - 192.168.0.0/16
- Loopback: 127.0.0.1

IPv6

- 128-bit
- Extensive address space
- Written in hex
- Supports auto-configuration

Subnetting

- Dividing networks into smaller subnets
- Formula:
  Number of hosts = 2^(32 – subnet bits) – 2

7. Routing

Types of Routing

- **Static Routing** – manually configured
- **Dynamic Routing** – routing protocols update automatically

Dynamic Routing Protocols

- **Distance Vector:** RIP
- **Link State:** OSPF
- **Hybrid:** EIGRP
- **Path Vector:** BGP (Internet backbone)

Metrics

- Hop count

- Bandwidth
- Delay
- Load

8. Transport Layer

TCP (Transmission Control Protocol)

- Connection-oriented
- Reliable
- Ordered delivery
- Flow control → **Sliding Window**
- Congestion control
- 3-way handshake (SYN, SYN-ACK, ACK)

UDP (User Datagram Protocol)

- Connectionless
- Fast, no guarantee
- Used for: VoIP, video, gaming, DNS

Port Numbers

- HTTP – 80
- HTTPS – 443
- FTP – 21
- SSH – 22
- DNS – 53
- SMTP – 25

9. Error Detection & Correction

Error Detection

- Parity bit
- Checksum
- CRC (Cyclic Redundancy Check) → most powerful

Error Correction

- Hamming Code

- FEC (Forward Error Correction)
- ARQ Protocols:
    - Stop-and-wait
    - Go-Back-N
    - Selective Repeat (most efficient)

10. Data Link Layer

Responsibilities

- Framing
- Physical addressing
- Error detection
- Flow control
- MAC control

MAC Protocols

- CSMA/CD – Ethernet
- CSMA/CA – Wi-Fi

Switching Devices

- **Hub** – broadcasts to all
- **Switch** – forwards by MAC
- **Router** – forwards by IP
- **Bridge** – divides collision domains

11. Wireless Networks

Wi-Fi (802.11 Standards)

- 802.11a/b/g/n/ac/ax
- CSMA/CA + RTS/CTS

Bluetooth

- Short range, low power

Mobile Networks

- 2G, 3G, 4G, 5G
- LTE uses OFDM

12. Network Security

Common Attacks

- DoS/DDoS
- ARP Spoofing
- IP Spoofing
- Man-in-the-Middle
- Packet sniffing
- DNS poisoning

Security Tools

- Firewalls
- IDS/IPS
- VPN (IPsec)
- SSL/TLS

13. Application Layer Protocols

- **HTTP/HTTPS** – web
- **FTP/SFTP** – file transfer
- **SMTP/POP3/IMAP** – email
- **DNS** – name resolution
- **DHCP** – automatic IP assignment
- **SNMP** – network monitoring
- **SSH** – secure remote login

🌟 Ultra-Condensed Exam Summary

- **OSI Layers:** Physical → Application
- **TCP** reliable / **UDP** fast
- **IP addressing:** IPv4 = 32-bit, IPv6 = 128-bit
- **Routers = Network Layer**, Switch = Data Link
- **RIP (distance vector), OSPF (link state)**
- **Laptop IP = private range**, HTTPS = 443
- **Errors:** CRC detection, Hamming correction
- **CSMA/CD for wired Ethernet, CSMA/CA for Wi-Fi**