# Local Area Network (LAN)

As the name suggests, the local area network is a computer network that operates in a small area, i.e., it connects computers in a small geographical area like within an office, company, school, or any other organization. So, it exists within a specific area, e.g. home network, office network, school network, etc.

A local area network may be a wired or wireless network or a combination of both. The devices in a LAN are generally connected using an Ethernet cable, which offers an interface to connect multiple devices like router, switches, and computers. For example, using a single router, few Ethernet cables, and computers, you can create a LAN at your home, office, etc. In this network, one computer may act as a server and other computers, which are part of the network, may serve as clients.

| Topologies of LAN |
|---|

Topology: It refers to the arrangement of computers (nodes) in a computer network. The main topologies of a local area network are as follows:

Ring Topology:
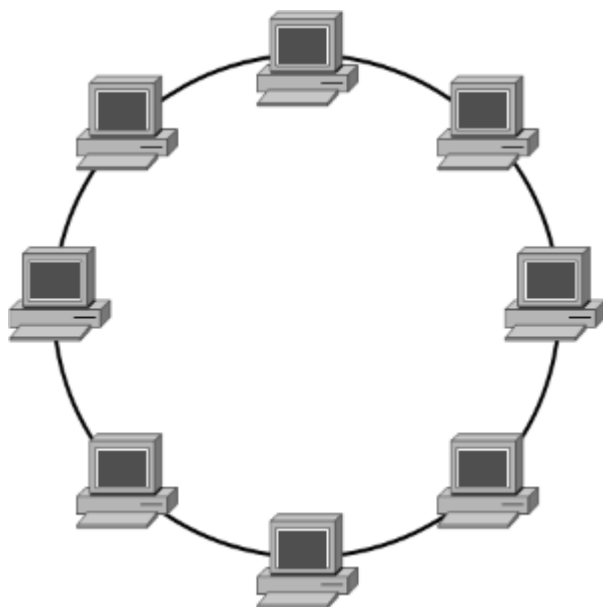
As the name suggests, in a ring topology, the computers are connected in a circular and closed loop. The message in this topology moves only in one direction around the ring from one node to another node and is checked by each node for a matching destination address. So, the data keeps moving until it reaches its destination. All nodes are equal; a client-server relationship does not exist between them. As the nodes are in the form of a ring, if one node fails to transmit the data, the flow of communication is severed.

Star Topology:
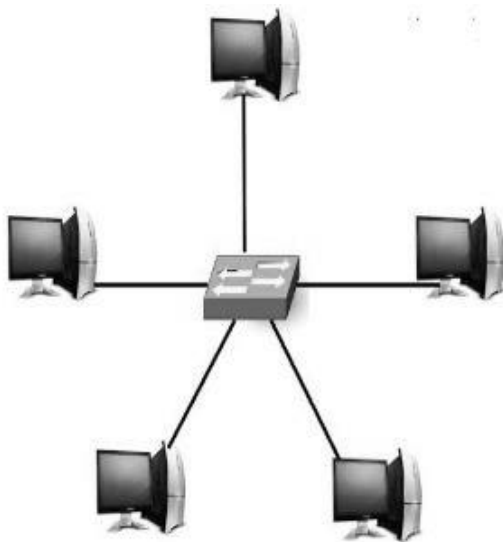
In this topology, all the computers are separately connected to a central node or connection point, which can be a server, a hub, a router, or a switch. This topology offers an advantage that if a cable does not work, only the respective node will suffer, the rest of the nodes will work smoothly. All data or messages that one node sends to another passes through the central hub.

This topology is easy to design and implement as well as it is easy to add additional nodes to the central node. The major drawback of this topology is that it is prone to bottleneck or failure at the central connection point, i.e., failure at the central node will affect the entire communication.

Bus Topology:
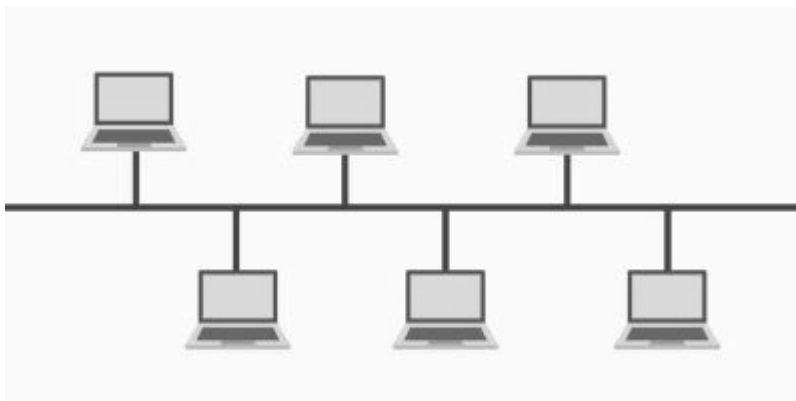
In this arrangement, the nodes (computers) are connected through interface connectors to a single communication line (central cable) that carries the message in both the directions. The central cable to which all the nodes are connected is the backbone of the network. It is called a bus. The signal in this arrangement travels in both directions to all the machines until it finds the recipient machine. It is easy to set up than other topologies as it uses only a single central cable to establish the network.

Benefits of LAN

- It offers a higher operating speed than WAN and MAN.
- It is less expensive and easy to install and maintain.
- It perfectly fulfils the requirement of a specific organization, such as an office, school, etc.
- It can be wired or wireless or a combination of both.
- It is more secure than other networks as it is a small set up that can be easily taken care of.

Primary Functions of LAN

- **Sharing of files:** It allows you to share or transfer files from one computer to another computer within the LAN. For example, in a bank, it can be used to send a file with the details of transactions of a customer from the server to clients.
- **Sharing of printers:** It also allows shared access to a printer, file servers, etc. For example, ten computers that are connected through LAN can use a single printer, file server, fax machine, etc.
- **Sharing of Computational capabilities:** It allows the clients to access to the computational power of a server, e.g., an application server as some applications which run on clients in a LAN may require higher computational capabilities.
- **Mail and message related services:** It allows sending and receiving mails between computers of a LAN. You are required to have a mail server for this.
- **Database services:** It also allows storing and retrieving data with the help of a database server.

Ethernet

Ethernet is a widely deployed LAN technology. This technology was invented by Bob Metcalfe and D.R. Boggs in the year 1970. It was standardized in IEEE 802.3 in 1980.

Ethernet shares media. Network which uses shared media has high probability of data collision. Ethernet uses Carrier Sense Multi Access/Collision Detection (CSMA/CD) technology to detect collisions. On the occurrence of collision in Ethernet, all its hosts roll back, wait for some random amount of time, and then re-transmit the data.

Ethernet connector is, network interface card equipped with 48-bits MAC address. This helps other Ethernet devices to identify and communicate with remote devices in Ethernet.

MAC Address in Computer Network

In order to communicate or transfer the data from one computer to another computer we need some address. In Computer Network various types of address are introduced; each works at different layer. Media Access Control Address is a physical address which works at Data Link Layer. In this article, we will discuss about addressing in DLL, which is MAC Address.

Media Access Control (MAC) Address

MAC Addresses are unique **48-bits** hardware number of a computer, which is embedded into network card (known as **Network Interface Card**) during the time of manufacturing. MAC Address is also known as **Physical Address** of a network device. In IEEE 802 standard, Data Link Layer is divided into two sublayers –

1. Logical Link Control(LLC) Sublayer
2. Media Access Control(MAC) Sublayer

MAC address is used by Media Access Control (MAC) sublayer of Data-Link Layer. MAC Address is word wide unique, since millions of network devices exist and we need to uniquely identify each.
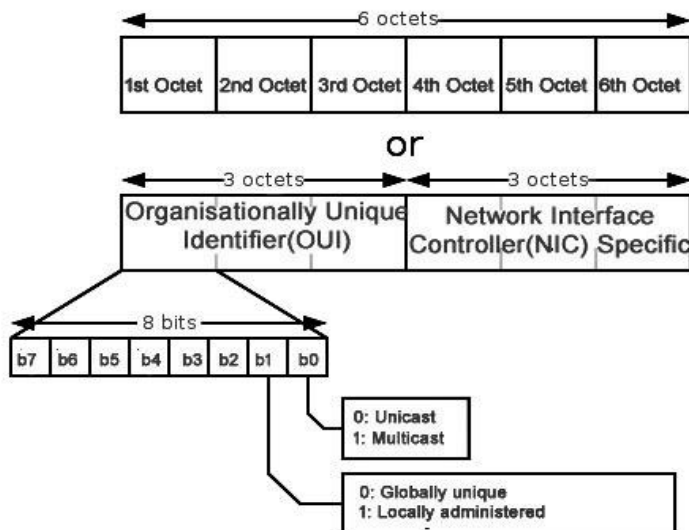
Format of MAC Address

MAC Address is a 12-digit hexadecimal number (6-Byte binary number), which is mostly represented by Colon-Hexadecimal notation. First 6-digits (say 00:40:96) of MAC Address identifies the manufacturer, called as OUI (**Organizational Unique Identifier**). IEEE Registration Authority Committee assigns these MAC prefixes to its registered vendors.

Here are some OUI of well-known manufacturers:

CC: 46:D6 - Cisco
3C:5A:B4 - Google, Inc.
3C:D9:2B - Hewlett Packard
00:9A: CD - HUAWEI TECHNOLOGIES CO.,LTD

The rightmost six digits represent **Network Interface Controller**, which is assigned by manufacturer.

As discussed above, MAC address is represented by Colon-Hexadecimal notation. But this is just a conversion, not mandatory. MAC address can be represented using any of the following formats –

> **Hypen-Hexadecimal notation**
> 00-0a-83-b1-c0-8e

> **Colon-Hexadecimal notation**
> 00:0a:83:b1:c0:8e

> **Period-separated hexadecimal notation**
> 000.a83.b1c.08e

Types of MAC Address

1. **Unicast –** A Unicast addressed frame is only sent out to the interface leading to specific NIC. If the LSB (least significant bit) of first octet of an address is set to zero, the frame is meant to reach only one receiving NIC. MAC Address of source machine is always Unicast.
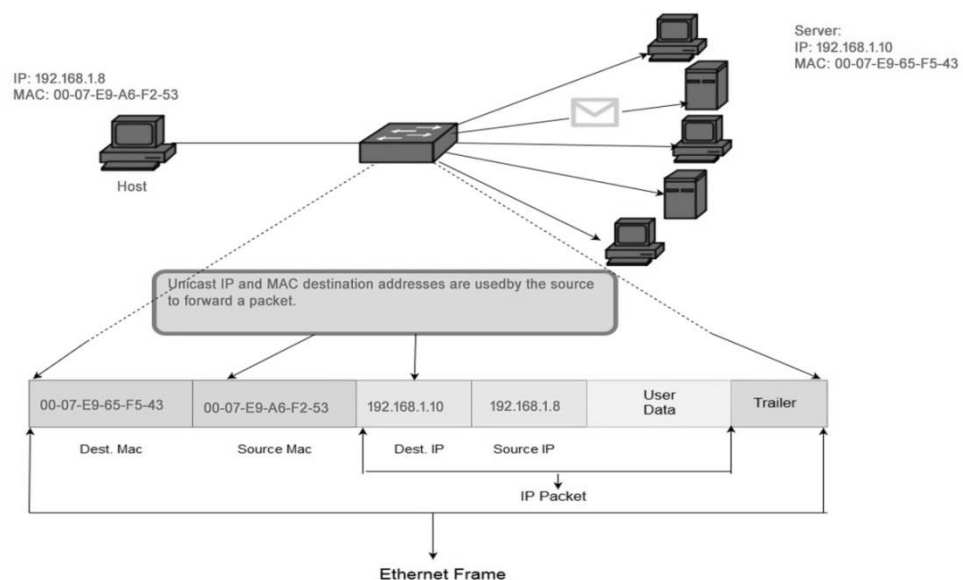
2. **Multicast –** Multicast address allow the source to send a frame to group of devices. In Layer-2 (Ethernet) Multicast address, LSB (least significant bit) of first octet of an address is set to one. IEEE has allocated the address block 01-80-C2-xx-xx-xx (01-80-

C2-00-00-00 to 01-80-C2-FF-FF-FF) for group addresses for use by standard protocols.

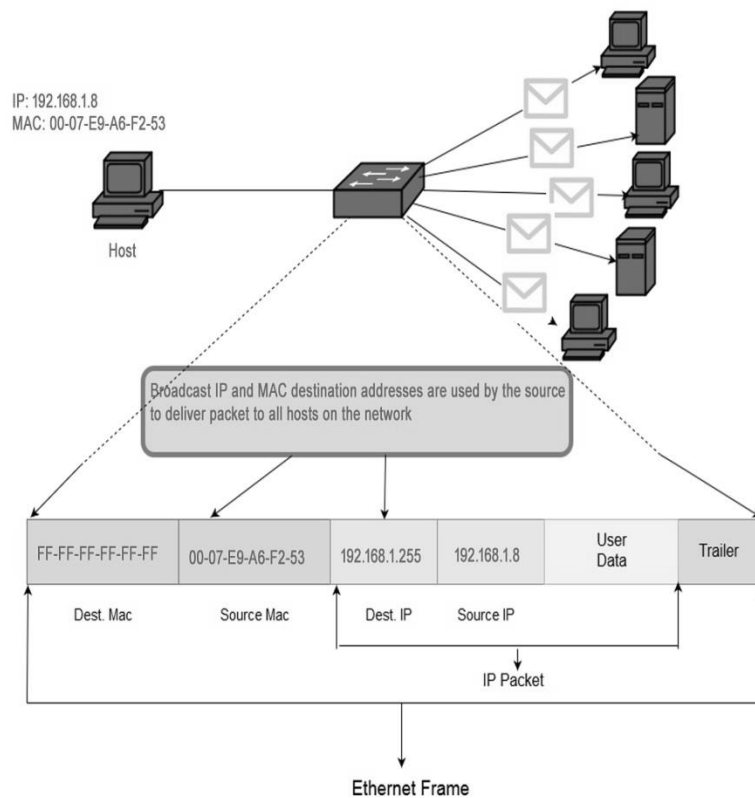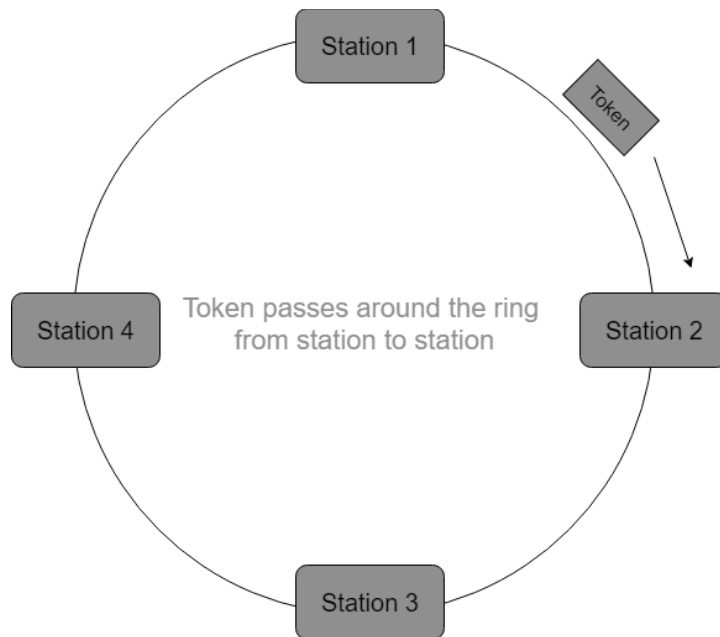IP: 192.168.1.8
MAC: 00-07-E9-A6-F2-53

Host

Multicast IP and MAC destination addresses deliver packet/frame to a specific group of hosts

01-00-5E-00-00-0A	00-07-E9-A6-F2-53	224.0.0.10	192.168.1.8	User Data	Trailer
Dest. Mac	Source Mac	Dest. IP	Source IP		

IP Packet
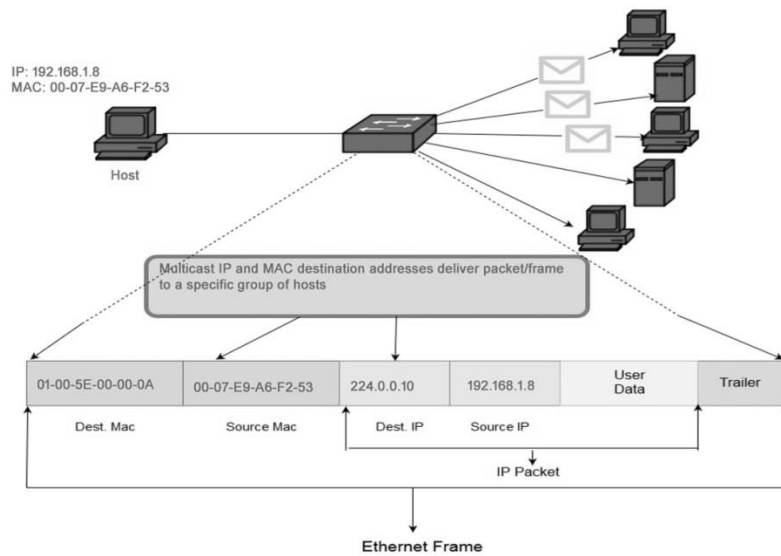
Ethernet Frame

3. **Broadcast –** Similar to Network Layer, Broadcast is also possible on underlying layer (Data Link Layer). Ethernet frames with ones in all bits of the destination address (FF-FF-FF-FF-FF-FF) are referred as broadcast address. Frames which are destined with MAC address FF-FF-FF-FF-FF-FF will reach to every computer belong to that LAN segment.

IP: 192.168.1.8
MAC: 00-07-E9-A6-F2-53

Host

Broadcast IP and MAC destination addresses are used by the source to deliver packet to all hosts on the network

FF-FF-FF-FF-FF-FF	00-07-E9-A6-F2-53	192.168.1.255	192.168.1.8	User Data	Trailer
Dest. Mac	Source Mac	Dest. IP	Source IP		

IP Packet

Ethernet Frame

TOKEN RING

Token passes around the ring from station to station

Working Mechanism

1. Systems in the LAN are arranged in a logical ring; each system receives data frames from its logical predecessor on the ring and sends them to its logical successor. The network may be an actual ring, with cabling connecting each node directly to its neighbours, but more often is a star, with the ring existing only logically in the wiring closet within the "multi-access unit" to which all the hosts connect.

2. Empty information frames are continuously circulated on the ring, along with frames containing actual data; any node receiving an empty frame and having nothing to send simply forwards the empty frame.

3. When a computer has a message to send, it waits for an empty frame. When it has one, it does the following:

    a) Inserts a token indicating that it is sending data in the frame -- this may be as simple as changing a zero to a one in the token section of the frame, although other schemes are possible, and is said to "hold the token" for that frame.

    b) Inserts the data it wants to transmit into the payload section of the frame.

    c) Sets a destination identifier on the frame.

4. When a computer receives a frame containing data (indicated by the token) it knows it cannot transmit data of its own and so it does the following:

    a) If it is not the sender or the destination, it simply retransmits the frame, sending it to the next host in the ring.

b) If it is the destination for the message, it copies the message from the frame and clears the token to indicate receipt.
c) If it is the sender (and assuming the destination node has indicated receipt of the frame by clearing the token) it sees that the message has been received, removes the message payload from the frame (restoring it to "empty" status) and sends the empty frame around the ring.

NETWORKING DEVICES

Computer network components are the major parts which are needed to install the software. Some important network components are **NIC**, **switch**, **cable**, **hub**, **router**, and **modem**. Depending on the type of network that we need to install, some network components can also be removed. For example, the wireless network does not require a cable.

Following are the major components required to install a network:

Bridge

A bridge operates at data link layer. A bridge is a repeater; with add on the functionality of filtering content by reading the MAC addresses of source and destination. It is also used for interconnecting two LANs working on the same protocol. It has a single input and single output port, thus making it a 2 port device.

Types of Bridges

- **Transparent Bridges: -** These are the bridge in which the stations are completely unaware of the bridge's existence i.e. whether or not a bridge is added or deleted from the network, reconfiguration of the stations is unnecessary. These bridges make use of two processes i.e. bridge forwarding and bridge learning.
- **Source Routing Bridges: -** In these bridges, routing operation is performed by source station and the frame specifies which route to follow. The hot can discover frame by sending a special frame called discovery frame, which spreads through the entire network using all possible paths to destination.
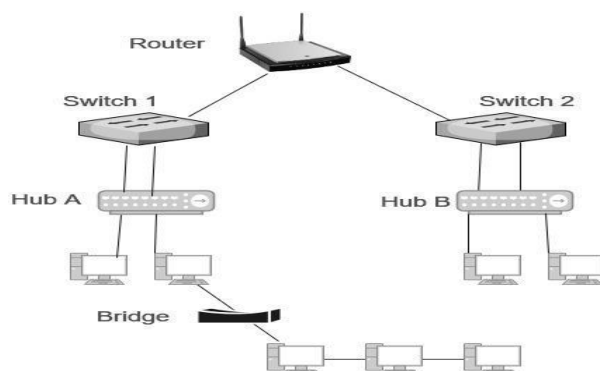
Switch

A switch is a hardware device that connects multiple devices on a computer network. A Switch contains more advanced features than Hub. The Switch contains the updated table that decides where the data is transmitted or not. Switch delivers the message to the correct destination based on the physical address present in the incoming message. A Switch does not broadcast the message to the entire network like the Hub. It determines the device to which the message is to be transmitted. Therefore, we can say that switch provides a direct connection between the source and destination. It increases the speed of the network.

Router

- A router is a hardware device which is used to connect a LAN with an internet connection. It is used to receive, analyze and forward the incoming packets to another network.
- A router works in a **Layer 3 (Network layer)** of the OSI Reference model.
- A router forwards the packet based on the information available in the routing table.
- It determines the best path from the available paths for the transmission of the packet.

Advantages of Router:

- **Security:** The information which is transmitted to the network will traverse the entire cable, but the only specified device which has been addressed can read the data.
- **Reliability:** If the server has stopped functioning, the network goes down, but no other networks are affected that are served by the router.
- **Performance:** Router enhances the overall performance of the network. Suppose there are 24 workstations in a network generates a same amount of traffic. This increases the traffic load on the network. Router splits the single network into two networks of 12 workstations each, reduces the traffic load by half.

Gateway

A gateway, as the name suggests, is a passage to connect two networks together that may work upon different networking models. They basically work as the messenger agents that take data from one system, interpret it, and transfer it to another system. Gateways are also called protocol converters and can operate at any network layer. Gateways are generally more complex than switch or router.

Repeater

A repeater operates at the physical layer. Its job is to regenerate the signal over the same network before the signal becomes too weak or corrupted so as to extend the length to which the signal can be transmitted over the same network. An important point to be noted about repeaters is that they do not amplify the signal. When the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength. It is a 2 port device.

1. **List any three characteristics of LAN.**

   Ans :
   - LAN is used for connecting two or more personal computers through a communication medium such as twisted pair, coaxial cable, etc.
   - It is less costly as it is built with inexpensive hardware such as hubs, network adapters, and Ethernet cables.
   - The data is transferred at an extremely faster rate in Local Area Network.

2. **Write a short note on Repeater.**

   Ans: Repeaters are network devices operating at physical layer of the OSI model that amplify or regenerate an incoming signal before retransmitting it. They are incorporated in networks to expand its coverage area. They are also known as signal boosters.

3. **Write the full form of CSMA/CD. What is CSMA/CD?**

   Ans: Carrier Sense Multiple Access / Collision Detection, a set of rules determining how network devices respond when two devices attempt to use a data channel simultaneously (called a collision). Standard Ethernet networks use CSMA/CD to physically monitor the traffic on the line at participating stations.

4. **What is token ring? Explain briefly.**

   Ans : A token ring network is a local area network (LAN) in which all computers are connected in a ring topology and pass one or more logical tokens from host to host. Only a host that holds a token can send data, and tokens are released when receipt of the data is confirmed. Token ring networks prevent data packets from colliding on a network segment because data can only be sent by a token holder and the number of tokens available is controlled.

5. **What is a switch?**

   Ans: A network switch is a hardware device that channels incoming data from multiple input ports to a specific output. It filters and forwards network packets from one networking device (switch, router, computer, server, etc.) to another. It is widely used in local area networks (LANs) to send each incoming message frame by looking at the physical device address.

6. **Define the term MAC address.**

   Ans: A MAC address is a hardware identification number that uniquely identifies each device on a network. The MAC address is manufactured into every network card, such as an Ethernet card, and therefore cannot be changed. A MAC address comprises of six groups of two hexadecimal digits, separated by hyphens, colons, or no separators. An example of a MAC address is 00:0A:89:5B:F0:11.

7. **What are the approaches followed by MAC?**
   Ans:
   - Controlled access
   - Contention based access

8. **Write the primary functions of router.**

   Ans : The router basically performs two major functions:

   1. **Forwarding –**
      Router receives the packets from its input ports, checks it header, performs some basic functions like checking checksum and then looks up to the routing table to find the appropriate output port to dump the packets onto, and forwards the packets onto that output port.
   2. **Routing –**
      Routing is the process by which the router ascertains the best path for the packet to reach the destination. It maintains a routing table which is made using different algorithms by the router only.

9. **Mention any two examples of LAN.**
   Ans :
   a. Networking in home, office
   b. Networking between a printer and several computers