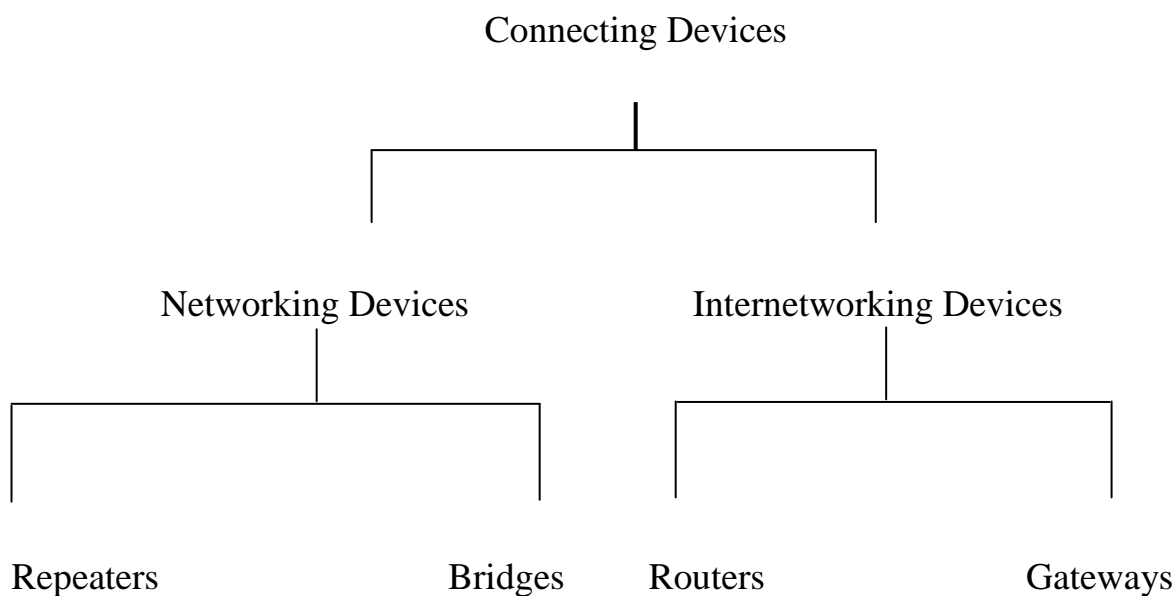


## Networking and Internetworking

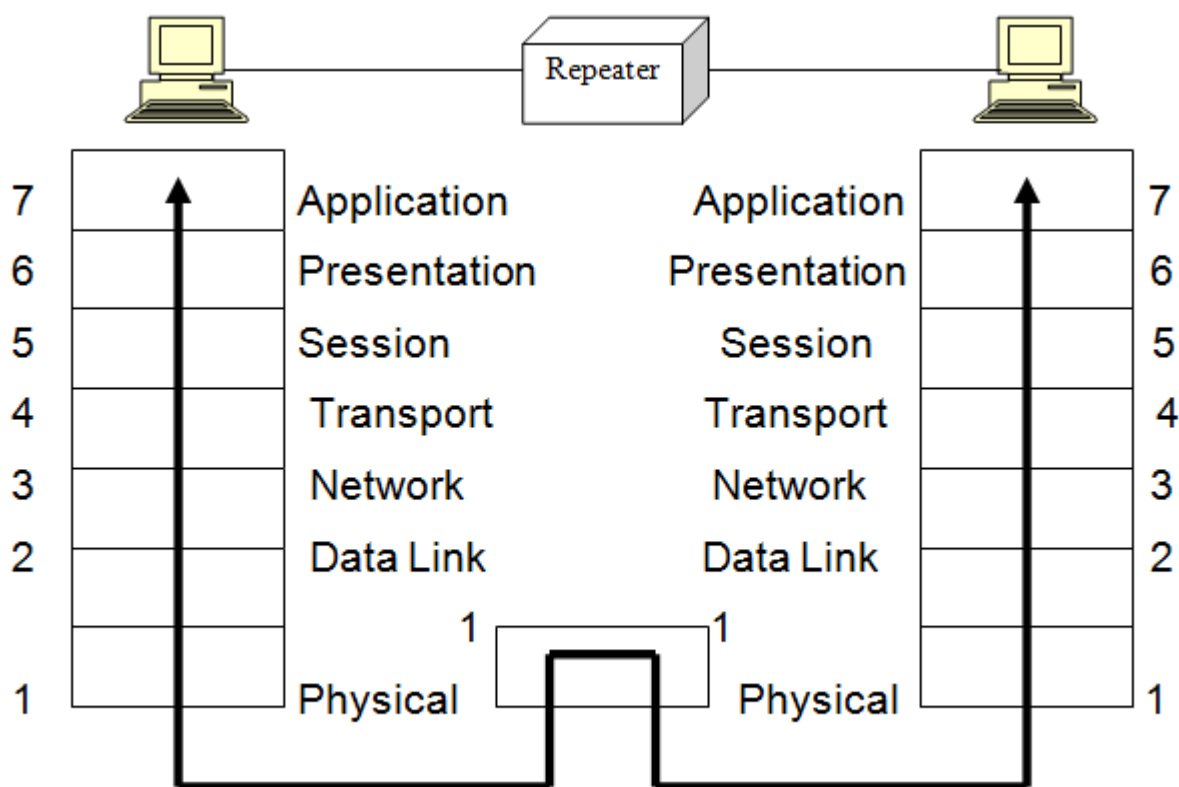
Two or more devices connected for the purpose of sharing data can form a network. Putting together a network is often more complicated than simply plugging cable into a hub. A LAN may need to cover more distance than its media can handle effectively. Or the number of stations may be too great for efficient delivery or management of the network, and the network may need to be subdivided.

Networking and internetworking devices are divided into four categories: repeaters, bridges, routers, and gateways as shown in figure below:



### 1- Repeaters:

A repeater (or regenerator) is an electronic device that operates on only the physical layer of the OSI model as shown in figure below:



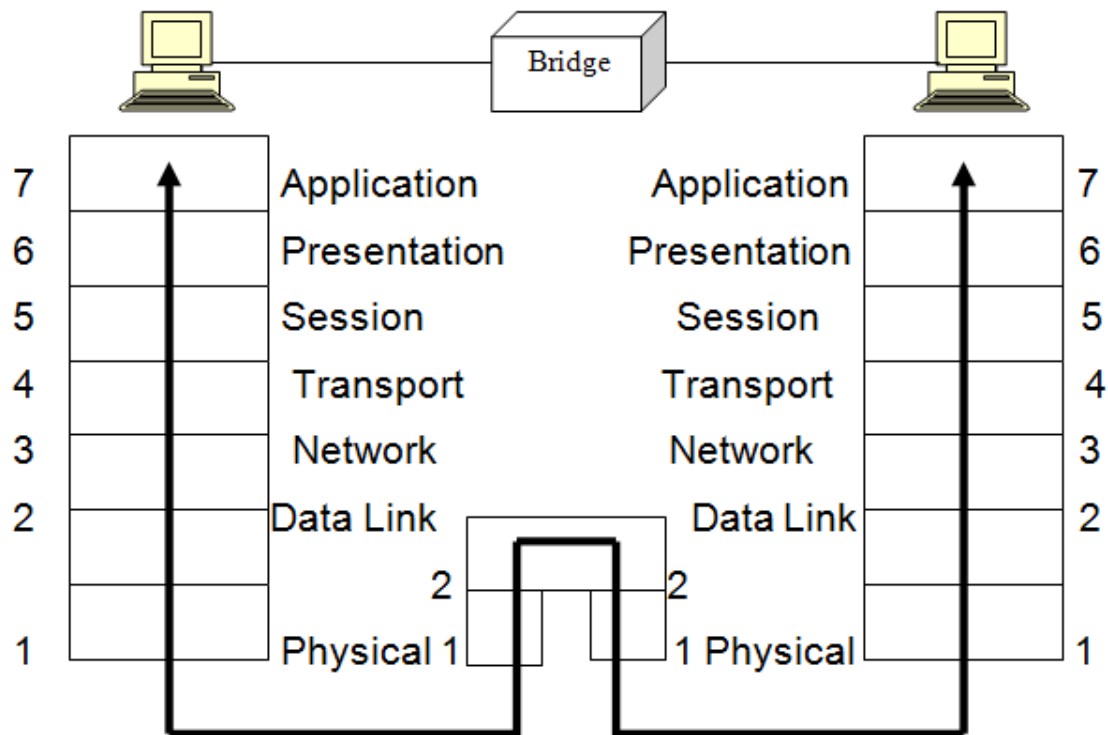
Signals that carry information within a network can travel a fixed distance before attenuation endangers the integrity of the data. A repeater installed on a link receives the signal before it becomes too weak or corrupted, regenerates the original bit pattern, and puts the refreshed copy back onto the link.

A repeater allows us to extend only the physical length of a network. The repeater does not change the functionality of the network in any way.

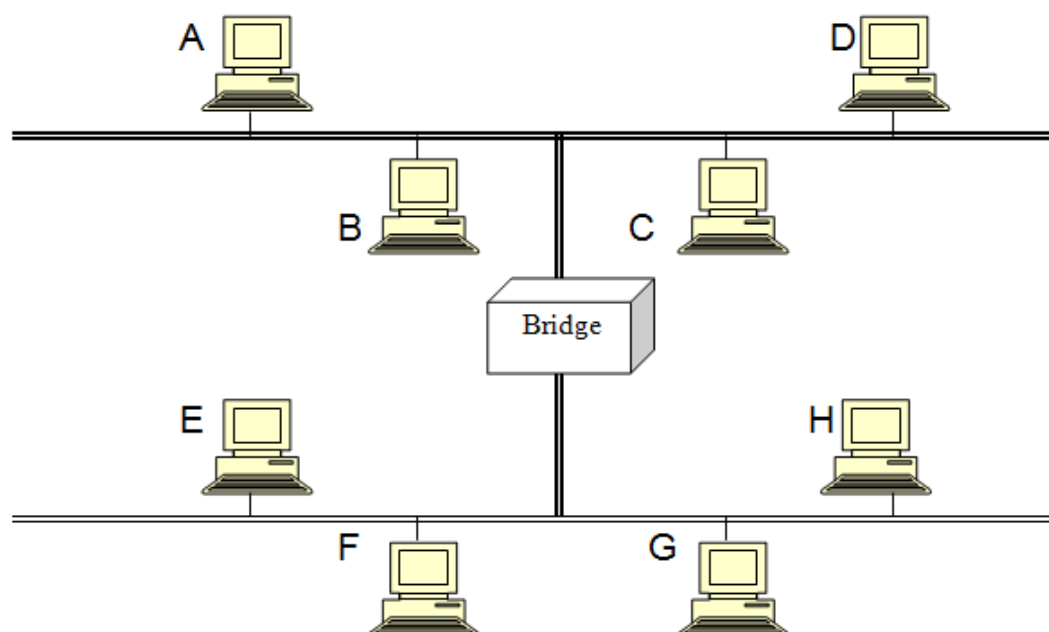
It is tempting to compare a repeater to an amplifier, but the comparison is inaccurate. An amplifier cannot discriminate between the intended signal and noise; it amplifies equally everything fed into it. A repeater does not amplify the signal; it regenerates it. When it receives a weakened or corrupted signal, it creates a copy bit for bit, at the original strength.

## 2- Bridges:

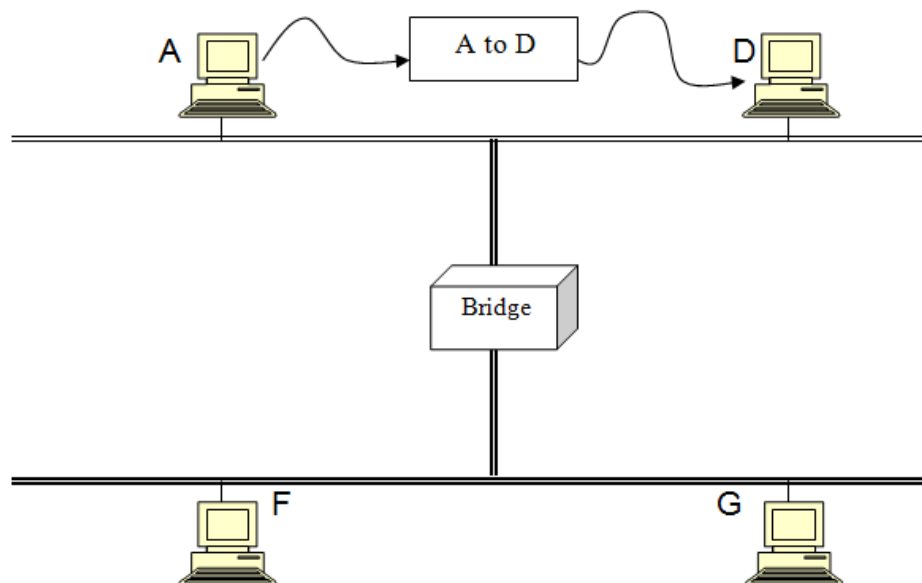
Bridges operate in both the physical and the data link layers of the OSI model as shown in following figure:



Bridges can divide a large network into smaller segments as shown in figure below:

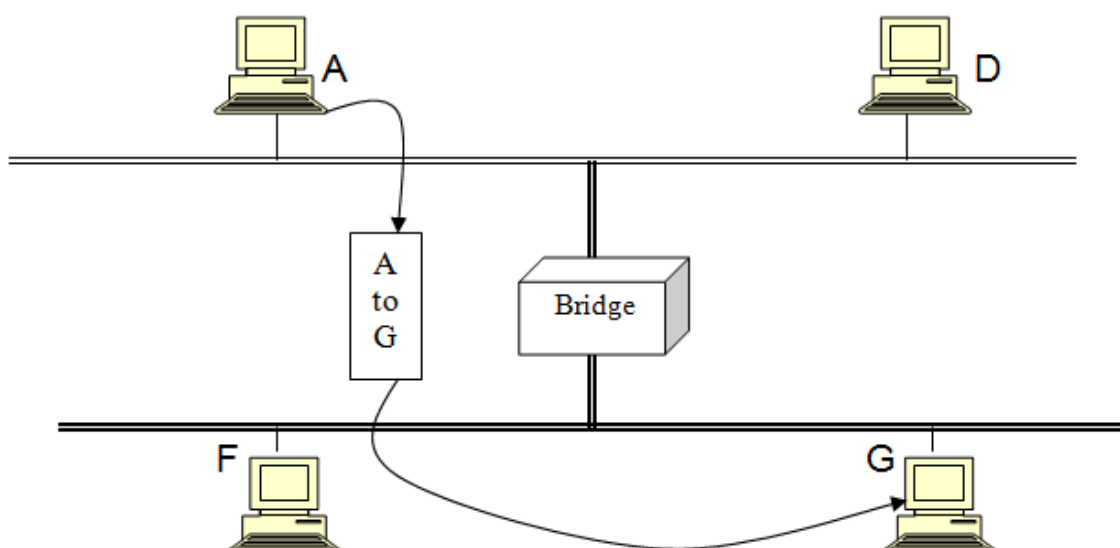


Unlike repeaters, however, bridges contain logic that allows them to keep the traffic for each segment separate. For example, figure below shows two segments joined by a bridge.



A packet from station A addressed to station D arrives at the bridge. Station A is on the segment as station D; therefore, the packet is blocked from crossing into the lower segment.

In figure below, a packet generated by station A is intended for station G. The bridge allows the packet to cross and relays it to the entire lower segment, where it is received by station G.



## Types of Bridges:

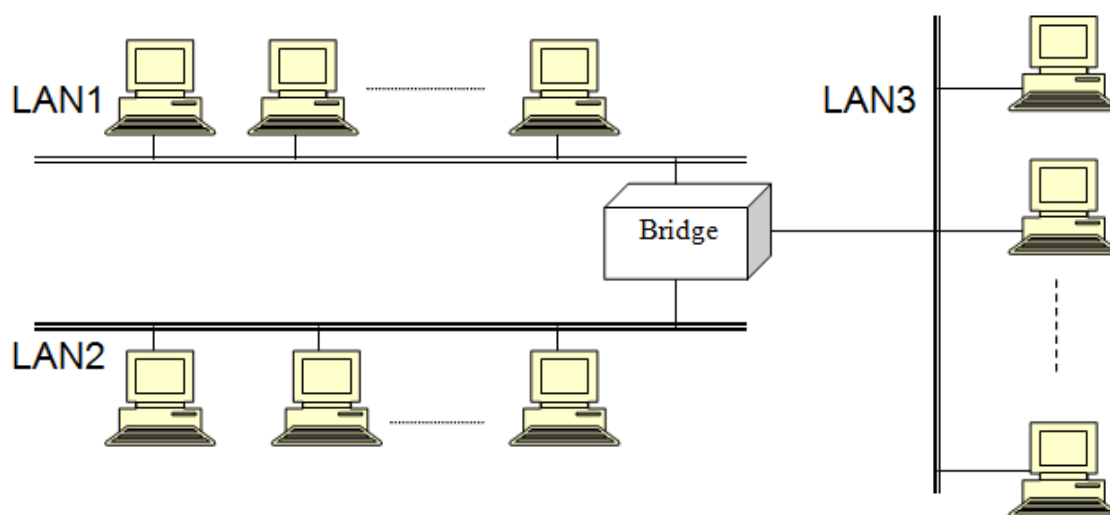
To select between segments, a bridge must have a look up table that contains the physical address of every station connected to it. The table indicates to which segment each station belongs.

### a- Simple Bridge:

Simple bridges are the most primitive and least expensive type of bridge. A simple bridge links two segments and contains a table that lists the address of all the stations included in each of them. What makes it primitive is that these addresses must be entered manually. Before a simple bridge can be used, an operator must sit down and enter the addresses of every station. Whenever a new station is added, the table must be modified. If a station is removed, the newly invalid address must be deleted.

### b- Multiport Bridge:

A multiport bridge can be used to connect more than two LANs, as shown in figure below:



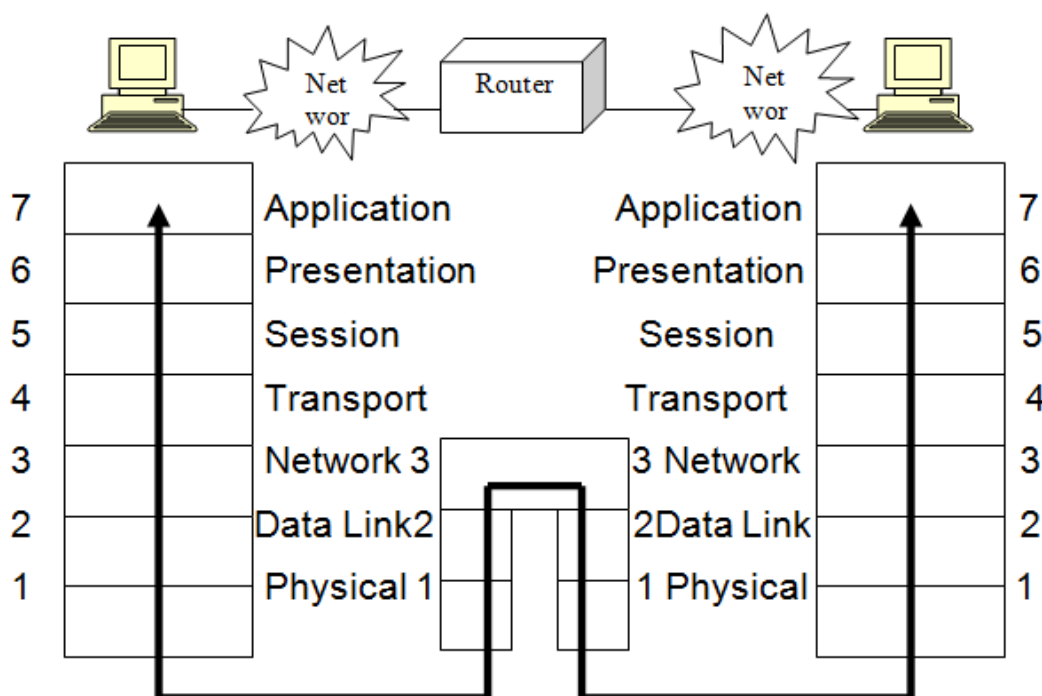
In this figure, the bridge has three tables, each one holding the physical addresses of stations reachable through the corresponding port.

### c- Transparent Bridge:

A transparent, or learning, bridge builds its table of station addresses on its own as it performs its bridge functions. When the transparent bridge is first installed, its table is empty. As it encounters each packet, it looks at both the destination and the source addresses. It checks the destination to decide where to send the packet. If it does not yet recognize the destination address, it relays the packet to all of the stations on both segments. It uses the source address to build its table. As it reads the source address, it notes which side the packet came from and associates that address with the segment to which it belongs.

### 3- Routers:

Repeaters and bridges are simple hardware devices capable of executing specific tasks. Routers are more sophisticated. They have access to network layer addresses and contain software that enables them to determine which of several possible paths between those addresses is the best for a particular transmission. Routers operate in the physical, data link, and network layers of the OSI model as shown in figure below:

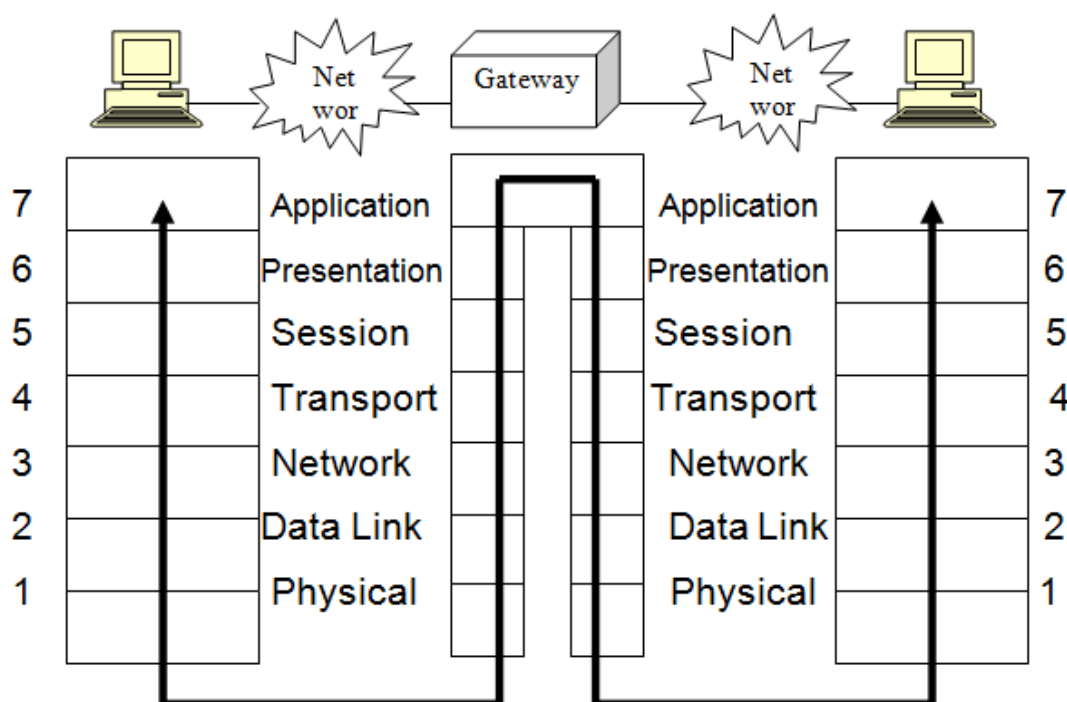


Routers act like stations on a network. But unlike most stations, which are members of only one network, routers have addresses on, and links to, two or more networks at the same

time. In their simplest function, they receive packets from one connected network and pass them to a second connected network.

#### 4- Gateways:

Gateways operate in all seven layers of the OSI model as shown in figure below:



A gateway is a protocol converter. A router by itself transfers, accepts, and relays packets only across networks using similar protocols. A gateway, on the other hand, can accept a packet formatted for one protocol and convert it to a packet formatted for another protocol before forwarding it.

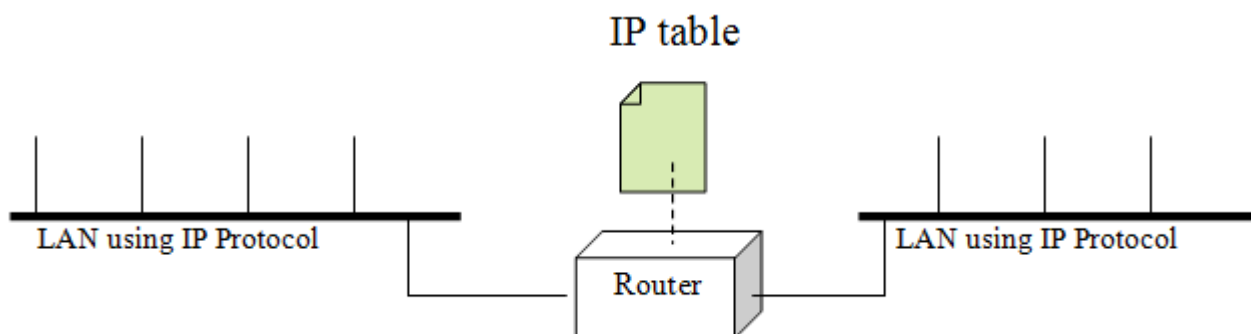
A gateway is generally software installed within a router. The gateway understands the protocols used by each network linked into the router and is therefore able to transfer from one to another.

#### Other Devices:

##### 1- Multiprotocol Routers:

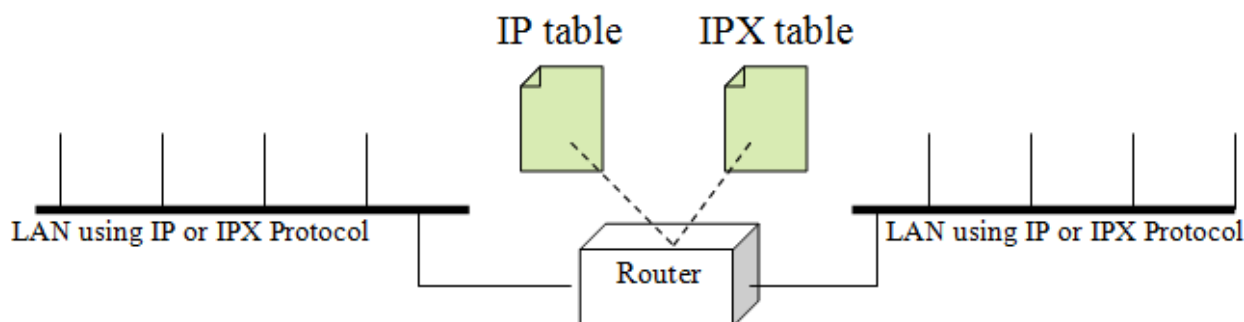
At the network layer, a router by default is a single protocol device. In other words, if two LANs are to be connected through a router, they should use the same protocol at the

network layer. However, multiprotocol routers have been designed to route packets belonging to two or more protocols. For example, two protocol routers can handle packets belonging to either of the two protocols, as shown in figure below:



Single protocol router

(The router passes only packets using IP, other packets are discarded)



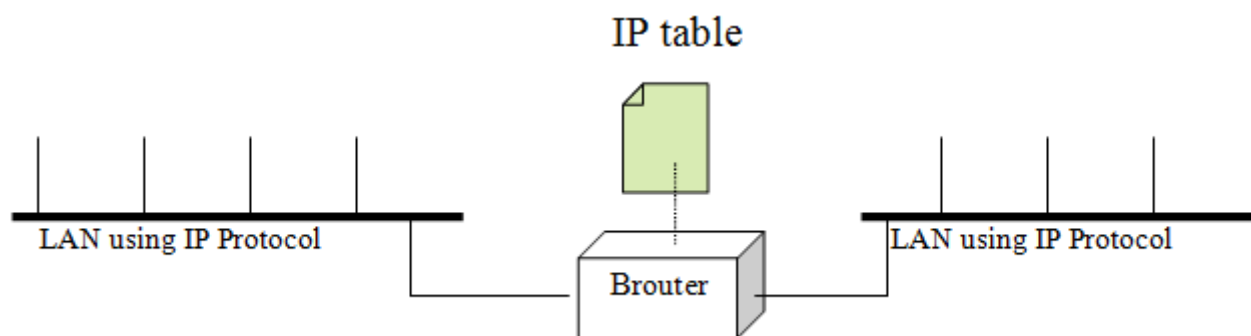
Multiprotocol router

(The router passes only packets using IP or IPX, other packets are discarded)

## 2- Brouters:

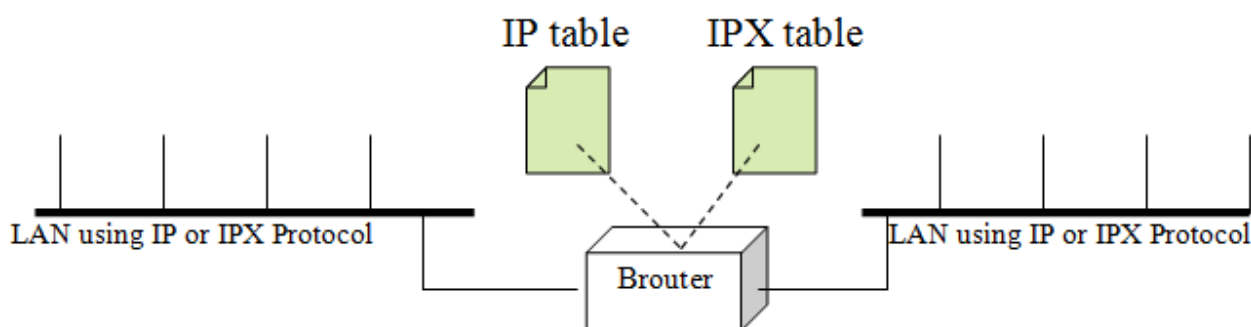
A brouter (bridge/router) is a single protocol or multiprotocol router that sometimes acts as a router and sometimes as a bridge. When a single protocol or multiprotocol brouter receives a packet belonging to one of the protocols for which it is designed, it routes the packet based on the network layer address; otherwise, it acts as a bridge and passes the packet using the data link layer address, as shown in figure below:





Single protocol router

(The router routes packets using IP, other packets are passed based on physical address)



Multiprotocol router

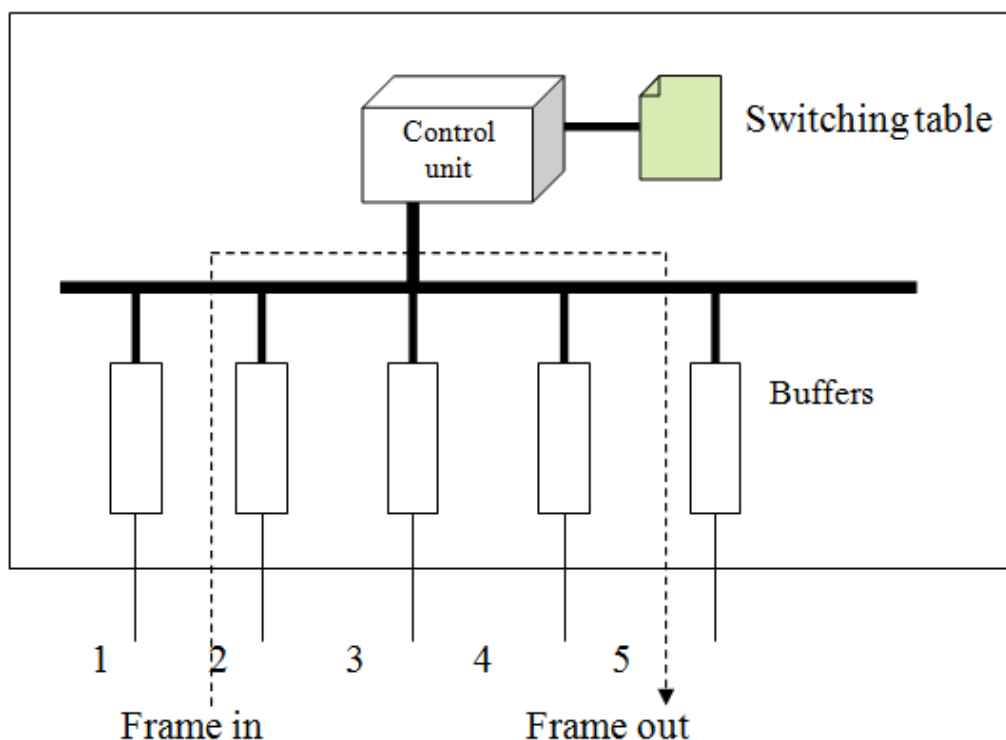
(The router routes packets using IP or IPX, other packets are passed based on physical address)

### 3- Switches:

A switch is a device that provides bridging functionality with greater efficiency. A switch may act as a multiport bridge to connect devices or segments in a LAN. The switch normally has a buffer for each link (network) to which is connected. When it receives a packet, it stores the packet in the going link. If the outgoing link is free, the switch sends the packet to that particular link.

Switches are made based on two different strategies (called fabrics): store-and-forward and cut-through. A store-and-forward switch stores the packet in the input buffer until the whole packet has arrived. A cut-through switch, on the other hand, forwards the packets to

the output buffer as soon as the destination address is received. The following figure shows the concept of a switch:



A packet arrives at port 2 and is stored in the buffer. The CPU and the control unit, using the information in the packet, consult the switching table to find the output port. The packet is then sent to port 5 for transmission.

A new generation of switches that are a combination of a router and a bridge has recently appeared on the market. These routing switches use the network layer destination address to find the output link to which the packet should be forwarded. The process is faster because the network layer software in a regular router finds only the network address of the next station and then passes this information to the data link layer software to find the output link.