🌐 Introduction to the Internet

The **Internet** is a **global system** of interconnected computer networks. It connects millions of computers and devices worldwide, forming a **"network of networks."** These computers may be of different types and belong to various organisations or individuals.

It allows the **sharing of information, data, and ideas** worldwide.

- It supports **fast communication**, **online research**, and **remote access** to resources.
- The Internet is **publicly accessible** – anyone with an internet connection can use it.

✉️ Use of the Internet in Communication

Communication is one of the **main uses** of the Internet. It has changed the way people interact.

Common Communication Tools:

1. **E-mail (Electronic Mail)** – Most widely used for sending messages instantly.
2. **Discussion Groups** – Online forums where users exchange ideas.
3. **Usenet News** – Public discussion boards are grouped by topic.
4. **Chat Groups / Messaging Apps** – Real-time text communication (e.g., WhatsApp, Telegram).
5. **Video Calling / Conferencing** – Face-to-face communication using tools like Zoom, Google Meet, etc.

- **Online Education** (e.g., YouTube, eLearning platforms)

- **Online Shopping** (e.g., Amazon, Flipkart)

- **Banking & Payments** (e.g., UPI, Internet Banking)

- **Social Networking** (e.g., Facebook, Instagram)
- **Government Services** (e.g., online form submission, Aadhaar updates)
- **Entertainment** (e.g., watching videos, listening to music, playing games)

📜 History of Internet

1. 1960s – The United States Department of Defence began a research project called ARPANET (Advanced Research Projects Agency Network).

2. 1969 – The first message was sent via ARPANET between the University of California, Los Angeles (UCLA) and Stanford University.

3. 1970s – TCP/IP (Transmission Control Protocol / Internet Protocol) was developed by Vinton Cerf and Robert Kahn.

4. 1983 – ARPANET adopted TCP/IP protocol, forming the basic structure of the Internet.

5. 1986 – NSFNET (National Science Foundation Network) replaced ARPANET and linked universities and research organizations.

6. 1991 – WWW (World Wide Web) was invented by Tim Berners-Lee at CERN (European Organization for Nuclear Research).

7. 1995 – The Internet was opened for commercial use, leading to the launch of websites, email, and online businesses.

8. 2000s onward – Rapid development of broadband, Wi-Fi (Wireless Fidelity), and smartphones

made the Internet easily accessible worldwide.

Computer Networks

Basics of Computer Networks

A Computer Network is a collection of computers and other devices connected to share resources (like files, printers, and the internet) and communication.
Examples: Internet, Office network, School Lab network, etc.

Types of Computer Networks

1. LAN – Local Area Network
2. MAN – Metropolitan Area Network
3. WAN – Wide Area Network
4. PAN – Personal Area Network

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1. LAN (Local Area Network)

- It is used to connect computers in a small geographical area, like office, home, school, or building.
- Example: Computer lab network.

Advantages of LAN:

- High data transfer speed.

- Low cost of setup.
- Easy to manage and maintain.
- Resource sharing (printer, files).

Disadvantages of LAN:

- Limited coverage area.
- Security issues.
- Regular maintenance is needed.

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2. MAN (Metropolitan Area Network)

- Covers a larger area than LAN, like an entire city.
- Connects multiple LANs within a city.
- Example: Cable TV network.

Advantages of MAN:

- Covers a larger area than LAN.
- Fast data communication within the city.
- Useful for government and educational institutions.

Disadvantages of MAN:

- Higher setup cost than LAN.
- Complex management.
- Data security risks.

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3. WAN (Wide Area Network)

- Covers vast geographical areas, like states and countries.
- Connects multiple LANs and MANs.
- Example: The Internet is the biggest WAN.

Advantages of WAN:

- Covers a very large area.
- Enables global communication.
- Centralised data and services.

Disadvantages of WAN:

- Very high cost.
- Slower speed compared to LAN.
- Complex design and security challenges.

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4. PAN (Personal Area Network)

- Covers a very short range, typically a few meters.
- Used by a single person to connect personal devices.

- Example: Bluetooth, Hotspot.

Advantages of PAN:

- Easy to use and manage.
- Very low cost.
- Good for personal data sharing.

Disadvantages of PAN:

- Limited range.
- Limited number of devices.
- Interference from other wireless devices.

Difference between LAN, MAN, and WAN:

Feature	LAN	MAN	WAN
Area Covered	Small (Building, Office)	Medium (City)	Large (Country, World)
Speed	High	Medium	Comparatively Low
Cost	Low	Medium	High
Ownership	Private	Private or Public	Mostly Public or Multiple owners
Examples	Office network	Cable TV network	Internet

Network Transmission Media

Transmission media are the pathways through which data travels in a network.

Types of Network Transmission Media:

1. Guided Media (Wired)
2. Unguided Media (Wireless)

Guided Media is transmitting data signals through a physical path, such as cables or wires. These are also called **wired transmission media.**

Below are the most commonly used types:

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1. Twisted Pair Cable

- **Definition:** This cable consists of two insulated copper wires twisted around each other. The twisting reduces interference from other nearby cables.

- **Types:**
  - **Unshielded Twisted Pair (UTP)** – commonly used in LANs and telephone lines.
  - **Shielded Twisted Pair (STP)** – has a metallic shield to protect against interference.
- **Uses:**
  - Telephone networks
  - Local Area Networks (LAN)
- **Speed & Distance:**
  - Moderate speed (up to 1 Gbps)

  - Limited distance (up to 100 meters)

Example: Used to connect computers in offices or homes using LAN.

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2. Coaxial Cable

- **Definition:** This cable has a central core conductor made of copper, surrounded by insulation, a metallic shield, and an outer insulating layer.
- **Structure:**
  - Central copper wire (carries data)
  - Plastic insulation
  - Metallic shield (prevents signal loss)
  - Outer cover
- **Uses:**
  - Cable TV transmission
  - Older computer networks
- **Speed & Distance:**
  - Higher bandwidth than twisted pair
  - Can carry signals up to several kilometres.

Example: Used by cable TV companies to deliver television services.

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3. Fibre Optic Cable

- **Definition:** This cable transmits data as light pulses through glass or plastic fibres.
- **Structure:**
  - Core (carries the light signals)

    - Cladding (reflects light into the core)
    - Protective outer coating
- **Uses:**
    - High-speed internet
    - Long-distance telephone and data communication

- **Advantages:**

    - Extremely high bandwidth (up to Tbps)
    - Can transmit data over **long distances** without signal loss
    - Immune to electromagnetic interference

Example: Used by ISPs (Internet Service Providers) to deliver ultra-fast broadband internet.

Comparison Table

Feature	Twisted Pair	Coaxial Cable	Fiber Optic Cable
Medium	Copper wires	Copper + Shielding	Glass or plastic
Speed	Moderate (Mbps–Gbps)	Medium (up to Gbps)	Very high (Gbps–Tbps)
Distance	Up to 100 meters	Few kilometers	Tens of kilometers

Interference	High	Moderate	Very Low
Cost	Low	Medium	High

2. Unguided Media (Wireless Media)

Unguided transmission means data is sent without any physical medium (like cables). It mainly has three types:

1. Radio Waves
2. Microwaves
3. Infrared

Radio Waves:

- These are electromagnetic waves that travel in all directions
- They are omnidirectional, meaning signals spread everywhere.
- Frequency range: 3KHz to 1GHz.
- No fixed path is needed, so any antenna can receive the signal.
- Uses: FM radio, TV, cordless phones, etc.
- Best for multicasting (one sender, many receivers).

Example of Radio Waves:

- FM radio is a good example. The radio waves bounce between the Earth's surface and ionosphere, allowing signals to travel long distances.

Applications of Radio Waves:

- Used in broadcasting (TV, radio).
- Great for wireless communication.

Microwaves:

Microwaves are also electromagnetic waves, but have higher frequencies than radio waves. There are two types:

1. Terrestrial Microwaves (Used for communication between towers on land)
2. Satellite Microwaves (Used for satellite communication in space

Terrestrial Microwave Transmission:

Definition:
Terrestrial communication is the transmission of information using ground-based stations, antennas, or towers, typically employing microwaves or radio waves.

- Uses antennas placed at high locations (like towers or rooftops).
- Signals travel in a straight line (not in all directions like radio waves).

2) Satellite Microwave Communication

- A satellite is an object that orbits the Earth at a fixed altitude.

- More reliable than cables and fibre optics because it provides more flexibility.
- We can communicate anywhere in the world using satellite communication.
- Used for TV broadcasting, GPS, and global communication.

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3) Infrared Communication

- Wireless technology used for short-range communication.
- Frequency range: 300GHz to 400THz.
- Used for data transfer between mobile phones, TV remotes, and computers in closed areas.

Characteristics of Infrared:

✔ High bandwidth → Very fast data transfer.
✔ Cannot pass through walls → So, communication stays within a single room.
✔ More secure → Less interference from external signals.
✔ Not reliable outdoors → Sunlight can interfere with infrared signals.

Computer Network Architecture

What is Computer Network Architecture?

- It refers to the physical and logical design of a network.
- Includes software, hardware, protocols, and transmission media.
- It defines how data flows in a network.

Types of Computer Network Architecture:

1. Peer-to-Peer (P2P) Network
2. Client-Server Network

1) Peer-to-Peer (P2P) Network

- In this type of network, every device (node) acts as both a client and a server.
- No dedicated servers → Each device shares its own resources.
- Works best in small environments (usually up to 10 computers).
- Each computer needs special permissions to share resources.

Example: File-sharing networks like BitTorrent

Client-Server Network

What is a Client-Server Network?

- A centralised network model where a central computer (server) manages resources.
- Clients (end users) access data like songs, videos, and files from the server.
- The server handles security, network management, and major operations.
- Clients communicate with each other through the server.
- Best suited for large networks.

Advantages of Client-Server Network

✔ Centralised system → Easy data backup.
✔ Dedicated server → Better performance.
✔ Improved security → Single server manages access.
✔ Faster resource sharing.

Diagram

OSI Model

Imagine you want to **send a letter to your friend.** But this is not just any letter—it's a magical letter that goes through **7 steps** before reaching your friend!

👉 **The OSI Model (Open Systems Interconnection Model)** is just like that. It is a set of **7 layers** that help computers send and receive data over the internet correctly.

🎭 The 7 Magical Steps (OSI Layers)

1️⃣ Physical Layer – "Roads and Wires"

- Just like a mail carrier (postman) needs **roads, vehicles, and mailboxes** to deliver a letter, computers need **cables, Wi-Fi signals, and network hardware** to send data.

2️⃣ Data Link Layer – "The Local Street"

- This layer makes sure that data moves correctly from one stop to another.
- It's like checking if the letter is moving **through the correct street** before reaching the next destination.

3️⃣ Network Layer – "Finding the Address"

- This layer decides **which city and house** the letter should go to.

- In computers, this works like an **IP Address (e.g., 192.168.1.1)**, which helps data reach the correct destination.

4️⃣ Transport Layer – "Safe Delivery"

- It ensures the data reaches safely without **getting lost** or **arriving in the wrong order**.
- Think of sending a **5-page letter**—this layer makes sure **all pages arrive in the correct order**.

5️⃣ Session Layer – "Keeping the Conversation Going"

- This layer opens and closes communication.
- Imagine calling your friend—this layer makes sure the **call stays connected** while you talk.

6️⃣ Presentation Layer – "Understanding the Message"

- If your friend doesn't speak your language, you **translate** for them, right?
- This layer **converts data into a format** (like JPG, MP3, or video) so that the computer can understand it.

7️⃣ Application Layer – "Reading the Letter"

- Finally, your friend **opens the letter and reads it**.
- This layer is what **you use every day**—like **Google Chrome, WhatsApp, and YouTube**.

🎯 Simple Example

Imagine you send a **WhatsApp message** to your friend. It goes through all the OSI model layers:
✅ The app (Application Layer) lets you type the message.
✅ The data is converted into the right format (Presentation Layer).
✅ A connection is made (Session Layer).
✅ The message is broken into packets and sent correctly (Transport Layer).
✅ The system finds the correct IP address (Network Layer).
✅ The data moves through Wi-Fi or cables (Data Link & Physical Layers).

Finally, your message reaches your friend! 🎉

Network Protocols -

🖥️ What is a Protocol?

A **protocol** is a **set of rules** that computers follow to communicate over a network. It ensures that data is sent and received correctly.

just like traffic rules help cars move safely on the road

For example, when you send a WhatsApp message, different protocols work together to deliver it to your friend.

1️⃣ Network Communication Protocols

These protocols help computers exchange data over a network.

- **Transmission Control Protocol (TCP):** Ensures data is delivered without errors and in the correct order. It verifies that all packets have reached their intended destinations. Example: Downloading a file or watching a YouTube video.

- **User Datagram Protocol (UDP):** This protocol sends data quickly but does not check for errors. It is used when speed is more important than accuracy, such as in online gaming or video calls.

- **Internet Protocol (IP):** Helps identify devices on a network by assigning them unique addresses. Example: Sending an email to a specific address on the internet.

2️⃣ Security Protocols

These protocols ensure data security and protect it from hackers.

- **HyperText Transfer Protocol Secure (HTTPS):** An encrypted version of HTTP that ensures safe communication between a web browser and a website.

  Example: Online banking or shopping.

- **Secure Sockets Layer (SSL) / Transport Layer Security (TLS):** Encrypts data to keep online transactions and communications secure. Example: Protecting passwords on login pages.

- **Internet Protocol Security (IPSec)** provides security for Internet traffic. It is often used in Virtual Private Networks (VPNs). An example is secure **remote access to a company's network.**

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3 File Transfer Protocols

These protocols are used to upload and download files between devices.

- **File Transfer Protocol (FTP):** This protocol transfers files between computers over a network. An example is uploading website files to a web server.
- **Secure File Transfer Protocol (SFTP):** A secure version of FTP that encrypts files during transfer. Example: Downloading confidential documents.
- **Trivial File Transfer Protocol (TFTP):** A simpler and faster file transfer protocol used mainly in networking devices. Example: Transferring configuration files to routers.

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5 Email Protocols

These protocols manage the sending and receiving of emails.

- **Simple Mail Transfer Protocol (SMTP):** Used to send emails from an email client to a mail server. Example: Sending an email from Gmail.
- **Post Office Protocol v3 (POP3):** Downloads emails to a device and removes them from the server. Example: Checking emails offline on a desktop email client.
- **Internet Message Access Protocol (IMAP):** Allows users to read emails without downloading them. Example: Accessing emails from multiple devices like a phone and a laptop.

6️⃣ Web Browsing Protocols

These protocols help in loading web pages and browsing the internet.

- **HyperText Transfer Protocol (HTTP):** Fetches web pages from servers and displays them in a browser. Example: Opening a news website.
- **HyperText Transfer Protocol Secure (HTTPS):** A secure version of HTTP that protects user data. Example: Logging into Facebook or online banking.
- **Domain Name System (DNS):** Translates human-readable website names (e.g., google.com) into numerical IP addresses. Example: Opening a website without typing its IP address.
- **Dynamic Host Configuration Protocol (DHCP):** Automatically assigns IP addresses to devices in a network.

  Example: Connecting to Wi-Fi without manually entering network details.

📌 Summary

Protocols are essential for different types of network activities:
✔ **TCP/IP** helps transfer data over the internet.
✔ **HTTP/HTTPS** allows browsing websites securely.
✔ **SMTP, POP3, and IMAP** manage email communication.
✔ **FTP/SFTP** is used for file transfers.

✔ **DNS and DHCP** help with internet connectivity.

WWW (World Wide Web)

The **World Wide Web (WWW)** is a system of **interconnected web pages** that can be accessed through the **Internet** using a **web browser. Tim Berners-Lee presented the concept of www in 1989.**

Key Components of the WWW:

1. **Website** – A collection of related web pages.
2. **Web Page** – A single document on the internet (e.g., about.html).
3. **Web Browser** – A software to access websites (e.g., Chrome, Firefox).
4. **Search Engine** – A tool to find websites (e.g., Google, Bing).

Website Address & Web Page

- **Website Address (URL):** The **unique location** of a website on the internet. Example: https://www.wikipedia.org
- **Web Page:** A single document displayed on a website. Example: Wikipedia's homepage.

URL (Uniform Resource Locator)

A **URL** is the complete address of a webpage.

Example:
https://www.example.com/products.html

Types of URLs:

- **Absolute URL** → The **full** web address, including domain & file name.
  - Example: https://www.example.com/about.html

- **Relative URL** → A **shorter** link that works within the same website.
  - Example: /about.html (works inside example.com).

Domain Name & ISP

Domain Name:

A domain name is the **name of a website.**
Example: www.google.com, www.facebook.com

The structure of a URL (Uniform Resource Locator) consists of several components:

1. Scheme (Protocol) – Specifies how to access the resource (e.g., http://, https://, ftp://).

2. Host (Domain Name or IP Address) – Identifies the website or server (e.g., www.example.com).

3. Port (Optional) – Specifies the communication port (default: 80 for HTTP, 443 for HTTPS).

4. Path – Indicates the specific resource or page (e.g., /about-us).

5. Query Parameters (Optional) – Provides additional data using ?key=value pairs (e.g., ?id=10&name=raj).

6. Fragment (Optional) – Identifies a section within a page using # (e.g., #section1).

Example URL Breakdown:

https://www.example.com:8080/products?id=123

Scheme(Protocol): https://

Host: www.example.com

Port: 8080

Path: /products

Query: ?id=123

Fragment: #reviews

Common Domain Extensions:

- .com → Commercial websites (Google, Amazon)
- .org → Organizations (Wikipedia, NGOs)
- .edu → Educational institutions (Harvard.edu)
- .gov → Government websites (India.gov.in)

ISP (Internet Service Provider):

An ISP is a company that **provides internet access**.
Examples: Jio, Airtel, BSNL, Vodafone.

Circuit-Switched vs. Packet-Switched Services

Circuit-Switched Network:

- A **dedicated connection** is established between sender and receiver.

- Used in **old telephone networks**.
- Example: Landline calls.

Packet-Switched Network:

- Data is divided into **small packets** and sent separately.
- Used in **modern internet communication**.
- Example: Email, WhatsApp, YouTube.

Addressing System: IP Address, MAC, IMEI

Every device has a **unique address for communicating over the internet**.

1. IP Address (Internet Protocol Address)

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1. What is an IP Address?

IP stands for Internet Protocol.
An IP address is a unique numerical label assigned to each device connected to a computer network that uses the Internet Protocol for communication.

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2. Format of IP Address

- An **IPv4 address** is made up of **32 bits**.

- These 32 bits are divided into **4 parts**, called **octets**.

- Each **octet** = 8 bits.
- Each **octet** is written in **decimal format** and separated by **dots (.)**.

Example:

- 192.168.1.1

This is one IP address. Each number (192, 168, 1, 1) is an octet.

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3. Value Range of Each Octet

- Each octet can range from **0 to 255** (since 8 bits can represent 2^8 = 256 values).

Example Ranges:

- 0.0.0.0 to 255.255.255.255

So, **valid IPs** include:

- 10.0.0.1
- 172.16.254.3
- 192.168.0.255

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4. Static vs Dynamic IP Address

Type	Description
Static	Fixed IP address that does not change. Good for servers and printers.
Dynamic	IP address assigned temporarily by DHCP. Changes every time you connect.

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5. Recap (Quick Notes)

- IP Address is a 32-bit number
- Divided into **4 octets**
- Each octet = **8 bits** = 1 byte
- Values range: **0 to 255**
- Separated by **dots**
- Written in **decimal format**

- Two types: **Static** and **Dynamic**
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1. What is a MAC Address?

MAC stands for Media Access Control.

It is a unique hardware identifier assigned to every network interface card (NIC) by the manufacturer.

- **MAC address is used to identify devices on a local network (LAN).**
- **It works at the Data Link Layer (Layer 2) of the OSI model.**

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2. Format of MAC Address

- **A MAC address is 48 bits long.**
- **It is represented as 12 hexadecimal digits.**
- **These are usually written in six groups of two characters, separated by colons (:) or hyphens (-).**

Format Example:

00:1A:2B:3C:4D:5E

or

00-1A-2B-3C-4D-5E

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8. Recap (Quick Notes)

- **MAC = Media Access Control**
- **Unique 48-bit hardware address**
- **Format: 00:1A:2B:3C:4D:5E**
- **Works on Data Link Layer (Layer 2)**
- **Permanent ID for local device recognition**

3. IMEI (International Mobile Equipment Identity)

- A **15-digit unique number** assigned to every mobile phone.
- Used to **track stolen phones.**

Modes of Connecting to the Internet

There are **various ways** to connect to the internet.

1. Hotspot

- Uses **mobile data** to create a **Wi-Fi connection** for other devices.

2. LAN Cable (Ethernet)

- A **wired connection** is used in offices and gaming.
- More **stable and faster** than Wi-Fi.

3. Wi-Fi Connection

- Wireless internet using a **router**.
- Used in homes, offices, and public places.

4. Broadband Connection

- High-speed internet through **fiber-optic, DSL, or cable**.
- Examples: JioFiber, Airtel Xstream.

5. USB Tethering

- Connects a mobile phone to a **computer via USB** to share internet.

Web Browsers

A **web browser** is software used to **access websites**.

Popular Web Browsers:

Browser	Developer
Google Chrome	Google

Mozilla Firefox	Mozilla
Microsoft Edge	Microsoft
Safari	Apple
Opera	Opera Software

Functions of a Web Browser:

- Load and display web pages.
- Save bookmarks for easy access.
- Store browsing history.
- Allow private browsing (Incognito Mode).

Search Engine & How It Works

A **search engine** is a program that helps users **find information** on the web.
Examples: **Google, Bing, Yahoo**

1. Web Crawling

- Search engines use **bots (crawlers)** to **scan** websites.

2. Indexing

- The scanned data is **organized** into a **database**.

3. Search Algorithm

- Uses **mathematical formulas** to rank search results.
- Factors include **keywords, website popularity, and relevance**.

4. Popular Search Engines

- **Google** – Most used search engine.
- **Bing** – Microsoft's search engine.
- **Yahoo** – Once popular, now less used.
- **DuckDuckGo** – Privacy-focused, does not track users.

🌐 What is the Internet?

The Internet is a global network that connects millions of computers and devices around the world. It allows users to access websites, communicate via email and messaging, watch videos, use apps, and much more. It is public, meaning anyone with a connection can use it.

Examples:

Searching on Google

Watching videos on YouTube

Chatting on WhatsApp

Shopping on Amazon

🏢 What is an Intranet?

An Intranet is a private network that is used only within an organisation such as a company, school, or government office. It helps employees or members to communicate, share documents, access internal information, and work efficiently. Only authorized users can access it, usually with a username and password.

Examples:

Logging into a school staff portal

Accessing company HR policies from the office network

Viewing employee attendance dashboard in a company