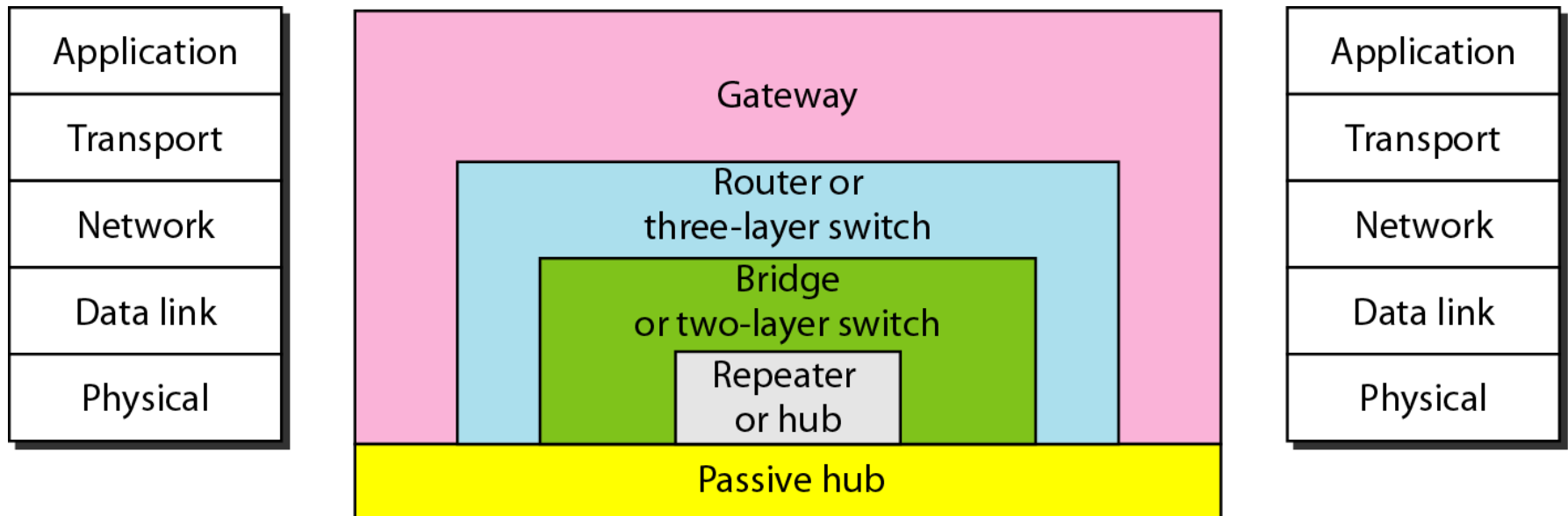# Networking Devices

Introduction

- LANs do not normally operate in isolation but they are connected to one another or to the Internet.

- To connect LANs, connecting devices are needed and various connecting devices are such as bridge, switch, router, hub, repeater.

CONNECTING DEVICES

- Connecting devices into five different categories based on the layer in which they operate in a network.

Five categories of connecting devices

Hubs

- A hub is used as a central point of connection among media segments.
- Cables from network devices plug in to the ports on the hub.
- Types of HUBS :
  - A **passive hub** is just a connector. It connects the wires coming from different branches.
  - The signal pass through a passive hub without regeneration or amplification.
  - Connect several networking cables together
  - **Active hubs or Multiport repeaters-** They regenerate or amplify the signal before they are retransmitted.
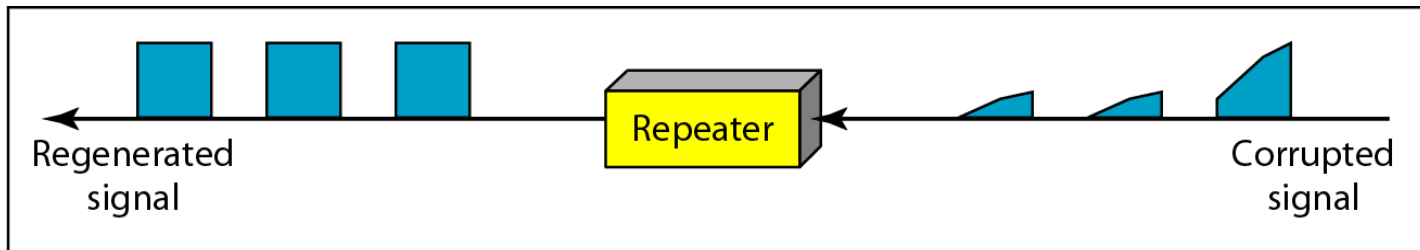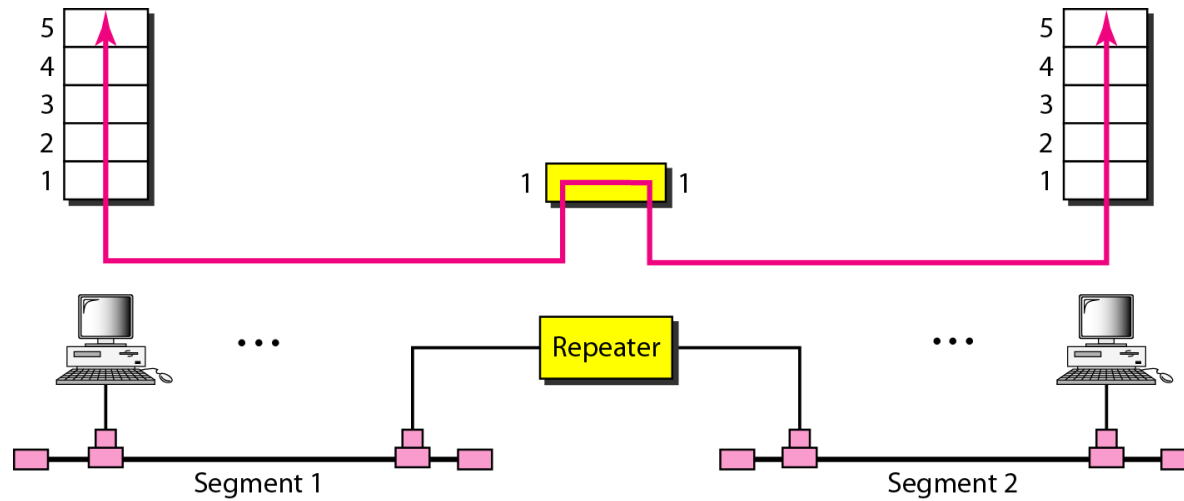
Repeaters

- A repeater is a device that operates only at the PHYSICAL layer.

- A repeater can be used to increase the length of the network by eliminating the effect of attenuation on the signal.

- It connects two segments of the same network, overcoming the distance limitations of the transmission media.

- A repeater forwards every frame; it has no filtering capability.

- A repeater is a regenerator, not an amplifier.

- Repeaters can connect segments that have the same access method. (CSMA/CD, Token Passing, Polling, etc.)
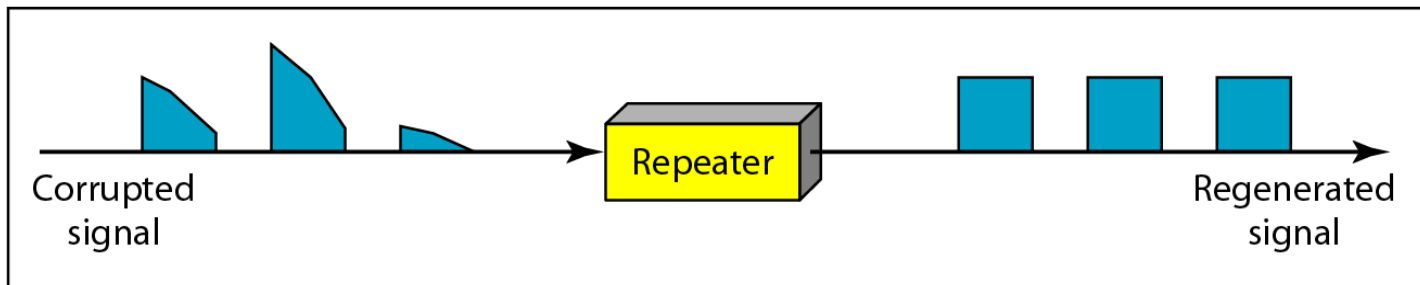
Optic fiber repeater

Repeater connecting two segments of a LAN

Segment 1

Segment 2

Regenerated signal

Repeater

Corrupted signal

a. Right-to-left transmission.

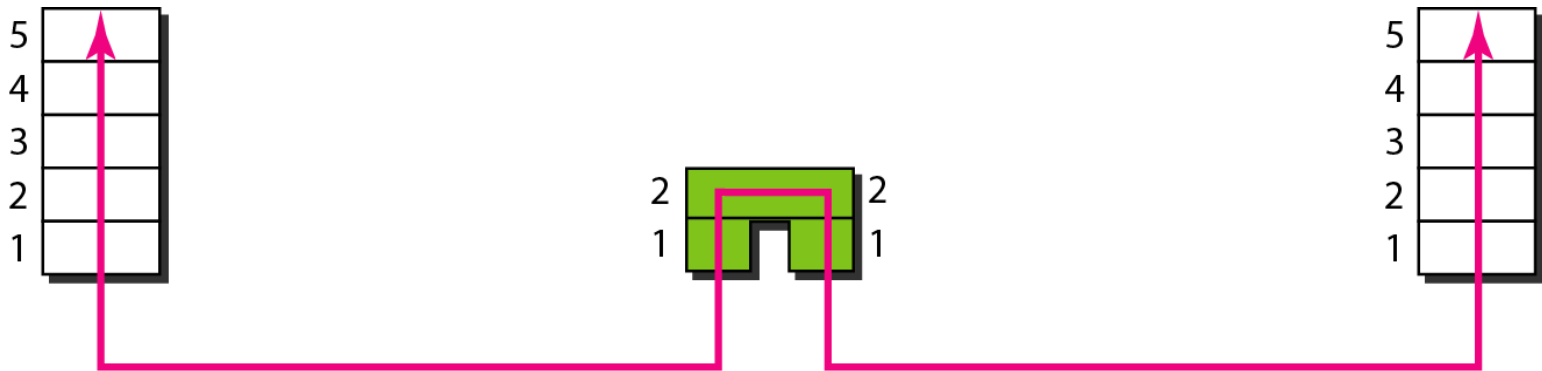Corrupted signal

Repeater

Regenerated signal

b. Left-to-right transmission.
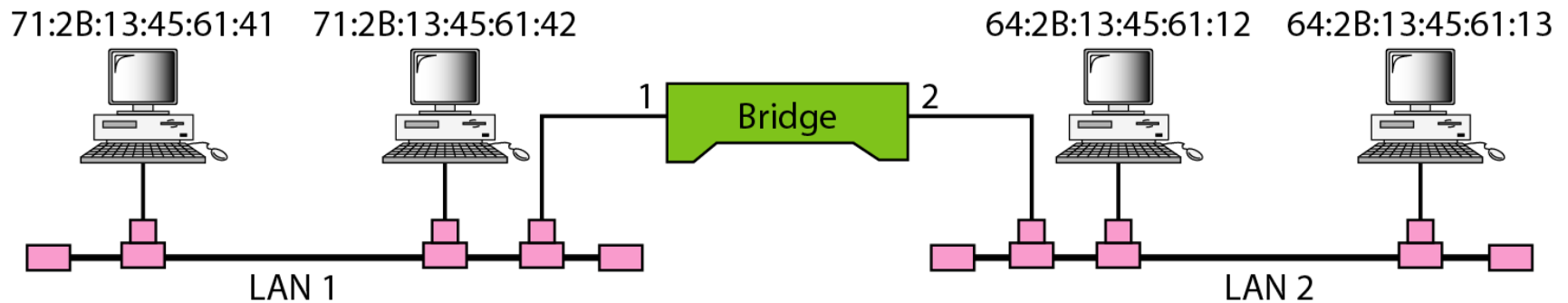
Function of a repeater

Bridges

- Operates in both the PHYSICAL and the data link layer.
- As a PHYSICAL layer device, it regenerates the signal it receives.
- As a data link layer device, the bridge can check the PHYSICAL/MAC addresses (source and destination) contained in the frame.
- A bridge has a table used in filtering decisions.
- It can check the destination address of a frame and decide if the frame should be forwarded or dropped.
- If the frame is to be forwarded, the decision must specify the port.
- A bridge has a table that maps address to ports.
- Limit or filter traffic keeping local traffic local yet allow connectivity to other parts (segments).

A bridge connecting two LANs

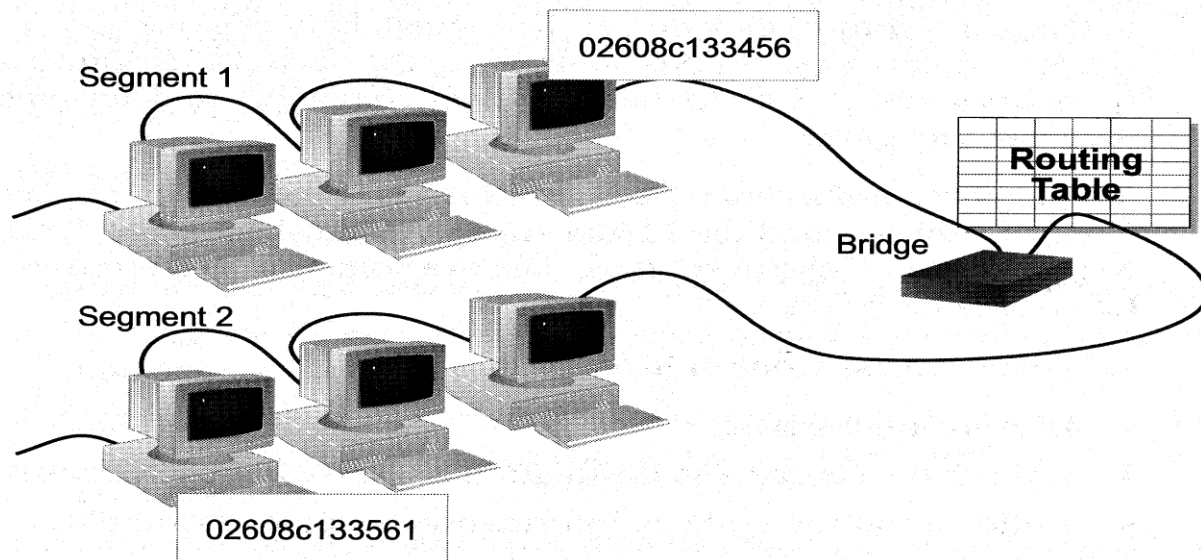| Address	Port
71:2B:13:45:61:41	1
71:2B:13:45:61:42	1
64:2B:13:45:61:12	2
64:2B:13:45:61:13	2

Bridge Table

A bridge does not change the physical (MAC) addresses in a frame.
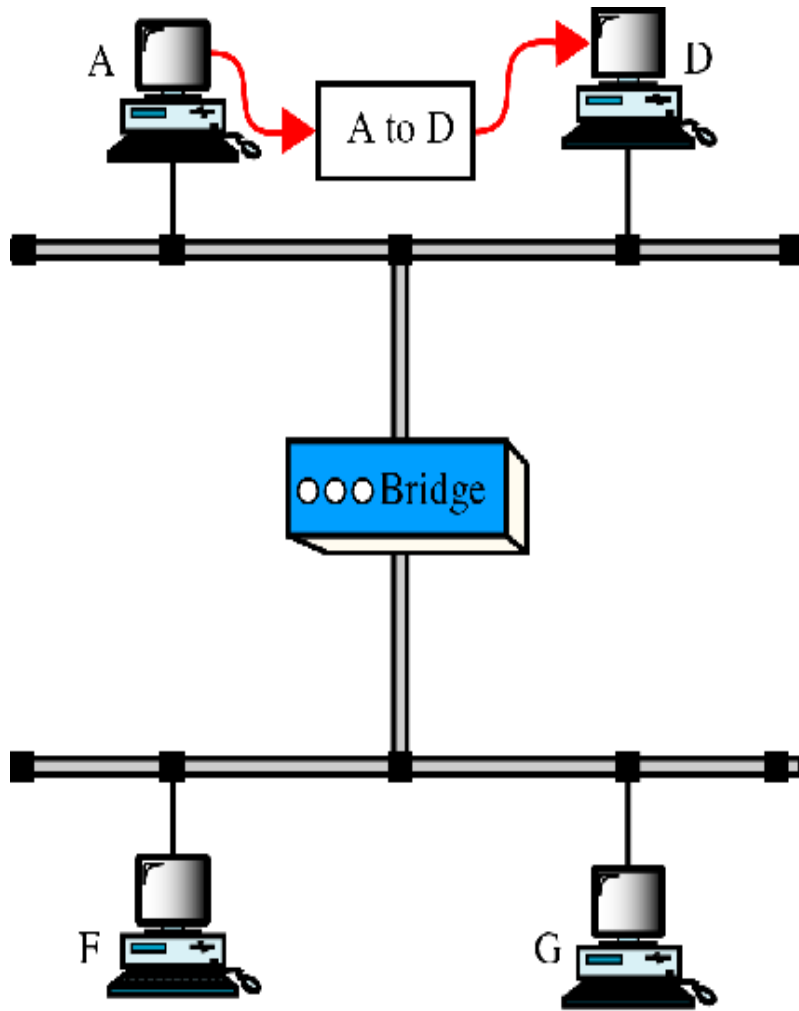
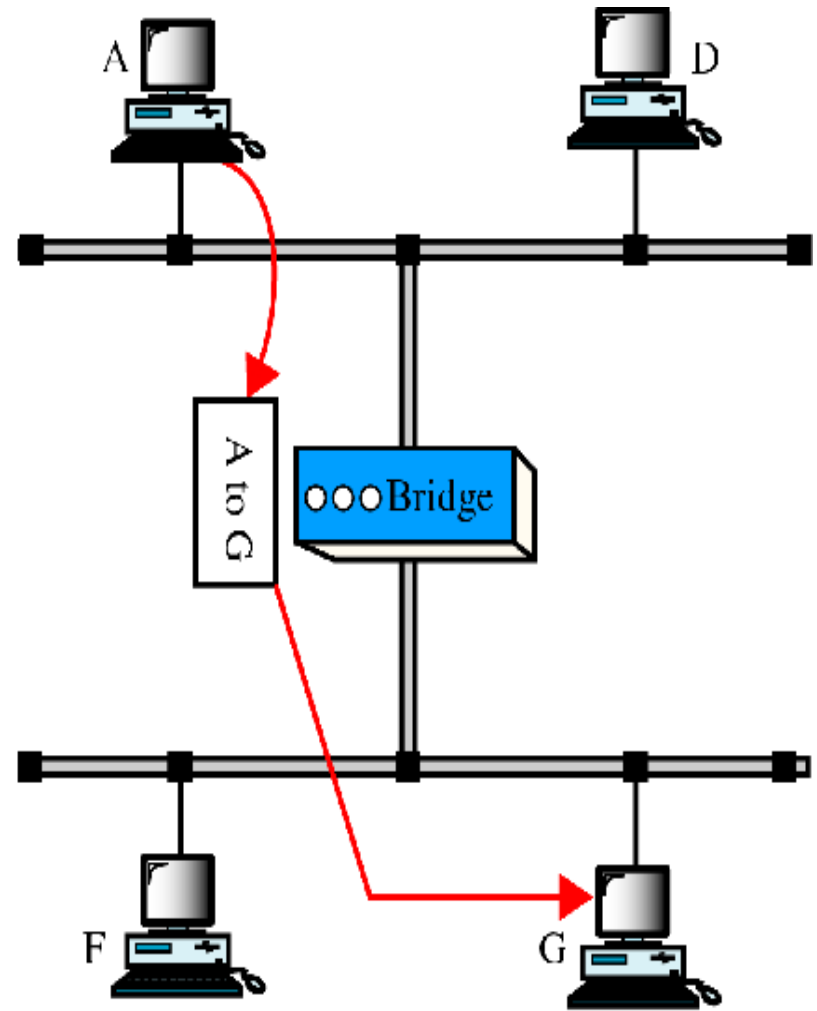# How Bridges Work

- Bridges work at the Media Access Control Sub-layer of the OSI model

    - Routing table is built to record the segment no. of address

    - If destination address is in the same segment as the source address, stop transmit

    - Otherwise, forward to the other segment

Function of Bridge

a. A packet from A to D

b. A packet from A to G

Characteristics of Bridges

- **Routing Tables**
  - Contains one entry per station of network to which bridge is connected.
  - Is used to determine the network of destination station of a received packet.
- **Filtering**
  - Is used by bridge to allow only those packets destined to the remote network.
  - Packets are filtered with respect to their destination and multicast addresses.
- **Forwarding**
  - the process of passing a packet from one network to another.
- **Learning Algorithm**
  - the process by which the bridge learns how to reach stations on the internetwork.

Types of Bridges

- Transparent Bridge
  - Also called learning bridges
  - Build a table of MAC addresses as frames arrive
  - Ethernet networks use transparent bridge
  - Duties of transparent bridge are : Filtering frames, forwarding and blocking
- Source Routing Bridge
  - Used in Token Ring networks
  - Each station should determine the route to the destination when it wants to send a frame and therefore include the route information in the header of frame.
  - Addresses of these bridges are included in the frame.
  - Frame contains not only the source and destination address but also the bridge addresses.

Advantages And Disadvantages Of Bridges

- Advantages of using a bridge
  - Extend physical network
  - Reduce network traffic with minor segmentation
  - Creates separate collision domains
  - Reduce collisions
  - Connect different architecture
- Disadvantages of using bridges
  - Slower that repeaters due to filtering
  - Do not filter broadcasts
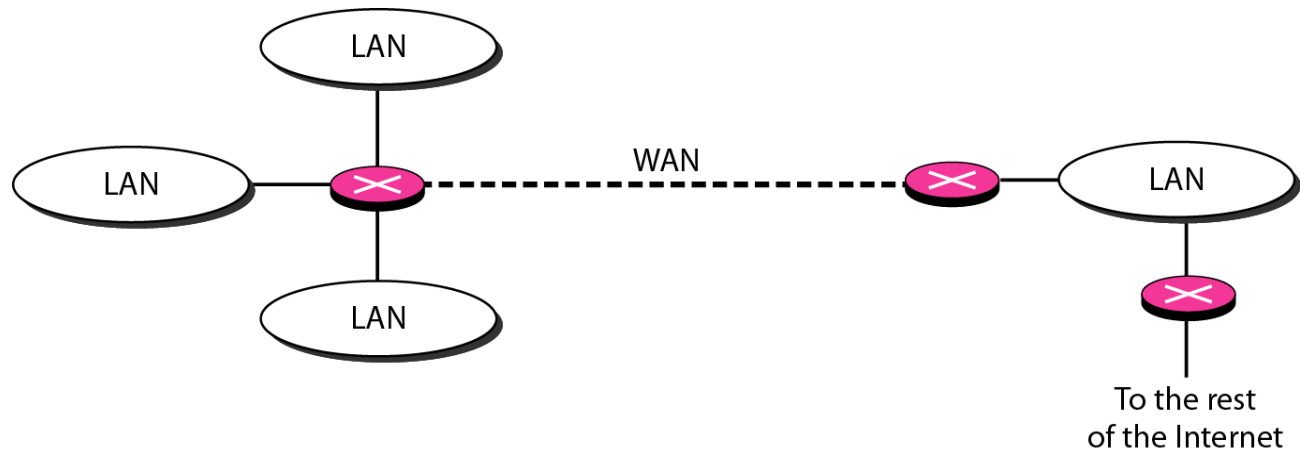 - More expensive than repeaters

Two and Three layer switches

- Two layer switch operate at PHY and data link layer
- Three layer switch operates at network layer
- Bridge is an example of two-layer switch.
- Bridge with few port can connect a few LANs
- Bridge with many port may be able to allocate a unique port to each station, with each station on its own independent entity. This means no competing traffic (no collision as we saw in Ethernet)

3-layer switches

- E.g. router.

- Routes packets based on their logical addresses (host-to-host addressing)

- A router normally connects LANs and WANs in the Internet and has a routing table that is used for making decision about the route.

- The routing tables are normally dynamic and are updated using routing protocols.

Routers connecting independent LANs and WANs

Advantages and Disadvantages of Routers

- Advantages
  - Routers
  - provide sophisticated routing, flow control, and traffic isolation
  - are configurable, which allows network manager to make policy based on routing decisions
  - allow active loops so that redundant paths are available
- Disadvantages
  - Routers
  - are protocol-dependent devices that must understand the protocol they are forwarding.
  - can require a considerable amount of initial configuration.
  - are relatively complex devices, and generally are more expensive than bridges.

Routers versus Bridges

- Addressing
  - Routers are explicitly addressed.
  - Bridges are not addressed.
- Availability
  - Routers can handle failures in links, stations, and other routers.
  - Bridges use only source and destination MAC address, which does not guarantee delivery of frames.
- Message Size
  » Routers can perform fragmentation on packets and thus handle different packet sizes.
  » Bridges cannot do fragmentation and should not forward a frame which is too big for the next LAN.
- Forwarding
  » Routers forward a message to a specific destination.
  » Bridges forward a message to an outgoing network.

- Priority
  - » Routers can treat packets according to priorities
  - » Bridges treat all packets equally.
- Error Rate
  - » Network layers have error-checking algorithms that examines each received packet.
  - » The MAC layer provides a very low undetected bit error rate.
- Security
  - » Both bridges and routers provide the ability to put "security walls" around specific stations.
  - » Routers generally provide greater security than bridges because
    - – they can be addressed directly and
    - – they use additional data for implementing security.

Brouters: Bridging Routers

- Combine features of bridges and routers.

- Capable of establishing a bridge between two networks as well as routing some messages from the bridge networks to other networks.

- Are sometimes called (Layer 2/3) switches and are a combination of bridge/router hardware and software.

Gateway

- Interchangeably used term router and gateway
- Connect two networks above the network layer of OSI model.
- Are capable of converting data frames and network protocols into the format needed by another network.
- Provide for translation services between different computer protocols.
- **Transport gateways** make a connection between two networks at the **transport layer.**
- **Application gateways** connect two parts of an application in the **application layer**, e.g., sending email between two machines using different mail formats
- Broadband-modem-router is one e.g. of gateway