

## Unit 1

### Computer Networks and the Internet

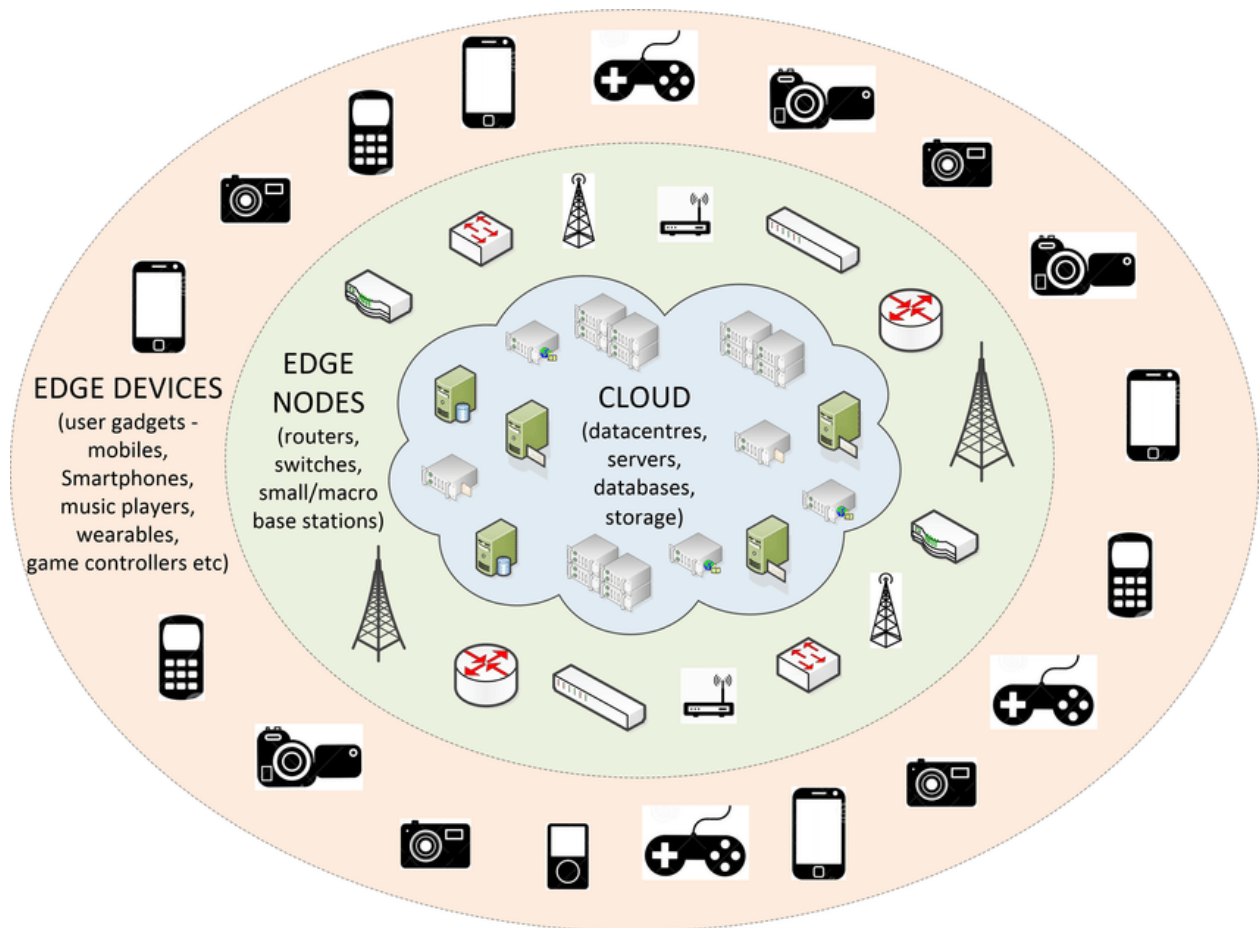
#### 1.1 The Internet

It is a collection of computers and other peripheral devices. The Internet is a global system of interconnected computer networks that use the standard Internet protocol suite (TCP/IP) to link devices worldwide. It serves as the backbone for numerous services, including the World Wide Web (WWW), email, file sharing, and more.



#### 1.2 The Network Edge

The network edge refers to the portion of a network that directly interfaces with end users or devices, serving as the boundary between local networks and the broader Internet or other external networks. This concept is critical in modern networking, particularly with the rise of edge computing and the need for low-latency, high-performance connectivity.



## Access Networks

Access networks are the crucial link between end users and the broader telecommunications infrastructure, enabling connectivity to the Internet and other services. These networks are fundamental for providing the "last mile" connection from Internet Service Providers (ISPs) to homes, businesses, and mobile users

## Physical Media

Physical media refers to the actual physical materials used to transmit data in a network. These materials can vary widely in their properties, applications, and performance characteristics.

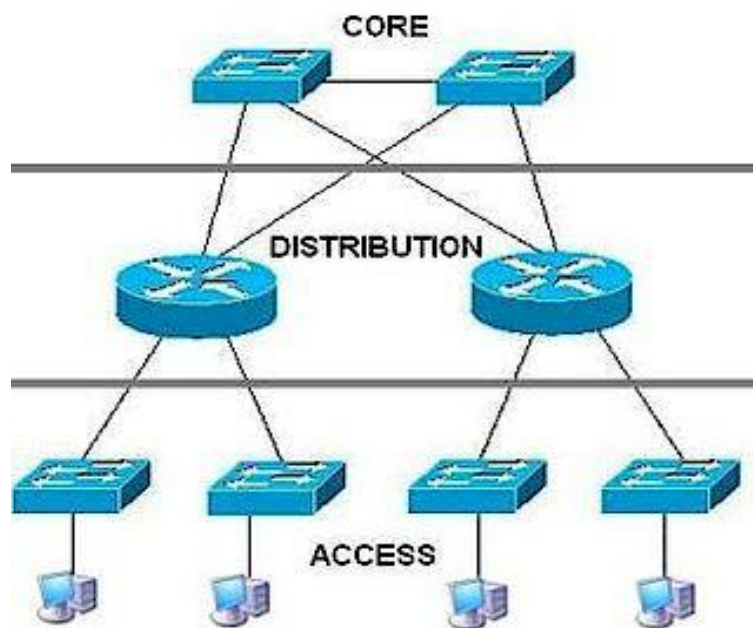
### 1.3 The Network Core

The network core is the central part of a telecommunications network that provides high-speed, high-capacity pathways for data to travel between different access networks and end points. It is responsible for routing large volumes of data efficiently and reliably across vast distances. In general, it follows three layers

1.Core layer

2.Distribution Layer

3. Access Layer



### Packet Switching

Packet switching is a data transmission method where messages are broken into smaller packets, sent independently over a network, and reassembled at the destination. Each packet contains part of the data and control information (e.g., source, destination, sequence number). This technique optimizes network resource use and provides high efficiency, scalability, and robustness.

## **Circuit Switching**

Circuit switching is a method of communication where a dedicated communication path or circuit is established between two endpoints for the duration of the connection. It is commonly used in traditional telephone networks.

### **1.4 Delay**

In networking, delay (or latency) refers to the time it takes for data to travel from the source to the destination. It is a critical factor in the performance and efficiency of network communications.

### **Loss**

In networking, loss refers to the failure of one or more transmitted packets to reach their intended destination. Packet loss can significantly affect the performance and reliability of a network.

### **Throughput in Packet-Switched Networks**

In packet-switched networks, throughput refers to the rate at which data is successfully transmitted from the source to the destination over a given period. It is a key measure of network performance and efficiency.

## **1.5 Protocol Layers and Their Service Models**

### **Protocol Layers**

Protocol layers refer to the hierarchical structure used in computer networks to facilitate communication between devices. Each layer serves a specific function and communicates with corresponding layers on other devices. The most referenced protocol stack is the OSI (Open Systems Interconnection) model, which consists of seven layers:

**1. Physical Layer:** This is the lowest layer, concerned with the physical transmission of data over the network medium. It defines the electrical, mechanical, and procedural specifications for transmitting data.

**2. Data Link Layer:** This layer deals with the reliable transmission of data across the physical link. It includes protocols for error detection, correction, and data framing. Ethernet and Wi-Fi are examples of data link layer technologies.

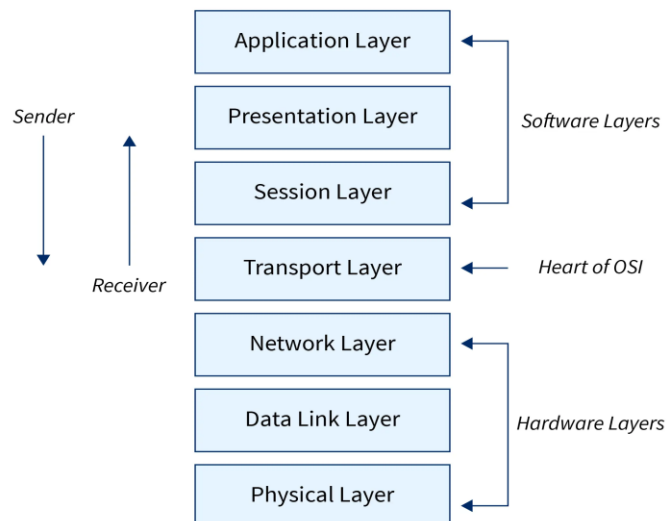
**3. Network Layer:** The network layer manages the routing of data packets from the source to the destination across multiple networks. IP (Internet Protocol) is a fundamental protocol at this layer, responsible for addressing and routing.

**4. Transport Layer:** This layer ensures end-to-end communication between devices. It manages the segmentation and reassembly of data, flow control, and error correction. TCP (Transmission Control Protocol) and UDP (User Datagram Protocol) operate at this layer.

**5. Session Layer:** The session layer establishes, maintains, and terminates connections between applications on different devices. It manages sessions and synchronization between communicating systems.

**6. Presentation Layer:** This layer handles data formatting and conversion, ensuring that information sent from one application can be properly interpreted by another. It deals with encryption, compression, and data translation.

**7. Application Layer:** The topmost layer, the application layer, provides network services directly to end-users and applications. Protocols like HTTP, SMTP, FTP, and DNS operate at this layer, facilitating functions such as web browsing, email, file transfer, and domain name resolution.



## Service Models:

- **Connection-Oriented Service:** Offers a reliable, ordered, and error-checked communication channel between sender and receiver. Examples include TCP (Transmission Control Protocol) in the transport layer.
- **Connectionless Service:** Provides an unreliable, unordered, and error-prone communication channel, where each packet is treated independently. Examples include UDP (User Datagram Protocol) in the transport layer.
- **Acknowledgment-Based Service:** Requires acknowledgment messages from the receiver to confirm successful data transmission. It ensures reliability but introduces overhead. TCP utilizes an acknowledgment-based service.
- **Best-Effort Service:** Offers no guarantees regarding data delivery or reliability. It's commonly used in connectionless protocols like UDP.
- **Flow-Control Service:** Regulates the rate of data transmission to prevent overwhelm or congestion in the network. It's often implemented at the transport layer.
- **Error-Control Service:** Detects and corrects errors in transmitted data, ensuring data integrity. It's typically included in connection-oriented protocols like TCP.

## Layered Architecture

The layered architecture in networking is a design framework that divides the complex process of data communication into manageable layers, each responsible for specific tasks. This approach facilitates standardization, interoperability, modularity, and scalability. The most referenced models for layered architecture are the OSI (Open Systems Interconnection) model and the TCP/IP (Transmission Control Protocol/Internet Protocol) model.

## Encapsulation

Encapsulation in networking refers to the process of adding headers (and sometimes footers) to data as it moves down through the layers of the OSI or TCP/IP model. Each layer adds its own header (and possibly a footer) to the data,

which contains control information relevant to the layer's function. This encapsulation is crucial for organizing data transmission and ensuring proper communication between network devices.

## **1.6. History of Computer Networking and the Internet**

The history of computer networking and the Internet is a journey of innovation that began in the 1950s with early concepts of time-sharing systems and packet switching theory. The 1960s saw the creation of ARPANET, the first operational packet-switching network, which connected multiple universities. The 1970s were marked by the development of key network protocols, including TCP/IP, which became the foundation of Internet communication. The 1980s witnessed the standardization and expansion of networks, with the introduction of the Domain Name System (DNS) and the creation of NSFNET. The 1990s ushered in the rise of the Internet with the invention of the World Wide Web by Tim Berners-Lee, the launch of the Mosaic web browser, and the commercialization of the Internet. The 2000s to the present day have seen the proliferation of broadband and wireless technologies, the emergence of social media and cloud computing, and the integration of the Internet into everyday life through mobile devices, IoT, and AI. This history highlights the Internet's transformation from a niche academic project to a global network essential to modern society.