# Networks and Operating Systems

## Week 1:

### 1. What is a Network?

* A network is a system that connects multiple nodes (devices) to transfer information.
* Examples: The Internet, telephone networks, cellular networks, and sensor networks.

### 2. Characteristics of the Internet

* Global Connectivity: Connects users and devices worldwide.
* Decentralization: No single entity controls the entire Internet.
* Scalability: Can support an increasing number of users and devices.
* Interoperability: Uses common protocols (TCP/IP, HTTP, DNS).
* Real-time Communication: Supports messaging, video calls, and live streaming.
* Anonymity & Security Issues: Involves privacy concerns and cybersecurity threats.

### 3. Internet Structure – A Network of Networks

The Internet connects different networks through Internet Service Providers (ISPs).

Hierarchical structure:

* Tier 1 ISPs: Backbone providers (e.g., AT&T, NTT).
* Tier 2 ISPs: Regional providers connecting to Tier 1.
* Tier 3 ISPs: Local ISPs providing home and business Internet access.

Internet Exchange Points (IXPs) allow ISPs to interconnect.

### 4. Protocols and How Data Moves

Protocols define rules for communication (e.g., HTTP, TCP, WiFi).

Packet-Switching:

* Data is broken into packets before transmission.
* Packets travel through multiple routers before reaching the destination.
* Efficient and allows multiple users to share the network.

Circuit-Switching (used in telephone networks):

* A dedicated path is reserved for the entire call duration.
* Less efficient than packet-switching.

### 5. Network Core vs. Network Edge

* Network Edge: Where users and devices connect (homes, businesses, mobile devices).
* Network Core: The backbone of the Internet, consisting of interconnected routers and data centers.

### 6. Access Networks and Physical Media

Wired Networks:

* Fiber Optic (fastest, high bandwidth).
* Coaxial Cable (used for broadband).
* DSL (Digital Subscriber Line) (uses telephone lines).

Wireless Networks:

* WiFi (local area).
* Cellular (4G, 5G) (wide-area).
* Satellite Networks (global but high latency).

### 7. Packet Delay and Loss

* Transmission Delay: Time taken to send a packet.
* Queueing Delay: Packets wait in a router’s queue before transmission.
* Packet Loss: Occurs when packets are dropped due to congestion.

### 8. Reliability and Failure

* Networks have many components (routers, switches, software).
* A system with 50 components, each 99% reliable, has only a 39.5% chance of working perfectly.
* Solution: Redundancy and error correction.