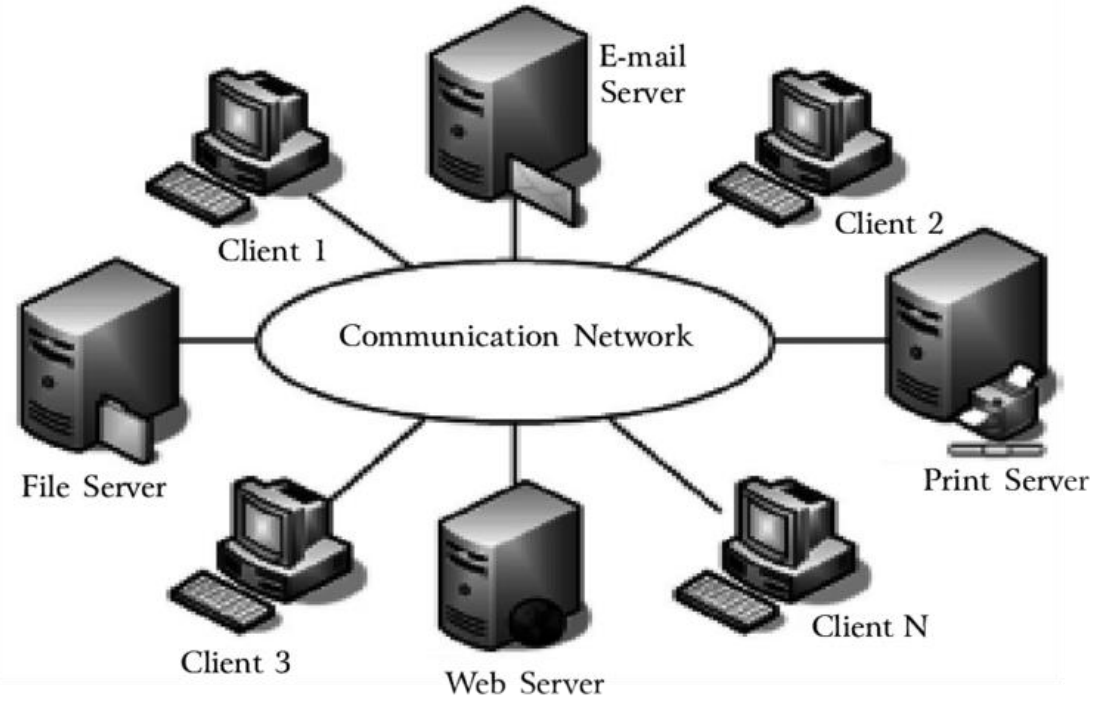
Chapter 1- Computer Networks & the Internet

- Introduction to Computer Networks, Advantages of Computer Networks
- **Types of Networks:** Local Area Network, Wide Area Network, Metropolitan Area Network, Campus/Corporate Area Network, Personal Area Network, Peer-to-Peer Networks
- Physical Components of a Network
- **Network Metrics:** Downloading, Uploading, Buffering, Speed- Baud rate, Bandwidth
- **Wired Media:** Twisted-pair Wires, Coaxial Cables, Fiber Optic Cables,5G-technologies
- **Wireless Media:** Terrestrial Microwaves, Satellite Communication, Infrared Communication
- **Networking Devices:** Hub ,Repeater, Switch, Bridge, Router, Gateway , Network Interface Card, RJ45
- **Network Topologies:** Bus Topology, Star Topology, Ring Topology, Mesh topology, Hybrid Topology

Case study-1: Prepare a PPT/Poster about networking a lab with 90 systems and list out the issues identified in planning.

Introduction to computer networks

- A network is a set of devices (often referred to as nodes) connected by communication links in such a way that they can share resources.
- "Computer network" to mean a collection of autonomous computers interconnected by a single technology.
- The connection need not be via a copper wire; fiber optics, microwaves, infrared, and communication satellites can also be used.
- Networks of different sizes, shapes and forms connected together to make a larger network calle
- A resource may be:
- A file
- A folder
- A printer
- A disk drive



computer networks

Advantages:

- Connectivity and Communication
- Data Sharing
- Hardware Sharing
- Increasing storage capacity
- Internet Access
- Internet Access Sharing
- Data Security and Management
- Performance Enhancement and Balancing
- Entertainment
- E-commerce

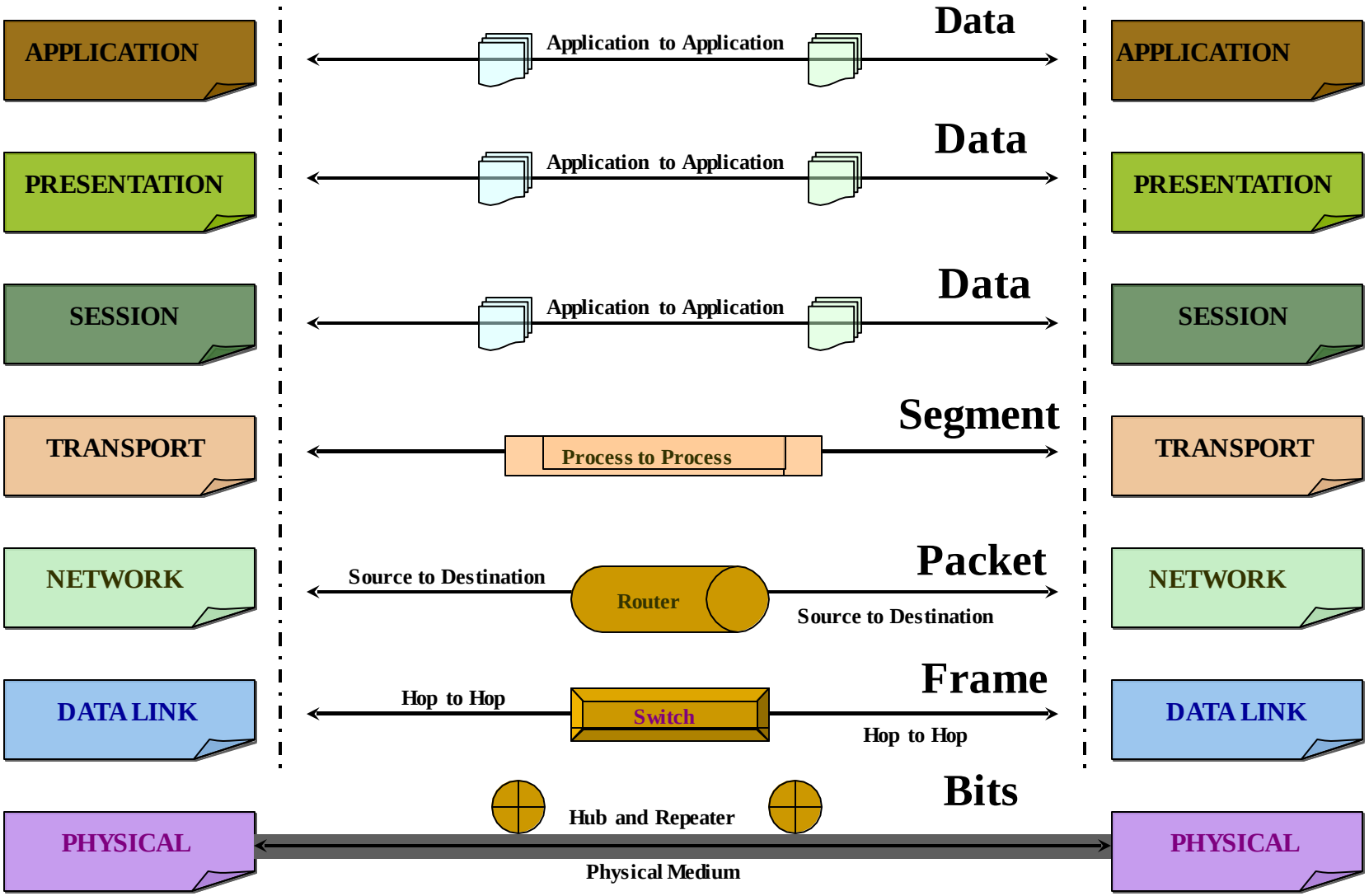
Disadvantages:

- Network Hardware, Software and Setup Costs
- Hardware and Software Management and Administration Costs
- Undesirable Sharing
- Illegal or Undesirable Behavior
- Data Security Concerns

Open System Interconnection (OSI) Reference Model

- OSI stands for Open Systems Interconnection
- Created by International Standards Organization (ISO)
- Was created as a framework and reference model to explain how different networking technologies work together and interact
- It is not a standard that networking protocols must follow
- Each layer has specific functions it is responsible for
- All layers work together in the correct order to move data around a network
- In its most basic form, it divides network architecture into seven layers which, from top to bottom, are the Application, Presentation, Session, Transport, Network, Data-Link, and Physical Layers.

OSI Reference Model



OSI Reference Model

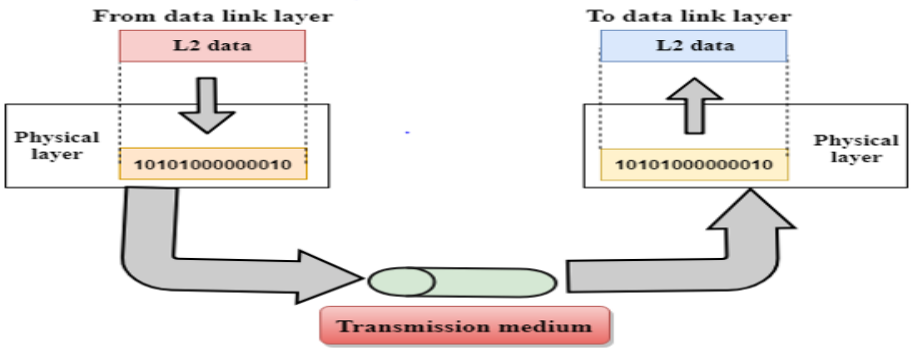
Physical layer:

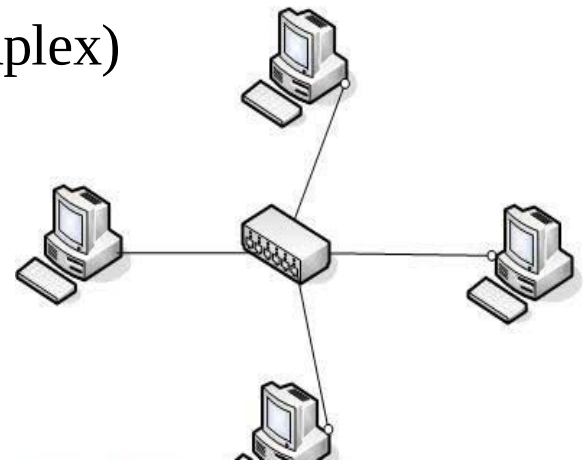
- Deals with all aspects of physically moving data from one computer to the next.
- Converts data from the upper layers into 1s and 0s for transmission over media.
- Defines how data is encoded onto the media to transmit the data
- Defined on this layer: Cable standards, wireless standards, and fiber optic standards.
- Copper wiring, fiber optic cable, radio frequencies, anything that can be used to transmit data is defined on the Physical layer of the OSI Model
- Device example: Hub-connects multiple PCs to a network.
- Used to transmit data

OSI Reference Model

Physical layer: Concerned

- Physical characteristics of interface and medium (Transmission medium)
- Representation of bits (stream of bits (0s or 1s) with no interpretation and encoded into signals) Data rate (duration of a bit, which is how long it last)
- Synchronization of bits (sender and receivers clock must be synchronized), Line configuration (Point-to-Point, Point-to-Multipoint)
- Physical topology
- Transmission mode (Simplex, half duplex, full duplex)





OSI Reference Model

Data link layer: (Host to Host)

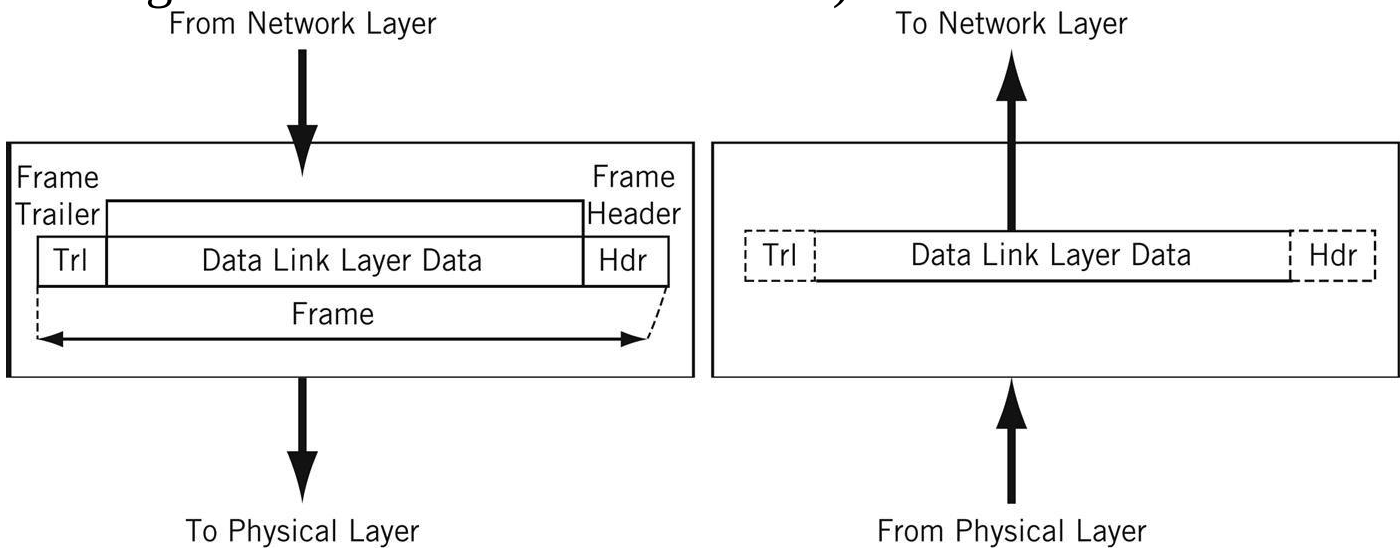
- Is responsible for moving frames from node to node or computer to computer
- Can move frames from one adjacent computer to another, cannot move frames across routers
- Encapsulation = frame
- Requires MAC address or physical address
- Protocols defined include Ethernet Protocol and Point-to-Point Protocol (PPP)
- Device example: Switch-connects multiple devices to a network.
- Two sublayers: Logical Link Control (LLC) and the Media Access Control (MAC)
- **Logical Link Control (LLC):** Data Link layer addressing, flow control, address notification, error control

OSI Reference Model

- **Media Access Control (MAC)**: Determines which computer has access to the network media at any given time
- Determines where one frame ends and the next one starts, called frame synchronization

Concerned:

- Framing (stream of bits into manageable data units) Physical addressing (MAC Address)
- Flow Control (mechanism for overwhelming the receiver) Error Control (trailer, retransmission)
- Access Control (defining master device in the same link)



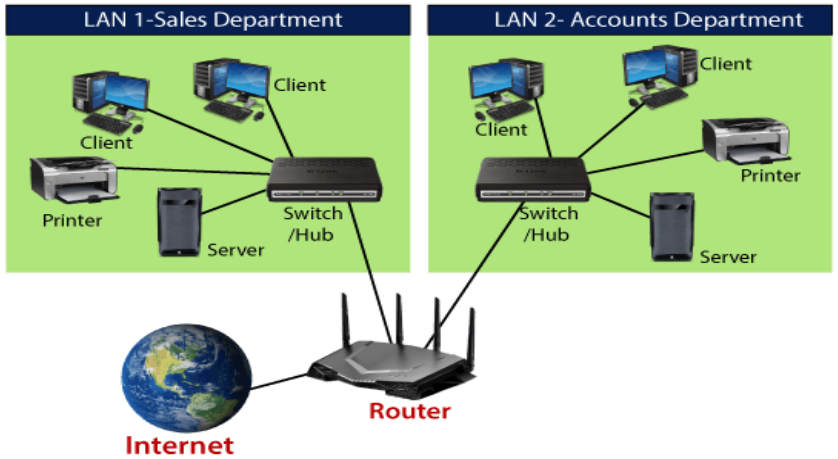
OSI Reference Model

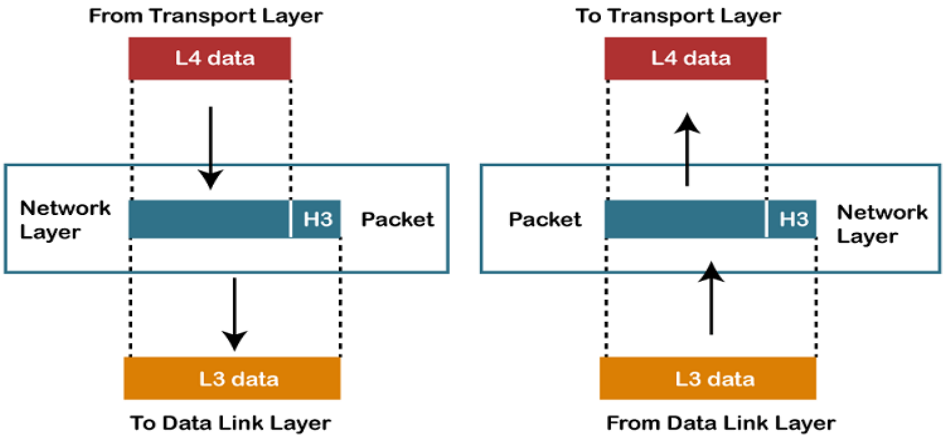
Network layer: (Source to Destination)

- Responsible for moving packets (data) from one end (source host) of the network to the other (destination host), called end-to-end communications
- Requires logical addresses such as IP addresses
- Device example: Router-connect 2 or more packet switching networks
- Routing is the ability of various network devices and their related software to move data packets from source to destination

Concerned: Logical addressing (IP Address)

- Routing (Source to destination transmission between networks)





OSI Reference Model

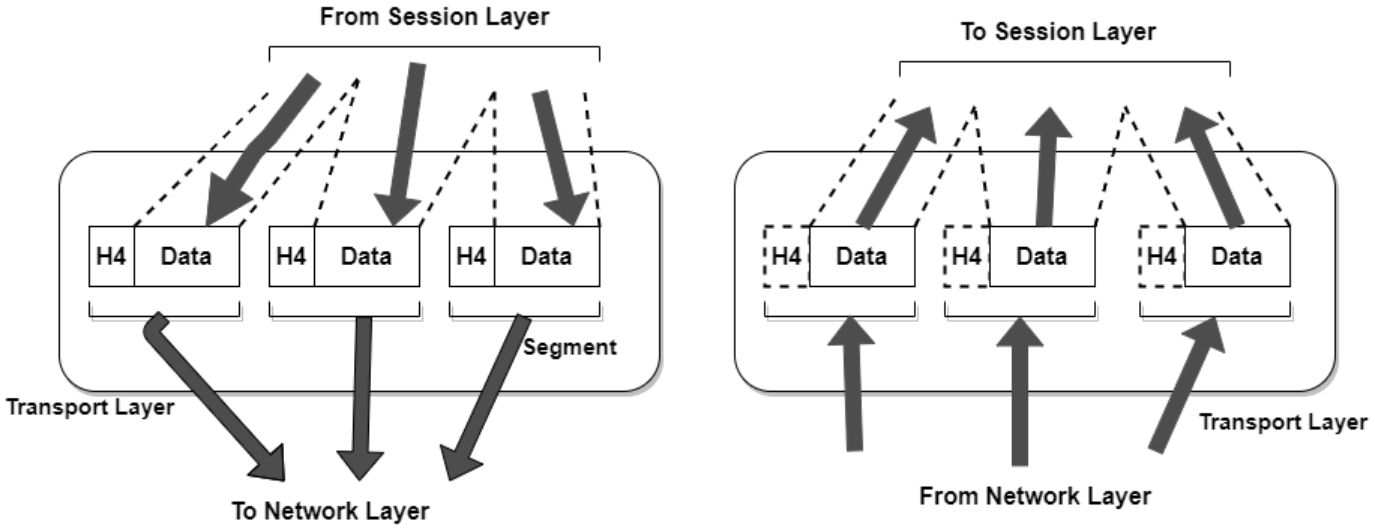
Transport layer: (Process to Process)

- Takes data from higher levels of OSI Model and breaks it into segments that can be sent to lower-level layers for data transmission
- Conversely, reassembles data segments into data that higher-level protocols and applications can use
- Also puts segments in correct order (called sequencing) so they can be reassembled in correct order at destination
- Concerned with the reliability of the transport of sent data
- May use a connection-oriented protocol such as TCP to ensure destination received segments
- May use a connectionless protocol such as user datagram protocol (UDP) to send segments without assurance of delivery
- Uses port addressing

OSI Reference Model

Transport layer: Concerned

- Service-point addressing (Port address)
- Segmentation and reassembly (Sequence umber)
- Connection control (Connectionless or connection oriented) Flow control (end to end)
- Error Control (Process to Process)



OSI Reference Model

Session layer:

- Responsible for managing the dialog between networked devices
- Establishes, manages, and terminates connections
- Provides duplex, half-duplex, or simplex communications between devices
- Provides procedures for establishing checkpoints, adjournment, termination, and restart or recovery procedures

Concerned:

- Dialog Control (Half
- Synchronization (Sy
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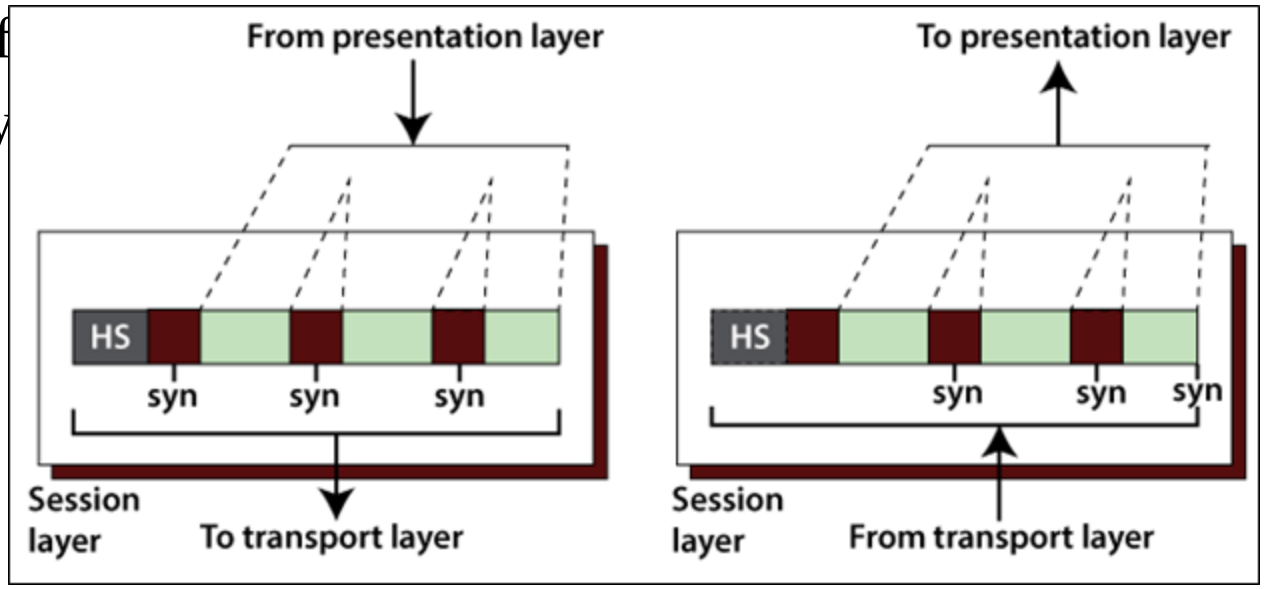
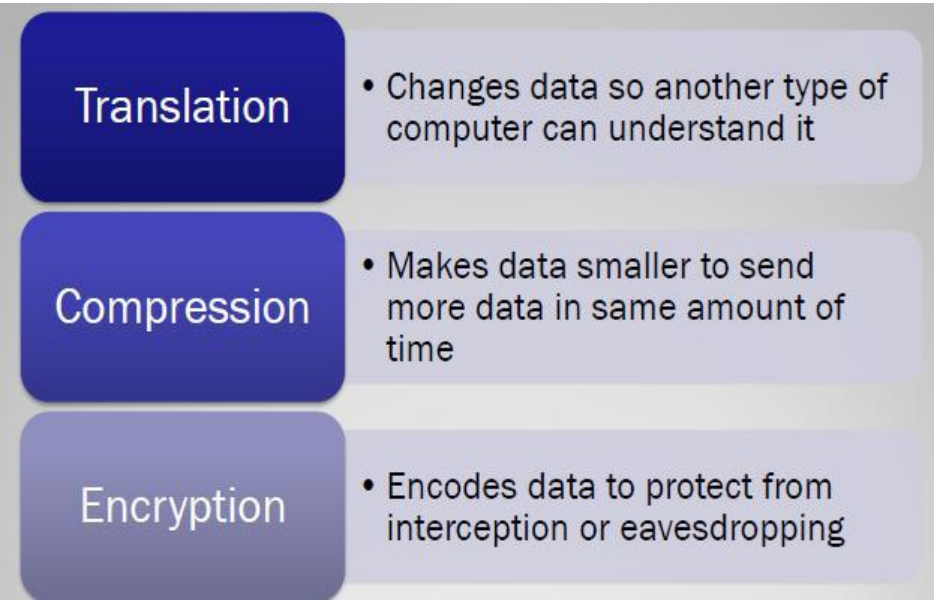
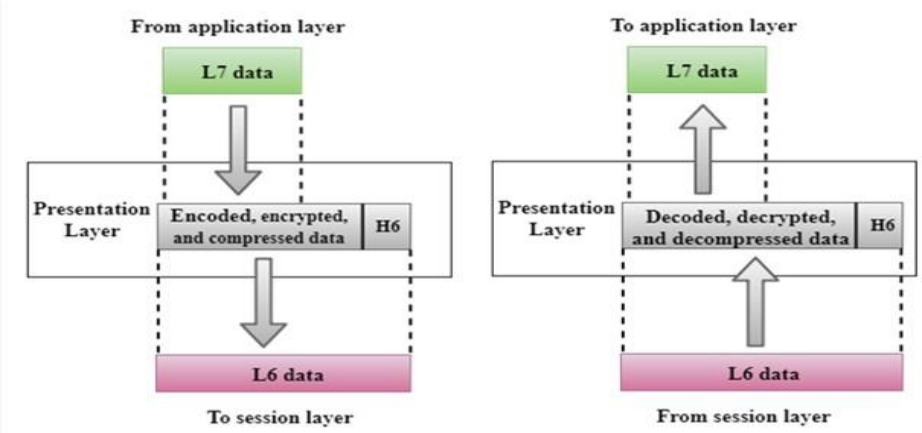


OSI Reference Model

Presentation layer:

- Concerned with how data is presented to the network
- Handles three primary tasks: –Translation , –Compression , –Encryption
- **Concerned:**
- Translation (interoperability between different encoding system) Encryption (Privacy schemes)
- Compression (data compression)





OSI Reference Model

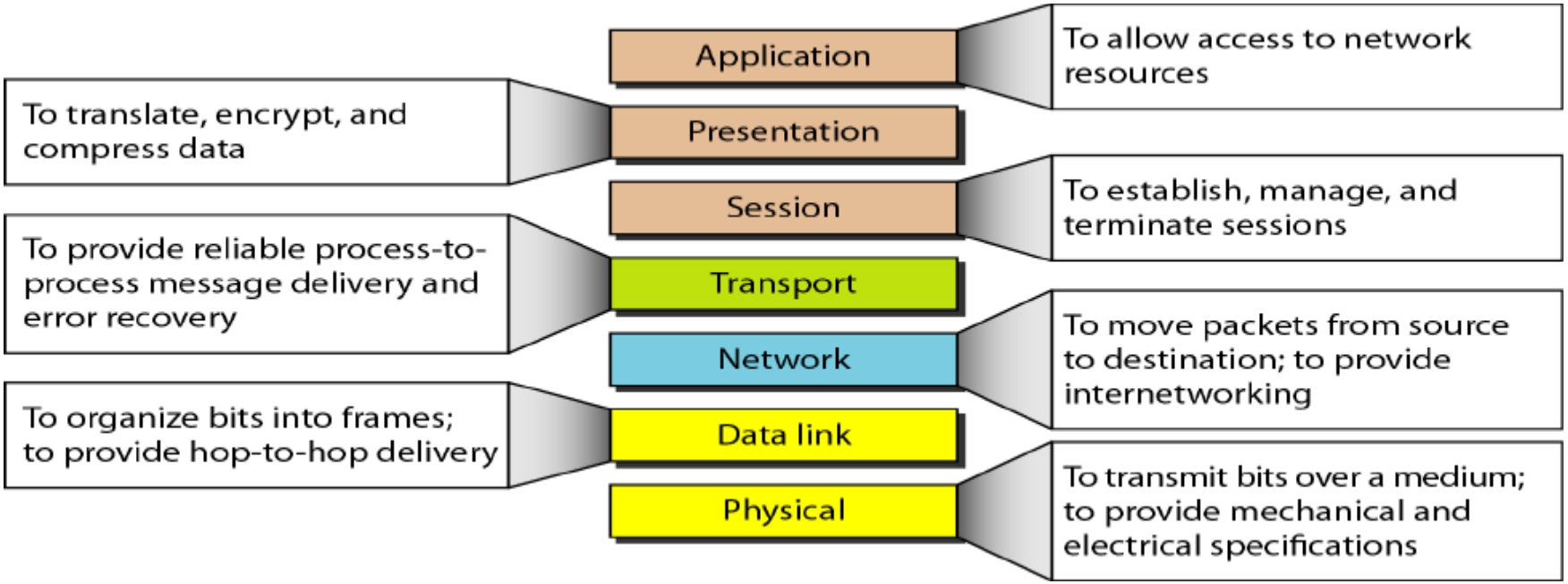
Application layer:

- Responsible for providing services to user
- Contains all services or protocols needed by application software or operating system to communicate on the network
- Examples o –Firefox web browser uses HTTP (Hyper-Text Transport Protocol) o –E-mail program may use POP3 (Post Office Protocol version 3) to read e-mails and SMTP (Simple Mail Transport Protocol) to send e-mails

Concerned:

- Network virtual terminal (Software), File transfer, access and management, Mail services
- Directory services (access to distributed database sources for global information about various objects and services)

OSI Reference Model

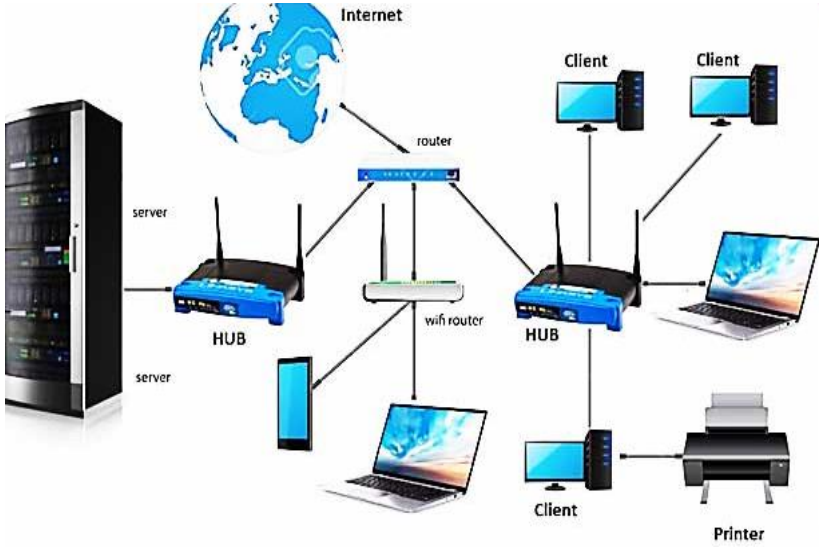


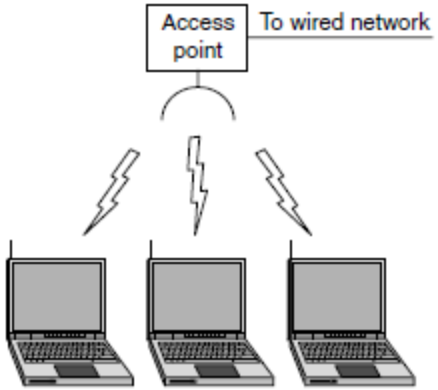
Types of Networks

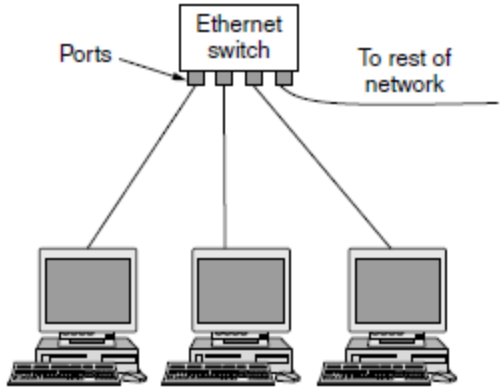
- Local Area Network
- Wide Area Network
- Metropolitan Area Network
- Campus/Corporate Area Network
- Personal Area Network
- Peer-to-Peer Networks

Local Area Network

- A local area network (LAN) is a computer network covering a small geographic area, like a home, office, or group of buildings
- Most LANs connect to the Internet at a central point: a router. Home LANs often use a single router, while LANs in larger spaces may additionally use network switches for more efficient packet delivery.
- LANs almost always use Ethernet, WiFi, or both in order to connect devices within the network. Ethernet is a protocol for physical network connections that requires the use of Ethernet cables. WiFi is a protocol for connecting to a network via radio waves.





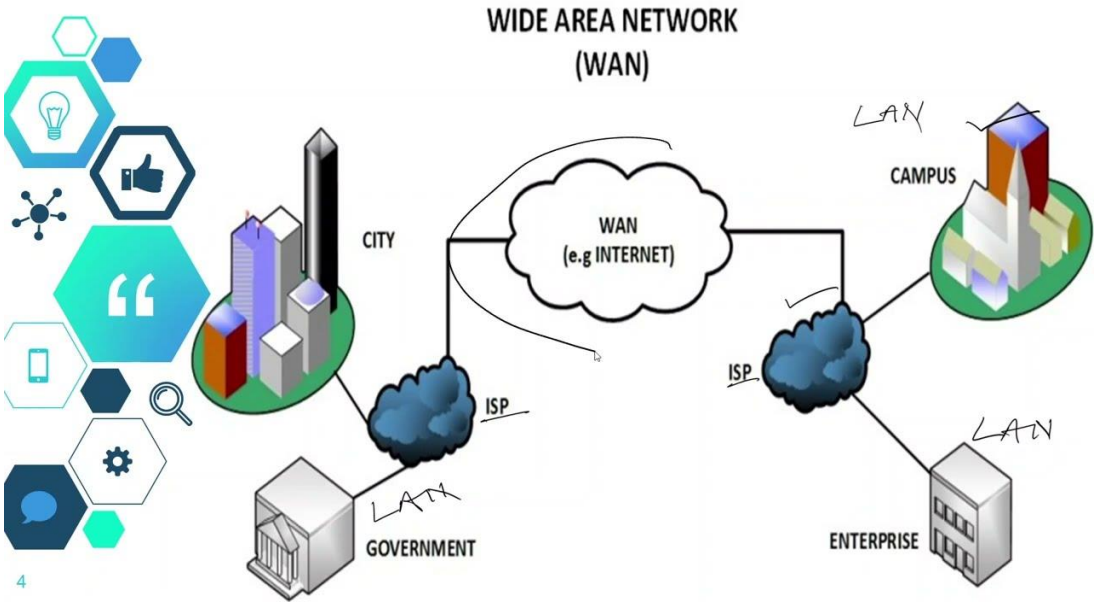


Local Area Network

- A variety of devices can connect to LANs, including servers, desktop computers, laptops, printers, IoT devices, and even game consoles. In offices, LANs are often used to provide shared access to internal employees to connected printers or servers.
- Speed up to 10Gbps.
- Topology is point-to-point links using a SWITCH that relays packets between the computers.
- Dividing LAN into small logical LANs useful to broadcast and restrict the packets between different departments of users.
- Service allocation- **Static allocation:** time allocation and round robin algorithm- lost in channel capacity.
- **Dynamic allocation:** 2 ways- Centralized and Decentralized
- Centralized: base station prioritize and allocates the channel.
- Decentralized: each system must decide itself whether to transmit- chaos handled by different algorithms.

Wide Area Network

- Wide Area Network (WAN) is a computer network that covers a broad area (i.e., any network whose communications links cross metropolitan, regional, or national boundaries). Or, less formally, a network that uses routers and public communications links
- The largest and most well-known example of a WAN is the Internet.
- WANs are used to connect LANs and other types of networks together, so that users and computers in one location can communicate with users and computers in other locations



Wide Area Network

- Each computer is a host and the network of these hosts is a **subnet** in WAN.
- 2 distinct components in the subnet: Transmission lines and switching elements.
- Transmission lines move bits between computers and switches has two or more transmission lines.
- **Routing algorithm** in the network make decisions to select paths between two routers.
- **Forwarding algorithm** in each router decides where to send the packet.

Examples of WAN:

- Satellite systems
- Cellular telephone networks

Wide Area Network

Varieties of WAN:

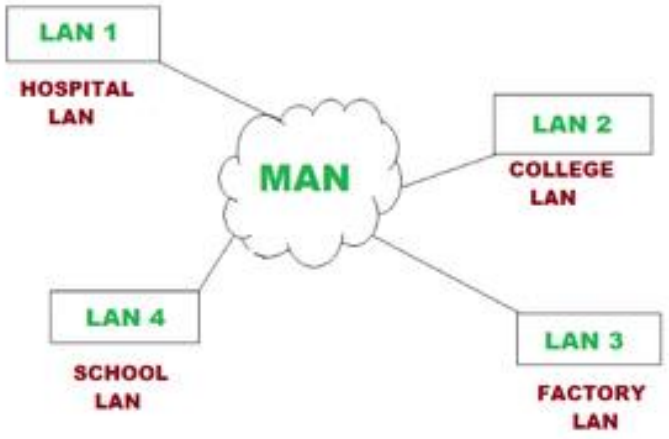
- Virtual private network (VPN)- virtualization and flexible usage of resources.
- Network service provider/ internet service provider handling a subnet.

Differences with LAN:

- Hosts and subnets in WAN are owned and operated by different people.
- Routers connect different kinds of networking technology.
- Subnet could be individual computers connected to LANs or the entire LANs.

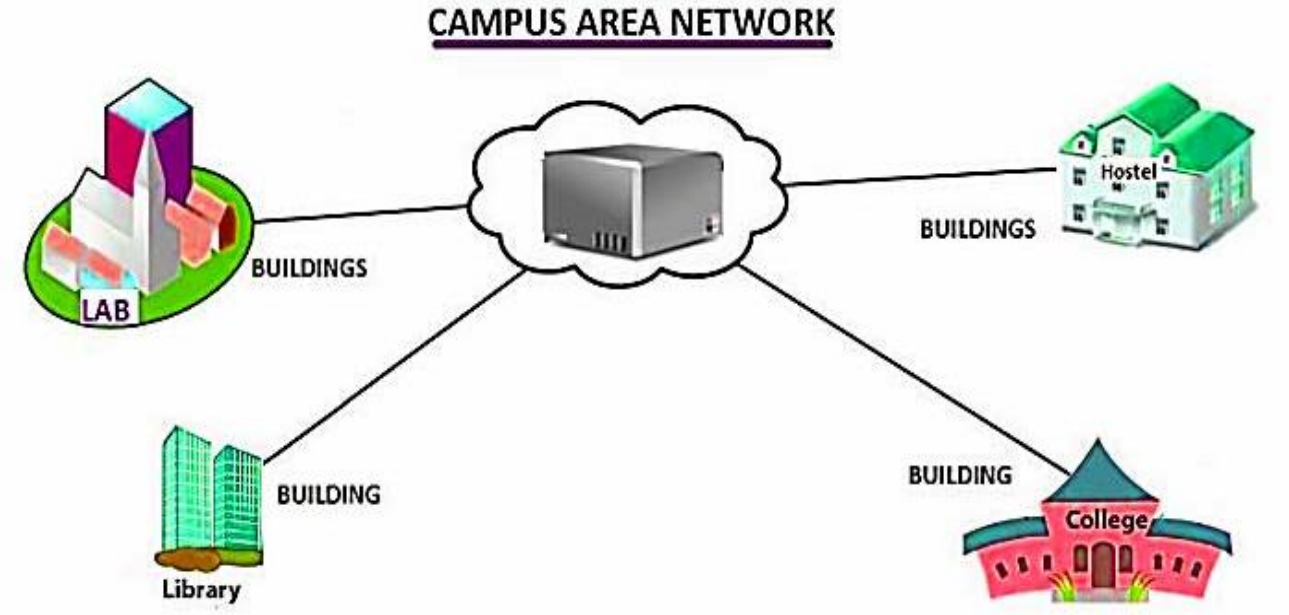
Metropolitan Area Network

- A metropolitan area network (MAN) is a network that interconnects users with computer resources in a geographic area or region larger than that covered by even a large local area network (LAN) but smaller than the area covered by a wide area network (WAN).
- The term is applied to the interconnection of networks in a city into a single larger network (which may then also offer efficient connection to a wide area network).
- It is also used to mean the interconnection of several local area networks by bridging them with backbone lines. The latter usage is also sometimes referred to as a campus network.
- Eg. Cable television networks, WiMax.



Campus or Corporate Area Network

- A campus area network (CAN) is a computer network that spans a limited geographic area. CANs interconnect multiple local area networks (LAN) within an educational or corporate campus. Most CANs connect to the public Internet.
- Parent organization owns and operates all the networking equipment and infrastructure.
- Typically manages by internal IT team.



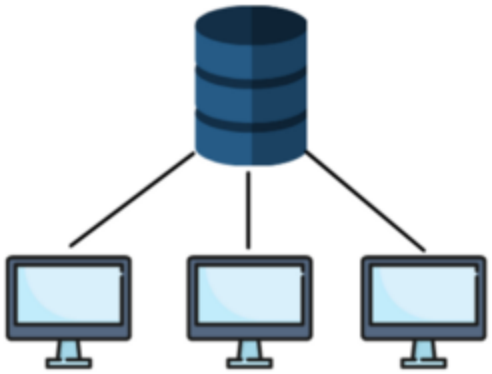
Personal Area Network

- A personal area network (PAN) connects electronic devices within a user's immediate area. The size of a PAN ranges from a few centimeters to a few meters. One of the most common real-world examples of a PAN is the connection between a Bluetooth earpiece and a smart phone. PANs can also connect laptops, tablets, printers, keyboards, and other computerized devices.
- The master (PC) tells the slaves what addresses to use, when they can broadcast, how long they can transmit, what frequencies they can use, and so on.
- Eg: Bluetooth devices, pacemaker, insulin pump, or hearing aid talks to a user-operated remote control.

Peer to Peer Network

- A peer-to-peer network is a network where the computers act as both workstations and servers.
- Great for small, simple, and inexpensive networks.
- In a strict peer-to-peer networking setup, every computer is an equal; a peer in the network.
- Each machine can have resources that are shared with any other machine.
- There is no assigned role for any particular device, and each of the devices usually runs similar software. Anv device can and will send requests to any other.

Client Server Architecture



Peer to Peer Architecture