UNIT II

PHYSICAL LAYER AND DATA LINK LAYER

Introduction to Data Transmission

Data transmission is the process of sending and receiving data between two or more devices over a communication medium. This transfer can occur over wired channels (like fiber optic cables) or wireless channels (like Wi-Fi or cellular networks).

Core Components

A basic data transmission system involves five key components:

- **Message**: The data or information to be communicated (text, audio, video, etc.).
- **Sender**: The device that originates and sends the data message (e.g., computer, smartphone).
- **Receiver**: The device that receives the message (e.g., printer, server).
- **Transmission Medium**: The physical path or channel the message travels through (e.g., cable, airwaves).
- **Protocol**: A set of rules that governs how the data is formatted, sent, and received, ensuring clear and accurate communication.

Types of Data Transmission

Data transmission is categorized by the direction of the data flow and the method of sending the data.

Type	Description	Example
Simplex	Data flows in only one direction (unidirectional).	Radio or TV broadcast
Half-Duplex	Data flows in both directions, but only one way at a time.	Walkie-talkie conversation
Full-Duplex	Data flows in both directions simultaneously (bidirectional).	A standard telephone call or broadband connection

Transmission Methods

Data can be moved in one of two main ways:

- **Serial Transmission**: Data is sent bit by bit over a single channel. It is generally slower but more reliable over longer distances and requires fewer wires.
- **Parallel Transmission**: Multiple bits are sent simultaneously over multiple channels. This method is faster but more susceptible to interference over long distances and more expensive due to the need for multiple wires.

Key Factors and Impairments

Several factors affect the speed and quality of data transmission:

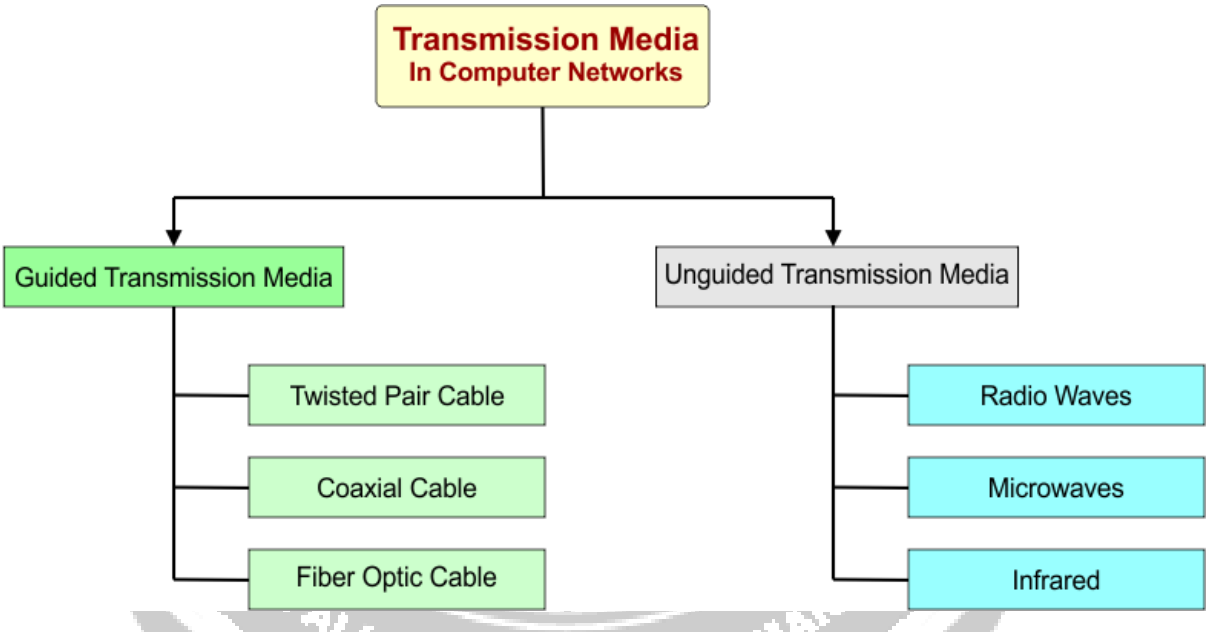
- **Bandwidth**: The maximum amount of data that can be transmitted over a medium in a fixed amount of time; higher bandwidth allows for faster data rates.
- **Latency**: The delay between the sender initiating a transfer and the data actually arriving at the receiver.
- **Transmission Impairments**: Signals can be distorted during transmission due to three primary issues:
  - **Attenuation**: Loss of signal strength (energy) as it travels over distance.
  - **Distortion**: The signal's shape changing, causing different frequency components to arrive at different times.
  - **Noise**: Unwanted signals or interference from external sources (e.g., static, crosstalk) that corrupt the data.

To ensure data integrity, various error detection and correction schemes, such as parity checks and checksums, are used to identify and manage errors introduced during the transmission process.

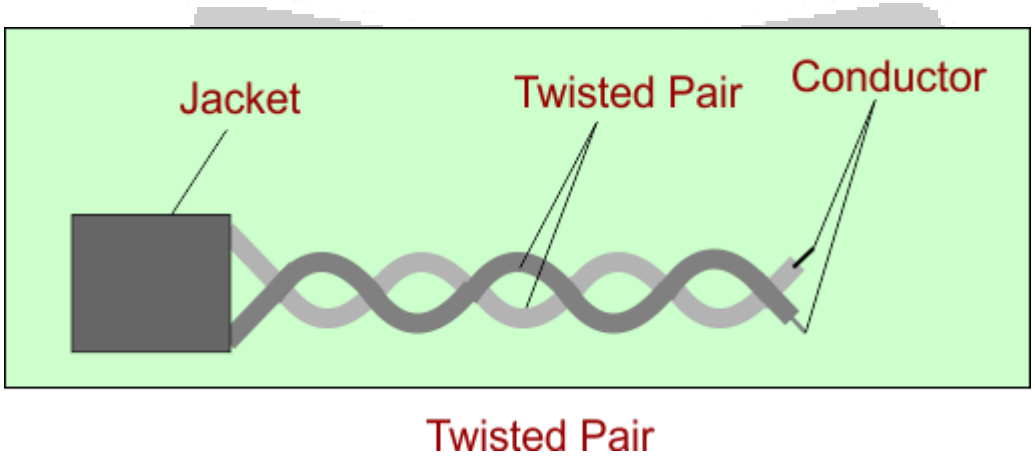
Guided Media: Twisted Pair, Coaxial Cable, Fiber Optic, Unguided (RF, Microwave, Satellite)

Guided Media

Guided media, also known as wired or bounded media, confine the signal within a physical pathway, providing a secure and reliable connection with minimal signal loss over certain distances.



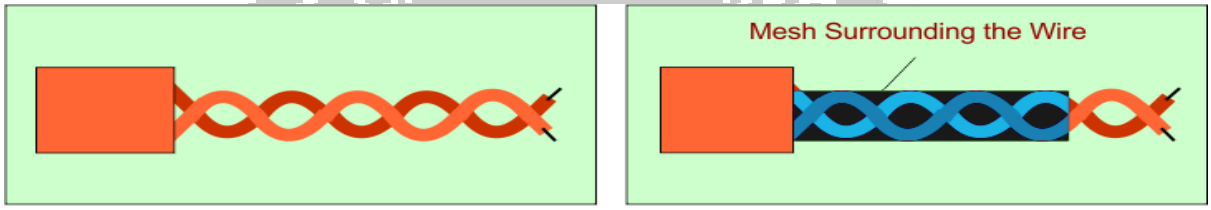
- **Twisted Pair**: Consists of two insulated copper wires twisted together to reduce electromagnetic interference (EMI) and crosstalk. It is a widely used and cost-effective option.



Twisted Pair

- **Types**: Unshielded Twisted Pair (UTP) and Shielded Twisted Pair (STP).

- **Unshielded Twisted Pair (UTP)** consists of pairs of insulated copper wires twisted together without any shielding around them to block external interference.
- **Shielded Twisted Pair (STP)** features additional shielding around the wires to minimize electromagnetic interference (EMI).



- **Applications**: Commonly used in local area networks (LANs) (e.g., Ethernet) and traditional telephone lines.

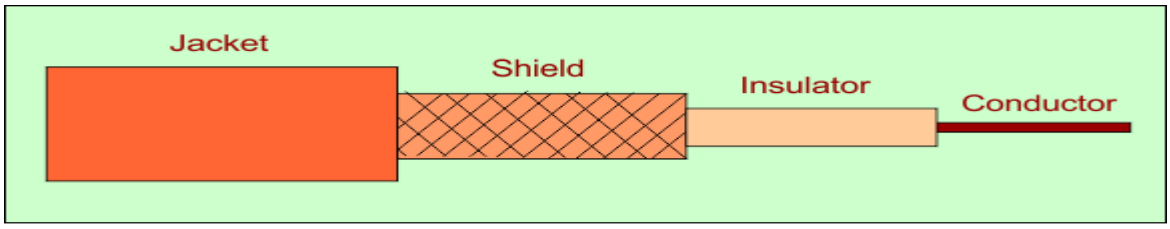
- **Coaxial Cable**

- **Description**: Features a central copper conductor, an inner insulator, a concentric conducting shield (metal foil or braid), and an outer protective jacket. This design offers better shielding against EMI than twisted pair cable.

There are two main types of **Coaxial Cable**:

- **Standard Coaxial Cable**: This is the most common type, which consists of the central copper core, insulation, metal shielding, and the outer jacket.
- **Shielded Coaxial Cable**: This variant features additional layers of shielding, such as a foil wrap or braided wire mesh, to provide extra protection against signal degradation and external interference.

Coaxial cables are widely used in applications where signal integrity is important, such as in **cable television (CATV)**, **broadband internet connections** (via cable modems), **CCTV security systems**, **satellite communications**, and **RF (radio frequency) transmission**. Their ability to maintain high-quality signal transmission over longer distances, combined with their shielding, makes them ideal for these applications.

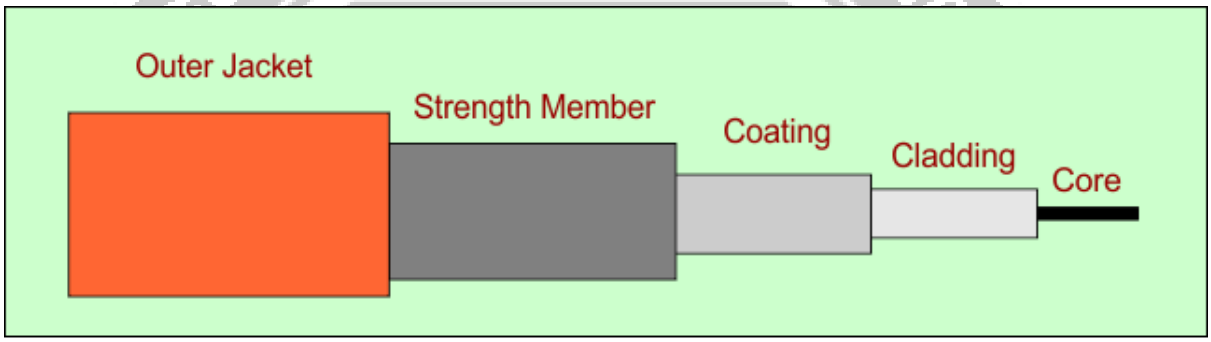


Coaxial Cable

- **Applications**: Heavily used for cable television systems, broadband internet connections, and some older LAN configurations.

- **Fiber Optic**

- **Description**: Transmits data in the form of light pulses through very thin strands of glass or plastic fiber. The core is surrounded by a cladding with a lower refractive index to ensure total internal reflection, keeping the light signal contained.



Fiber Optic

- **Single-modefiber(SMF):**
  It has a small core and allows only one mode of light to travel, making it suitable for long-distance communication with higher bandwidth and minimal signal distortion.

- **Multi-modefiber(MMF):**
  It has a larger core and allows multiple light modes to propagate, which is ideal for shorter distances due to modal dispersion that can affect signal quality over long ranges.

Fiber optic cables are widely used in internet backbone connections, cable television (CATV), high-speed data networks, medical imaging, and industrial applications due to their high bandwidth capacity, resistance to electromagnetic interference, and secure data transmission.