Batch: D2 Roll No.: 16010123325

Experiment / assignment / tutorial No.___1___

Grade: AA / AB / BB / BC / CC / CD /DD

Signature of the Staff In-charge with date

Experiment No. 1

TITLE: Study of Networking devices (Hub, router, Gateway, Switch etc.) and Transmission Media

---

AIM: To study different Networking devices and transmission media used in day to day networks.

Expected Outcome of Experiment:

CO:

Books/ Journals/ Websites referred:

1. A. S. Tanenbaum, “Computer Networks”, Pearson Education, Fourth Edition
2. B. A. Forouzan, “Data Communications and Networking”, TMH, Fourth Edition

---

Pre Lab/ Prior Concepts: Basics of LAN and Connecting devices

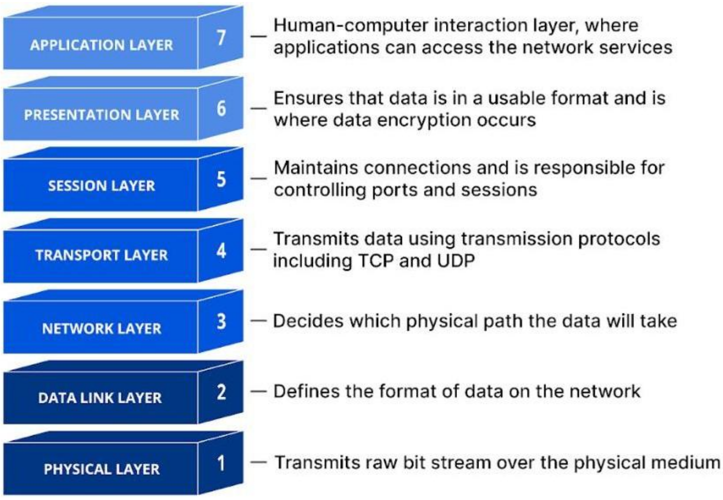
---

New Concepts to be learned: Layer wise connecting devices

Stepwise-Procedure:

Modern IT infrastructure consists of various interconnected network components that make communication and resource sharing possible throughout your organization. Whether securing sensitive data, facilitating collaboration, or simply ensuring uninterrupted access, a network of devices is at play - and the elements of these devices are critical to a business's successful operation.

The **OSI (Open Systems Interconnection) model** is a conceptual framework that standardizes communication functions of a networking or computing system into seven abstraction layers. Each layer has specific roles and interacts strictly with the layers directly above and below it.



Each layer of the OSI Model handles a specific job and communicates with the layers above and below itself. DDoS attacks target specific layers of a network connection; application layer attacks target layer 7 and protocol layer attacks target layers 3 and 4.

.

Study of Connecting Devices

1. Hub

- **Functionality:**
  Connects multiple devices in a Local Area Network (LAN) by broadcasting incoming data packets to all ports, regardless of the destination. Primarily used to share bandwidth among connected devices.

- **How it Works:**
  Operates at the **Physical Layer (Layer 1)** of the OSI model. When it receives a signal from one device, it regenerates and transmits the signal to all other ports. It does not filter or manage traffic, so collisions can occur.
- **Example:**
  An 8-port Ethernet hub used in small home or office LANs.
- **OSI Layer:** Layer 1 (Physical)

2. Repeater

- **Functionality:**
  Extends the range of a network by regenerating and amplifying signals that have weakened due to distance or interference.
- **How it Works:**
  Works purely at the **Physical Layer (Layer 1)**. The repeater receives a weakened or distorted electrical signal, regenerates it to its original strength, and retransmits it to the next segment.
- **Example:**
  Wi-Fi signal repeater used to extend wireless coverage in a building.
- **OSI Layer:** Layer 1 (Physical)

3. Switch

- **Functionality:**
  Connects devices within a single network segment and forwards data frames only to the intended recipient device by using MAC addresses, thereby reducing collisions and improving efficiency.
- **How it Works:**
  Primarily operates at the **Data Link Layer (Layer 2)**. It maintains a MAC address table to learn which devices are connected to which ports. Upon receiving a frame, it forwards it only to the port matching the destination MAC address.
  Advanced **Layer 3 switches** combine switching (Layer 2) with routing (Layer 3) capabilities to route traffic between VLANs and subnets using IP addresses.

- **Example:**

  Cisco Catalyst 2960 series Layer 2 switch; Layer 3 switches like Cisco Catalyst 3850 series.
- **OSI Layer:**

  Layer 2 (Data Link); Layer 3 for multilayer switches.

4. Bridge

- **Functionality:**

  Connects two or more network segments, filters traffic by MAC address to reduce collisions, and divides collision domains.
- **How it Works:**

  Works at the **Data Link Layer (Layer 2)**. It builds a MAC address table and forwards or filters frames based on whether the destination device is on the same or different segment, thereby controlling traffic flow between segments.
- **Example:**

  Ethernet bridge connecting two LAN segments in separate floors of an office building.
- **OSI Layer:** Layer 2 (Data Link)

5. Router

- **Functionality:**

  Connects multiple networks and forwards data packets based on logical (IP) addresses. It manages traffic within and between networks and routes data along optimal paths.
- **How it Works:**

  Operates at the **Network Layer (Layer 3)**. Routers read the destination IP address in the packet header, consult routing tables and protocols (such as OSPF, BGP), and forward packets toward the destination. Routers also create separate broadcast domains, reducing network traffic.
- **Example:**

  Home or enterprise router like Cisco ISR series, enabling connection between a LAN and the internet.
- **OSI Layer:** Layer 3 (Network)

6. Gateway

- **Functionality:**
  Acts as a translator between different network protocols or architectures, enabling communication between networks that use different protocols or data formats.
- **How it Works:**
  Operates at **multiple layers (Layers 4 to 7)** depending on the application. It performs protocol conversions, data translation, and communication between dissimilar networks (e.g., TCP/IP to IBM SNA). Because of its complexity, it can include functions such as data encryption, decryption, and content filtering.
- **Example:**
  VoIP gateway converting telephone signals into data packets; Email gateway translating different mail protocols.
- **OSI Layer:** Layers 4–7 (Transport, Session, Presentation, Application); can span multiple layers.

7. Network Interface Card (NIC)

- **Functionality:**
  Provides the physical interface between a computer and the network, enabling devices to connect and communicate over a network.
- **How it Works:**
  Operates at **Physical Layer (Layer 1)** and **Data Link Layer (Layer 2)**. The NIC encapsulates data into frames, adds MAC addresses, handles error detection, and converts data into signals for transmission over the physical medium (copper, fiber, wireless).
- **Example:**
  PCIe Gigabit Ethernet NIC in desktop computers; wireless NIC for Wi-Fi connectivity.
- **OSI Layer:** Layer 1 (Physical) and Layer 2 (Data Link)

Study of Transmission Media

The below information is given for reference purpose only; you need to replace this with the information you have searched

1. Twisted pair cable

In balanced pair operation, the two wires carry equal and opposite signals and the destination detects the difference between the two. This is known as differential mode transmission. Noise sources introduce signals into the wires by coupling of electric or magnetic fields and tend to couple to both wires equally. The noise thus produces a common-mode signal which is cancelled at the receiver when the difference signal is taken.

This method starts to fail when the noise source is close to the signal wires; the closer wire will couple with the noise more strongly and the common-mode rejection of the receiver will fail to eliminate it. This problem is especially apparent in telecommunication cables where pairs in the same cable lie next to each other for many miles. One pair can induce crosstalk in another and it is additive along the length of the cable. Twisting the pairs counters this effect as on each half twist the wire nearest to the noise-source is exchanged.

Provided the interfering source remains uniform or nearly so, over the distance of a single twist, the induced noise will remain common-mode. Differential signalling also reduces electromagnetic radiation from the cable, along with the associated attenuation allowing for greater distance between exchanges.

The twist rate (also called pitch of the twist, usually defined in twists per meter) makes up part of the specification for a given type of cable. Where nearby pairs have equal twist rates, the same conductors of the different pairs may repeatedly lie next to each other, partially undoing the benefits of differential mode. For this reason it is commonly specified that, at least for cables containing small numbers of pairs, the twist rates must differ.[

UTP cables are found in many Ethernet networks and telephone systems. For indoor telephone applications, UTP is often grouped into sets of 25 pairs according to a standard 25-pair color code originally developed by AT&T Corporation. A typical subset of these colors (white/blue, blue/white, white/orange, orange/white) shows up in most UTP cables. The cables are typically made with copper wires measured at 22 or 24 American Wire Gauge (AWG),[3] with the colored insulation typically made from an insulator such as polyurethane and the total package covered in a polyurethane jacket.

For urban outdoor telephone cables containing hundreds or thousands of pairs, the cable is divided into smaller but identical bundles. Each bundle consists of twisted pairs that have different twist rates. The bundles are in turn twisted together to make up the cable. Pairs having the same twist rate within the cable can still experience some degree of crosstalk. Wire pairs are selected carefully to minimize crosstalk within a large cable.

Unshielded twisted pair cable with different twist rates

UTP cable is also the most common cable used in computer networking. Modern Ethernet, the most common data networking standard, can use UTP cables. Twisted pair cabling is often used in data networks for short and medium length connections because of its relatively lower costs compared to optical fiber and coaxial cable.

UTP is also finding increasing use in video applications, primarily in security cameras. Many cameras include a UTP output with screw terminals; UTP cable bandwidth has improved to match the baseband of television signals. As UTP is a balanced transmission line, a balun is needed to connect to unbalanced equipment, for example any using BNC connectors and designed for coaxial cable.

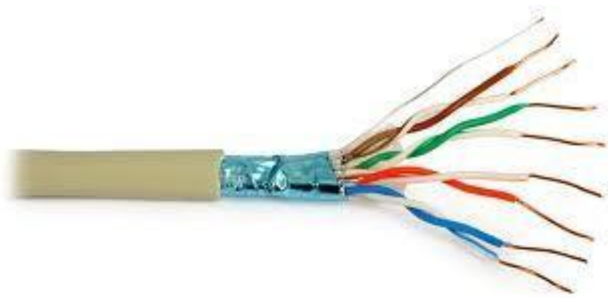


Fig 7.Twisted Pair Cable

2. Coaxial cable

Coaxial cable is the kind of copper cable used by cable TV companies between the community antenna and user homes and businesses. Coaxial cable is sometimes used by telephone companies from their central office to the telephone poles near users. It is also widely installed for use in business and corporation Ethernet and other types of local area network.

Coaxial cable is called "coaxial" because it includes one physicalchannel that carries the signal surrounded (after a layer of insulation) by another concentric physical channel, both running along the same axis. The outer channel serves as a ground. Many of these cables or pairs of coaxial tubes can be placed in a single outer sheathing and, with repeaters, can carry information for a great distance.

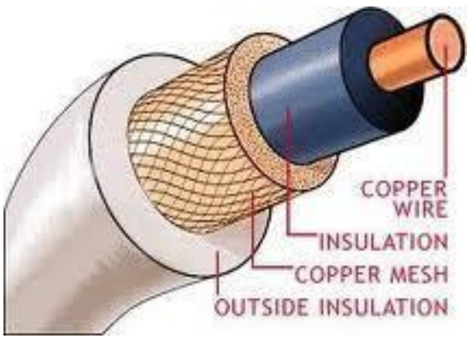


Fig 8.Coaxial Cable

Optical Fiber

Fiber-optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fiber. The light forms an electromagnetic carrier wave that is modulated to carry information. First developed in the 1970s, fiber-optic communication systems have revolutionized the telecommunications industry and have played a major role in the advent of the Information Age. Because of its advantages over electrical transmission, optical fibers have largely replaced copper wire communications in core networks in the developed world.

The process of communicating using fiber-optics involves the following basic steps: Creating the optical signal involving the use of a transmitter, relaying the signal along the fiber, ensuring that the signal does not become too distorted or weak, receiving the optical signal, and converting it into an electrical signal.

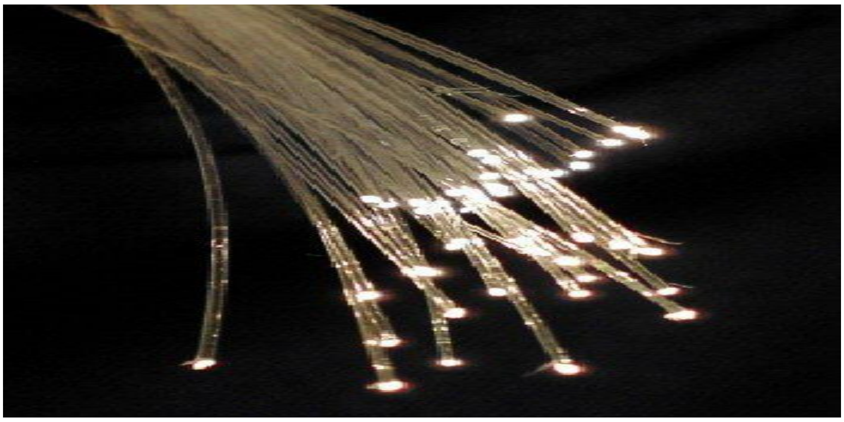


Fig 9.Fiber Optics Cable

Summary

The features of the connecting devices and transmission media can be explained in brief as follows:

Device	Functionality	How It Works	Example	OSI Layer
Hub	Connects devices in a LAN by broadcasting packets to all ports	Receives signals and transmits to all other ports; does not manage or filter data	8-port Ethernet hub	Layer 1 (Physical)
Repeater	Extends network range by regenerating/amplifying weak signals	Receives weak signals, regenerates, and retransmits them to next segment	Wi-Fi repeater	Layer 1 (Physical)
Switch	Connects devices and	Maintains MAC table;	Cisco Catalyst	Layer 2

	forwards frames only to intended recipient using MAC addresses	forwards frame to specific port based on destination MAC. Advanced switches can also route IP traffic	2960 (L2), Catalyst 3850 (L3)	(Data Link); Layer 3 for multilayer switches
Bridge	Connects/filter network segments to reduce collisions and divides domains	Uses MAC table to filter/forward frames between segments	Ethernet bridge between floors	Layer 2 (Data Link)
Router	Connects multiple networks; routes packets based on IP addresses	Reads destination IP, uses routing tables/protocols, and forwards packets accordingly	Cisco ISR router, home router	Layer 3 (Network)
Gateway	Translates and enables communication between networks with different protocols	Performs protocol/data conversion, encryption, content filtering for dissimilar networks	VoIP gateway, email gateway	Layers 4-7; may span OSI layers
NIC	Connects devices to the network; interface for physical/data link layers	Frames data, adds MAC, encodes for physical medium	PCIe Gigabit Ethernet NIC, wireless NIC	Layers 1 (Physical) & 2 (Data Link)

CONCLUSION:
Connecting devices and transmission media together form the backbone of modern network infrastructure. Each device - from hubs and switches to routers and gateways, plays a distinct role by operating at specific OSI layers to enable efficient, secure, and reliable communication between devices and networks. Similarly, the choice of transmission media—twisted pair, coaxial, or fiber optic—directly impacts network performance, cost, and scalability. Understanding these components and their functions is essential for designing, managing, and troubleshooting robust IT networks that meet organizational needs in today’s interconnected world.

Post Lab Questions

1. Compare Hub, switch, bridge, and gateway and specify the use in different cases.

Device	Functionality	OSI Layer	How It Works	Use Case Example
Hub	Connects multiple devices by broadcasting incoming packets to all ports (no filtering).	Layer 1 (Physical)	Regenerates and sends signals to all ports indiscriminately, creating a shared collision domain.	Small, simple LANs with low traffic where cost is a concern and security or efficiency is not critical.
Switch	Connects devices and selectively forwards data based on MAC addresses.	Layer 2 (Data Link); some Layer 3 switches	Maintains MAC address table; sends frames only to destination port, reducing collisions and congestion.	Medium to large LANs requiring efficient traffic management and reduced collisions; VLAN support.
Bridge	Connects two or more LAN segments, filtering traffic by MAC to reduce collisions between segments.	Layer 2 (Data Link)	Builds MAC address table and forwards or filters frames to control traffic flow between segments.	To segment network traffic between physically separated LAN segments to improve performance.
Gateway	Translates and connects different network protocols or architectures; enables communication between dissimilar networks.	Layers 4–7 (Varies by protocol)	Performs protocol translation and data conversion to allow interoperability across heterogeneous networks.	Connecting enterprise networks to external networks using different protocols (e.g., VoIP gateway, email gateway).

2. Which of the following device is used to connect two systems, especially if the systems use different protocols?
   A. hub
   B. bridge
   C. gateway
   D. repeater
   E. None of the above

3. Frames from one LAN can be transmitted to another LAN via the device

   A. Router
   B. Bridge
   C. Repeater
   D. Modem