Batch: D-2	**Roll No.:** 16010122151
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

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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

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

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New Concepts to be learned: Layer wise connecting devices

Stepwise-Procedure:

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Study of Connecting Devices

1. Hub

Functionality: A hub is a physical layer networking device that is used to connect multiple devices in a network. They are generally used to connect computers to a LAN. A hub has many ports in it. A computer that intends to be connected to the network is plugged in to one of these ports.

Layer of operation: Hubs operate at physical layer (layer 1) of OSI model.

Technical Features:

- Operates in half duplex mode
- Available in 4 to 24 port sizes
- Hosts are responsible for collision detection and retransmission of packets.
- There are three types of viz. active hub, passive hub and intelligent hub.

Pros:

- It can extend the total distance of the network.
- It does not seriously affect performance of the network.
- It is cheaper.
- It can connect different media types.

Cons:

- It does not have mechanisms such as collision detection and retransmission of packets.
- It does not operate in full duplex mode.
- It cannot connect different network architectures such as token ring and Ethernet etc.
- It cannot filter information i.e., it passes packets to all the connected segments.

1. **Repeater:**

Functionality: When an electrical signal is transmitted via a channel, it gets attenuated depending upon the nature of the channel or the technology. This poses a limitation upon the length of the LAN or coverage area of cellular networks. This problem is alleviated by installing repeaters at certain intervals. Repeaters amplify the attenuated signal and then retransmit it. Digital repeaters reconstruct signals distorted by transmission loss. Analog repeaters amplify the analog signal.

Layer of operation: Repeaters are network devices operating at the physical layer of the OSI model that amplify or regenerate an incoming signal before retransmitting it.

Technical Features: According to the types of signals that they regenerate, repeaters can be classified into two categories:

- Analog Repeaters: They can only amplify the analog signal.
- Digital Repeaters: They can reconstruct a distorted signal.

According to the types of networks that they connect, repeaters can be categorized into two types:

- Wired Repeaters: They are used in wired LANs.
- Wireless Repeaters: They are used in wireless LANs and cellular networks.

According to the domain of LANs they connect, repeaters can be divided into two categories:

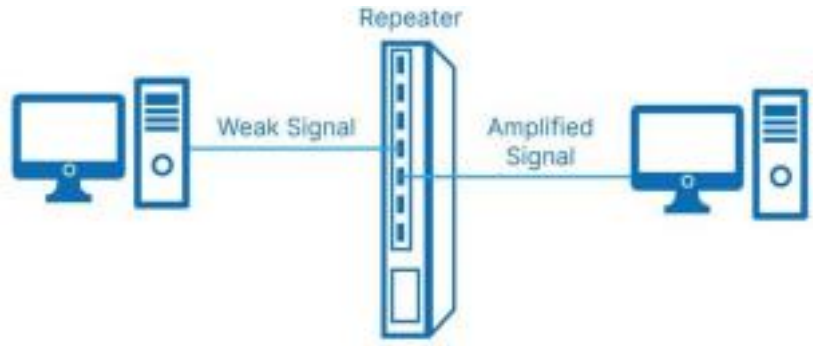
- Local Repeaters: They connect LAN segments separated by small distance.
- Remote Repeaters: They connect LANs that are far from each other.

Pros:

- Repeaters are simple to install and can easily extend the length or the coverage area of networks.
- They are cost effective.
- Repeaters don't require any processing overhead. The only time they need to be investigated is in case of degradation of performance.
- They can connect signals using different types of cables.

Cons:

- Repeaters cannot connect dissimilar networks.
- They cannot differentiate between actual signal and noise.
- They cannot reduce network traffic or congestion.
- Most networks have limitations upon the number of repeaters that can be deployed.



2. **Switch:**

Functionality:

A switch is a data link layer networking device which connects devices in a network and uses packet switching to send and receive data over the network. A switch also has many ports, to which computers are plugged in. However, when a data frame arrives at any port of a network switch, it examines the destination address and sends the frame to the corresponding device(s). Thus, it supports both unicast and multicast communications.

Layer of operation: A switch operates at the Data layer (Layer 2) of the OSI Reference Model.

Technical Features:

- It is available in various configurations and as per data transfer speeds such as 10/100/1000 Mbps or 10/100 Gbps.
- Operates in full duplex mode.

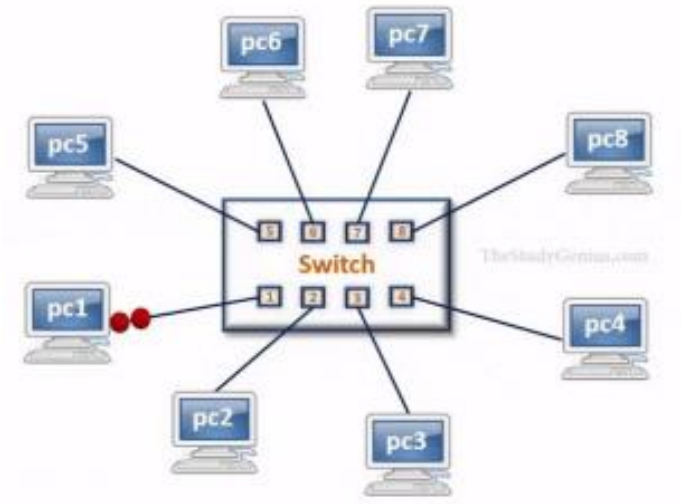
- Packet collision is avoided due to port to port data transmission.

Pros:

- They increase the available bandwidth of the network.
- They help in reducing workload on individual host PCs.
- They increase the performance of the network.
- Networks which use switches will have less frame collisions. This is due to the fact that switches create collision domains for each connection.
- Switches can be connected directly to workstations.

Cons:

- They are more expensive compared to network bridges.
- Network connectivity issues are difficult to be traced through the network switch.
- Broadcast traffic may be troublesome.
- Proper design and configuration is needed in order to handle multicast packets.
- While limiting broadcasts, they are not as good as routers.



3. **Bridge:**

Functionality: 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.

Layer of operation: A bridge operates at layer-2 i.e. data link layer of OSI stack.

Technical Features:

Three types of bridges are used in networks.

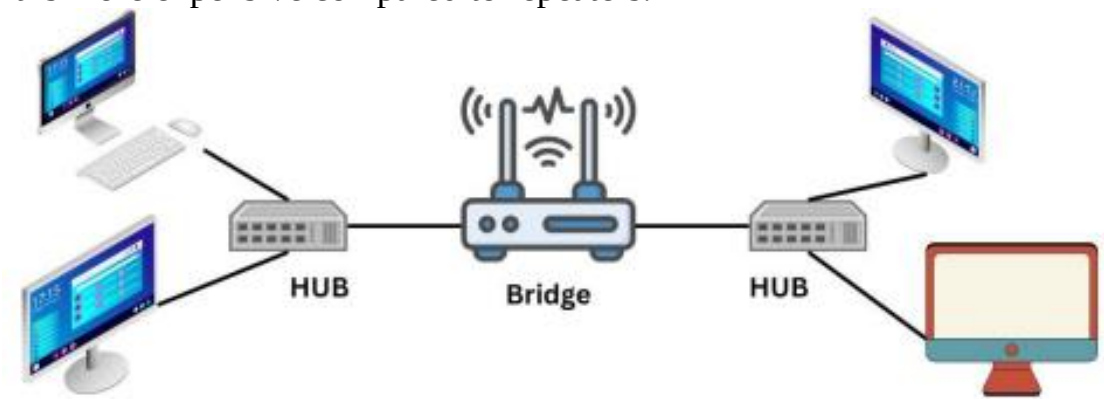
- Transparent Bridge: A transparent bridge is invisible to the other devices on the network. Transparent bridges perform only the function of blocking or forwarding data based on the MAC address; the devices on the network are oblivious to these bridges' existence. Transparent bridges are by far the most popular types of bridges.
- Translational Bridge: A translational bridge can convert from one networking system to another. As you might have guessed, it translates the data it receives. Translational bridges are useful for connecting two different networks, such as Ethernet and Token Ring networks. Depending on the direction of travel, a translational bridge can add or remove information and fields from the frame as needed.
- Source-route Bridge: Source-route bridges were designed by IBM for use on Token Ring networks. The source-route bridge derives its name from the fact that the entire route of the frame is embedded within the frame. This allows the bridge to make specific decisions about how the frame should be forwarded through the network. The diminishing popularity of Token Ring makes the chances that you'll work with a source-route bridge very slim.

Pros:

- It helps in extension of the physical network.
- It reduces network traffic with minor segmentation.
- It creates separate collision domains. Hence it increases available bandwidth to individual nodes as fewer nodes share a collision domain.
- It reduces collisions.
- Some bridges connect networks having different architectures and media types.

Cons:

- It is slower compared to repeaters due to filtering.
- It does not filter broadcasts.
- It is more expensive compared to repeaters.



4. **Router:**

Functionality: A Router is a networking device that forwards data packets between computer networks. A variety of routers are available depending upon their usages. The main types of routers are –

- Wireless Router− They provide Wi-Fi connection Wi-Fi devices like laptops, smartphones etc. They can also provide standard Ethernet routing. For indoor connections, the range is 150 feet while its 300 feet for outdoor connections.
- Broadband Routers− They are used to connect to the Internet through telephone and to use voice over Internet Protocol (VoIP) technology for providing high-speed Internet access. They are configured and provided by the Internet Service Provider (ISP).
- Core Routers− They can route data packets within a given network, but cannot route the packets between the networks. They help to link all devices within a network thus forming the backbone of network. It is used by ISP and communication interfaces.
- Edge Routers− They are low-capacity routers placed at the periphery of the networks. They connect the internal network to the external networks, and are suitable for transferring data packets across networks. They use Border Gateway Protocol (BGP) for connectivity. There are two types of edge routers, subscriber edge routers and label edge routers.
- Brouters− Brouters are specialised routers that can provide the functionalities of bridges as well. Like a bridge, brouters help to transfer data between networks. And like a router, they route the data within the devices of a network.

The router basically performs two major functions:

- Forwarding: Router receives the packets from its input ports, checks its 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.
- Routing: Routing is the process by which the router ascertains what is 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.

Layer of operation: Routers operate on the third layer of the OSI Model, the Network-Control Layer.

Technical Features:

- Input Port: This is the interface by which packets are admitted into the router, it performs several key functions as terminating the physical link at router.

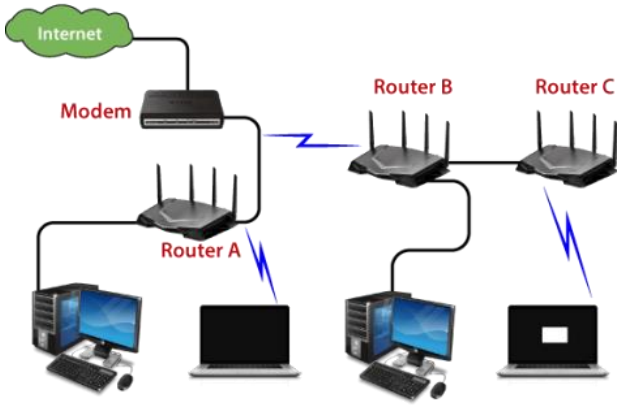
- Switching Fabric: This is the heart of the Router. It connects the input ports with the output ports. It is kind of a network inside a networking device.
- Output Port: This is the segment from which packets are transmitted out of the router. The output port looks at its queuing buffers (when more than one packets have to be transmitted through the same output port queuing buffers are formed) and takes packets, does link layer functions and finally transmits the packets to outgoing link.
- Routing Processor: It executes the routing protocols; it works like a traditional CPU. It employs various routing algorithms like link-state algorithm, distance-vector algorithm etc. to prepare the forwarding table, which is looked up to determine the forwarding table.

Pros:

- It provides connection between different network architectures such as Ethernet & token rings etc.
- It can choose the best path across the internetwork using dynamic routing algorithms.
- It can reduce network traffic by creating collision domains and also by creating broadcast domains.
- It provides sophisticated routing, flow control and traffic isolation.
- They are configurable which allows network managers to make policy based on routing decisions.

Cons:

- They operate based on routable network protocols.
- They are expensive compared to other network devices.
- Dynamic router communications can cause additional network overhead. This results in less bandwidth for user data.
- They are slower as they need to analyse data from layer-1 through layer-3.
- They require a considerable amount of initial configurations.



5. **Gateway:**

Functionality: Gateway is a network connecting device that can be used to connect two devices in two different networks implementing different networking protocols and overall network architecture.

Layer of operation: A gateway operates on all the layers of the OSI model.

Technical Features: There are two types of gateways that perform as the nodes specifically to connect the servers and other business systems in a comprehensive business association. The two prototypes of gateway subsuming:

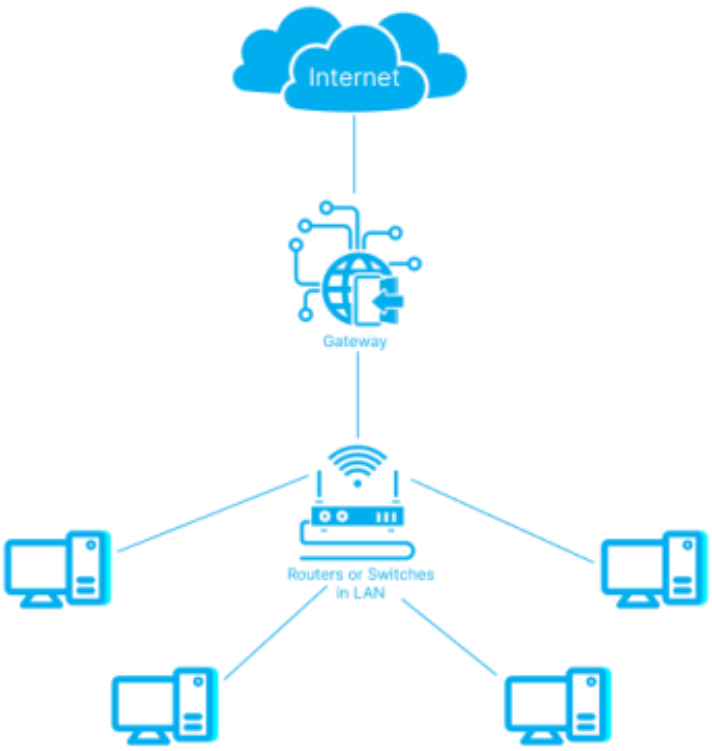
- Bidirectional Gateway.
- Unidirectional Gateway.

Pros:

- It can connect the devices of two different networks having dissimilar structures.
- It is an intelligent device with filtering capabilities.
- It has control over both collisions as well as a broadcast domain.
- It uses a full-duplex mode of communication.
- It has the fastest data transmission speed amongst all network connecting devices.
- It can perform data translation and protocol conversion of the data packet as per the destination network's need.
- It can encapsulate and decapsulate the data packets.
- It has improved security than any other network connecting device.

Cons:

- It is complex to design and implement.
- The implementation cost is very high.
- It requires a special system administration configuration.


Internet
Gateway
Routers or Switches
in LAN

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.

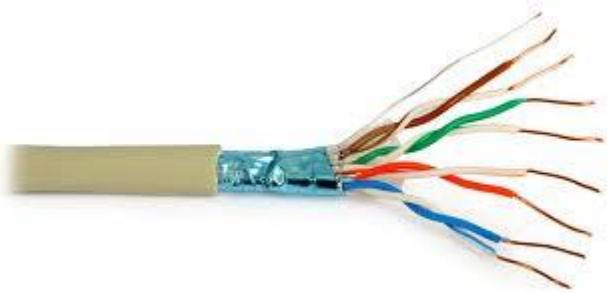


Fig 7.Twisted Pair Cable

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.

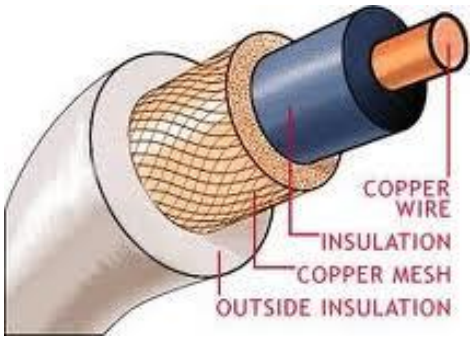


Fig 8.Coaxial Cable

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.

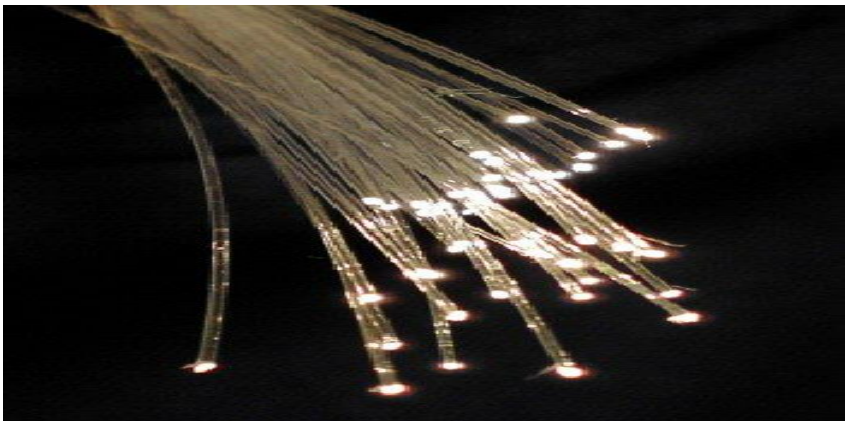


Fig 9.Fiber Optics Cable

Summary

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

CONCLUSION:-

In conclusion, connecting devices play a vital role in communication networks, serving as crucial components that establish and maintain seamless data transfer between various nodes and devices. These devices form the backbone of modern networks, enabling efficient data exchange and connectivity across diverse devices and locations.
Additionally, transmission media serve as the physical channels for data transmission in communication networks, offering different speed, capacity, and distance capabilities. The selection of appropriate transmission media is essential to ensure effective and reliable data transfer within the network.

Post Lab Questions

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

2. Hub

3. Function: A hub is a basic networking device that operates at the physical layer of the OSI model. It receives data packets from one port and broadcasts them to all other connected ports, regardless of the destination.
4. Use: Hubs are considered legacy devices and are rarely used in modern
5. networks. They are inefficient as they flood the network with unnecessary traffic,
6. leading to collisions and reduced network performance.
7.

8. Switch:

9. Function: A switch operates at the data link layer of the OSI model. It creates a dedicated connection (known as a switch port) between the sender and receiver
10. for data transmission, improving network efficiency by reducing collisions.
11. Use: Switches are widely used in local area networks (LANs) to improve network performance. They are essential for providing dedicated bandwidth to devices and facilitating efficient data transfer within a network.
12.

13. Bridge:

14. Function: A bridge operates at the data link layer and connects two separate network segments to form a single larger network. It examines the data link layer address (MAC address) of incoming packets and forwards them only to the appropriate segment.
15. Use: Bridges are used to expand network coverage and reduce network congestion. They are helpful in connecting LANs or segments of LANs that use the same network protocol.
16.

17. Gateway

18. Function: A gateway is a network node that acts as an entrance or exit point between two different networks with different communication protocols. It translates data between the two networks, allowing them to communicate effectively.
19. Use: Gateways are used to connect networks with different protocols, such as connecting a local network (e.g., LAN) to the internet (which uses various protocols like TCP/IP). They are crucial for enabling seamless communication between networks with different technologies.

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