SIT 202 COMPUTER NETWORKS AND COMMUNICATION

PHYSICAL LAYER LESSON REVIEW :

What is physical layer ?

The physical layer is the bottom layer in the TCP/IP protocol stack and is responsible for the actual transmission of raw data over a physical medium. Its main functions include:

1. **Data Transmission**: Converts data into electrical, optical, or radio signals for transmission.

2. **Signal Encoding**: Defines how bits are represented (e.g., voltage levels for electrical signals).

3. **Medium Specifications**: Determines the characteristics of the physical medium (e.g., cables, fiber optics, wireless).

4. **Synchronization**: Ensures that the sender and receiver are synchronized for accurate data transmission.

5. **Physical Topology**: Establishes the layout of devices in a network (e.g., star, ring).

Example

Consider a simple scenario of sending a text message from your smartphone to a friend’s phone:

1. **Data Creation**: You type a message (data).

2. **Signal Conversion**: The physical layer converts this text into a series of electrical signals.

3. **Transmission Medium**: These signals travel through the air as radio waves (if using cellular or WiFi) or through cables (if using a wired connection).

4. **Reception**: The receiving phone's physical layer captures these signals and converts them back into readable text.

In this example, the physical layer is crucial for ensuring that your message travels successfully from one device to another.

NOTE : in physical layer , bits are sent as signals over channels

How ?

1. **Electrical Signals**: In wired connections, bits are represented as voltage levels (high/low) or current variations.
2. **Optical Signals**: In fiber optics, bits are encoded as light pulses (on/off) transmitted through glass fibers.
3. **Radio Waves**: In wireless communications, bits are modulated onto radio waves through techniques like amplitude or frequency modulation.

These signals are then sent over the appropriate medium (copper wires, fiber optics, or air) to reach the destination, where they are decoded back into bits.

HUB , SWITCH , ROUTER – DIFFERENCES IN FUNCTIONS , OPERATIONS AND EFFICIENCY

Hub:

- **Function**: Connects multiple devices in a network.
- **Operation**: Operates at the physical layer, broadcasting incoming data packets to all ports.
- **Efficiency**: Less efficient; all devices share bandwidth, which can lead to collisions.

Switch:

- **Function**: Connects devices within a local area network (LAN).
- **Operation**: Operates at the data link layer; forwards data only to the specific device (MAC address) it’s intended for.
- **Efficiency**: More efficient than a hub; reduces collisions and improves overall network performance.

Router:

- **Function**: Connects different networks and directs data between them.
- **Operation**: Operates at the network layer; uses IP addresses to determine the best path for forwarding data.
- **Efficiency**: Manages traffic between networks, enabling communication across the internet and different subnetworks.

TRANSMISSION MEDIUM :

- **Wired (guided medium)**: copper cable and fibre optics
- **Wireless (unguided medium)**: WiFi (Wireless LAN), 4G and 5G are examples for wireless technologies

COPPER CABLE , FIBRE OPTICS : (WIRED)

Copper Cable

Copper cables were among the earliest physical mediums utilized in computer networks. There are various types of copper cables, including shielded twisted pair, unshielded twisted pair, and coaxial. Copper is a cost-effective choice compared to fiber optics, but it has limitations; signals cannot travel long distances and have a restricted range. Physical layer standards outline the specifications for cabling and connectors, such as the Ethernet standard (IEEE 802.3), which applies to both copper and fiber optic cables.

Fibre Optics

Fibre optics represent another wired medium in computer networks, offering several advantages over copper cables. They can transmit signals over long distances without being affected by electromagnetic interference, and they support higher capacity and faster data transfer rates. However, a notable downside is the higher cost associated with deployment. The diameter of an optical fiber is smaller than a human hair, allowing each fiber trunk to accommodate many fibers. Currently, fiber optics are extensively used in access networks, core networks, and data centers.

WIRELESS :

Wireless technologies are favored for their key advantage: mobility. Unlike wired mediums, wireless is an unguided medium that transmits electromagnetic signals without physical connections. However, wireless communication is generally less secure than copper or fiber optics and can be more susceptible to noise.

Types of Wireless Transmission:

- **Infrared**: Short-range communication using infrared light, often for remote controls.
- **Cellular Radio**: Uses radio waves for mobile communication over large areas (e.g., smartphones).
- **Microwaves**: High-frequency radio waves for long-distance communication, often used for satellite and point-to-point links.
- **mmWave**: Very high-frequency waves used for high-speed data transmission, particularly in 5G networks.

Wireless and Mobile Networks

WLAN (Wireless Local Area Network): A WLAN connects devices within a limited area, such as a home or office, using Wi-Fi technology to provide wireless internet access.

4G and 5G:

- **4G**: The fourth generation of mobile networks, offering improved data speeds and better connectivity compared to previous generations.
- **5G**: The fifth generation, providing even faster speeds, lower latency, and the capacity to connect a massive number of devices, enabling advancements in IoT and smart technologies.