Ministry of Higher Education and Scientific

Research Al-Mustaqbal University College

Department of Technical Computer Engineering

Lecture Number: 4

Computer Networks 3rd Stage

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NETWORK TOPOLOGY

A *topology* is a way of "laying out" the network.

Topologies can be either physical or logical.

Physical topologies describe how the cables are run.

Logical topologies describe how the network messages travel

NETWORK TOPOLOGY (CONT.)

Bus (can be both logical and physical)

Star (physical only)

Ring (can be both logical and physical)

Mesh (can be both logical and physical)

NETWORK TOPOLOGY (CONT.)

Bus

A bus is the simplest physical topology. It consists of a single cable that runs to every workstation

This topology uses the least amount of cabling, but also covers the shortest amount of distance.

Each computer shares the same data and address path. With a logical bus topology, messages pass through the trunk, and each workstation checks to see if the message is addressed to itself. If the address of the message matches the workstation's address, the network adapter copies the message to the card's on-board memory.

NETWORK TOPOLOGY (CONT.)

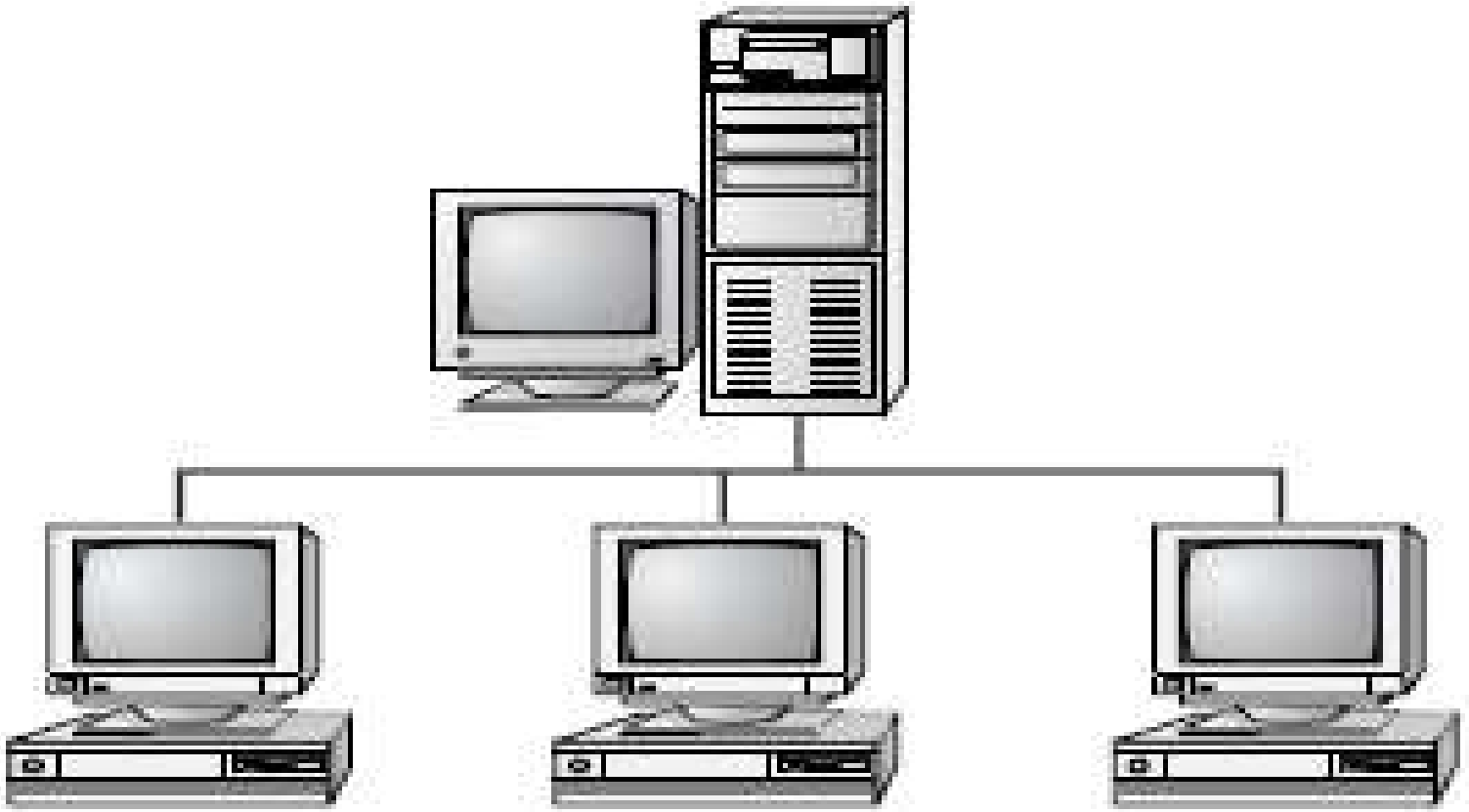
it is difficult to add a workstation

have to completely reroute the cable and possibly run two additional lengths of it.

if any one of the cables breaks, the entire network is disrupted. Therefore, it is very expensive to maintain.

NETWORK TOPOLOGY (CONT.)

Bus topology



NETWORK TOPOLOGY (CONT.)

Star Topology

A physical star topology branches each network device off a central device called a *hub*, making it very easy to add a new workstation.

Also, if any workstation goes down it does not affect the entire network. (But, as you might expect, if the central device goes down, the entire network goes down.)

Some types of Ethernet and ARCNet use a physical star topology. Figure 8.7 gives an example of the organization of the star network.

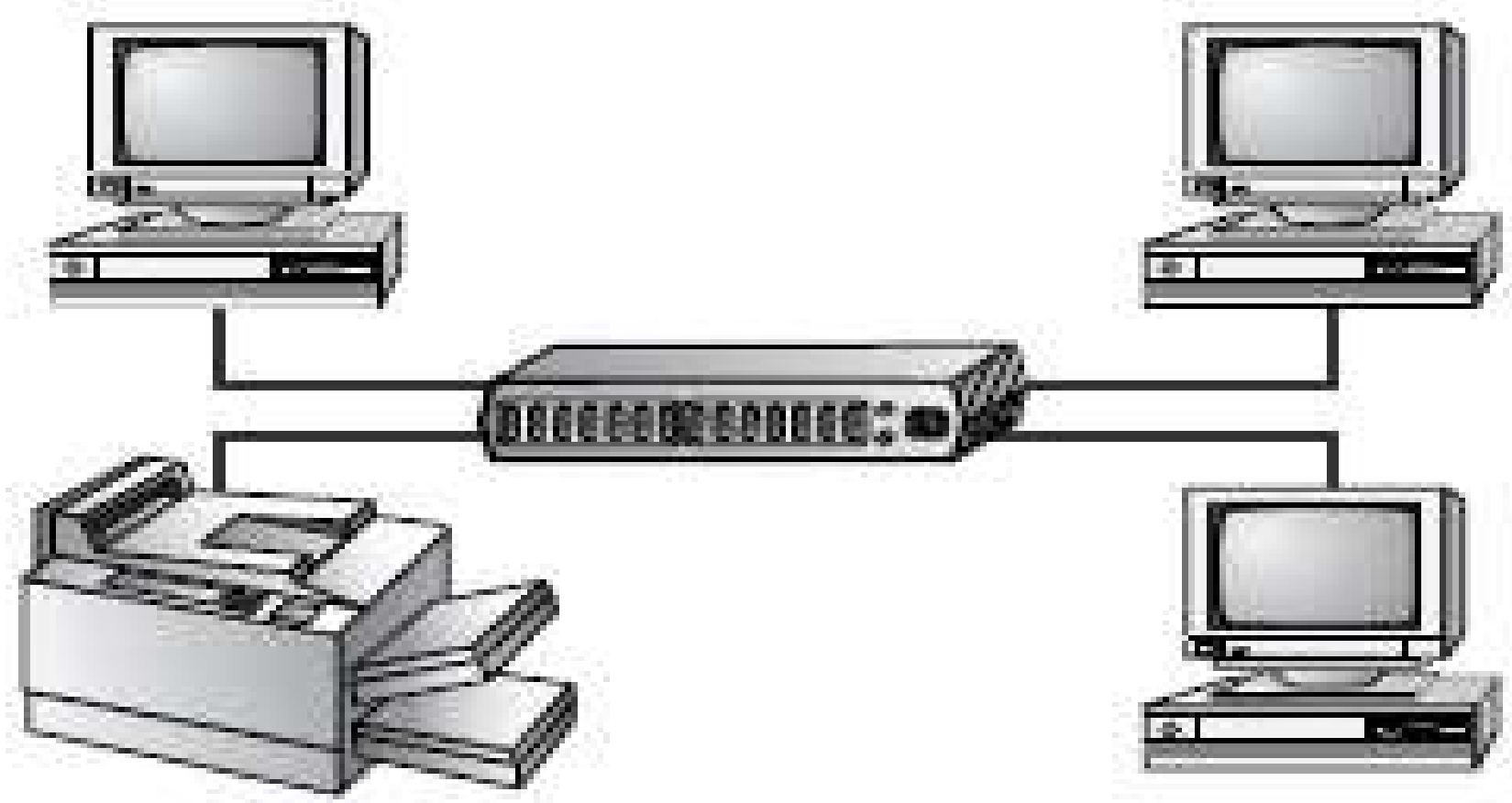
NETWORK TOPOLOGY (CONT.)

Star topologies are easy to install. A cable is run from each workstation to the hub. The hub is placed in a central location in the office.

Star topologies are more expensive to install than bus networks, because there are several more cables that need to be installed, plus the cost of the hubs that are needed.

NETWORK TOPOLOGY (CONT.)

Star Topology



NETWORK TOPOLOGY (CONT.)

Ring

Each computer connects to two other computers, joining them in a circle creating a unidirectional path where messages move workstation to workstation.

Each entity participating in the ring reads a message, then regenerates it and hands it to its neighbor on a different network cable.

NETWORK TOPOLOGY (CONT.)

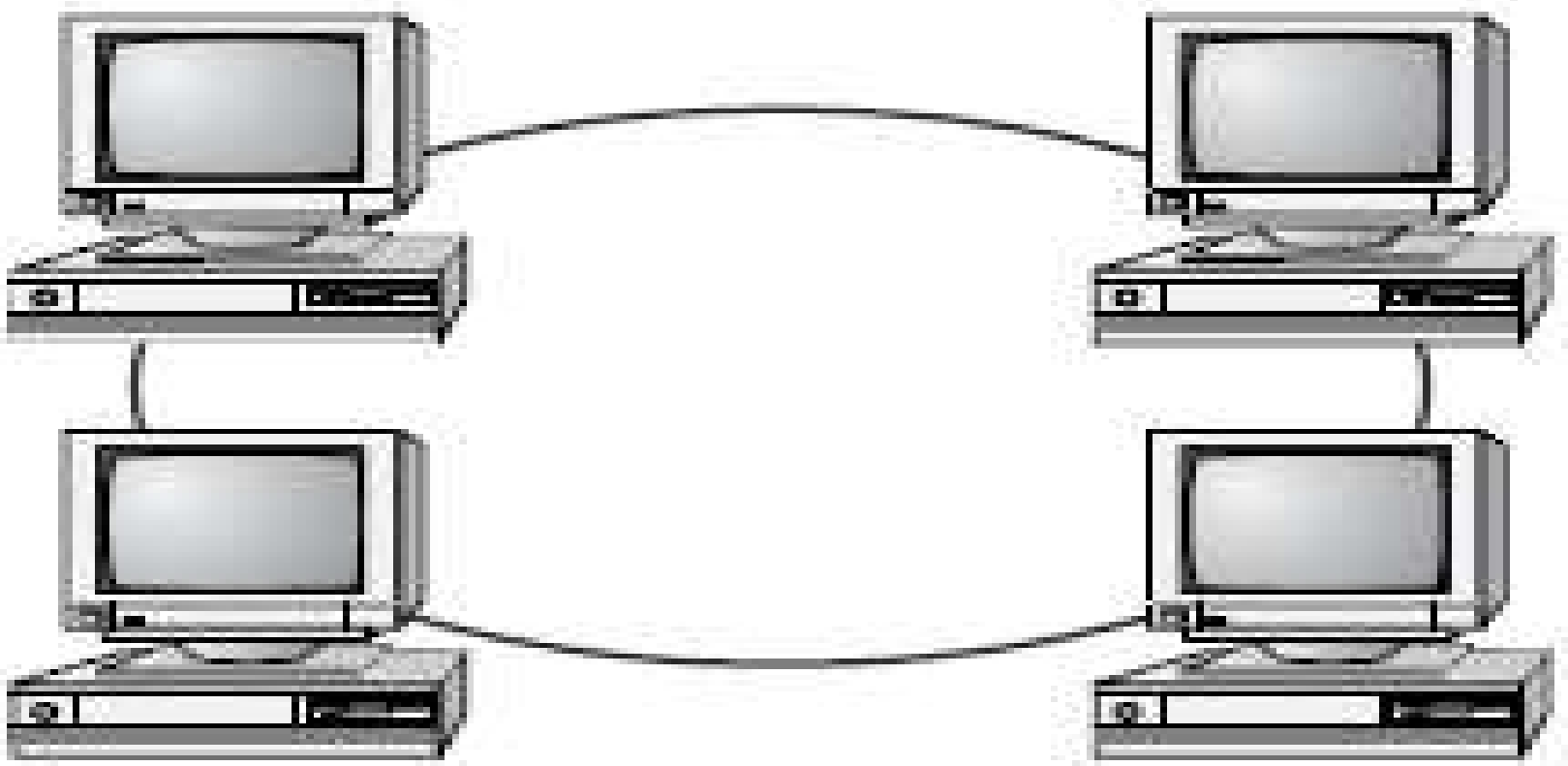
The ring makes it difficult to add new computers.

Unlike a star topology network, the ring topology network will go down if one entity is removed from the ring.

Physical ring topology systems don't exist much anymore, mainly because the hardware involved was fairly expensive and the fault tolerance was very low.

NETWORK TOPOLOGY (CONT.)

Ring Topology



NETWORK TOPOLOGY (CONT.)

Mesh

The *mesh topology* is the simplest logical topology in terms of data flow, but it is the most complex in terms of physical design.

In this physical topology, each device is connected to every other device

This topology is rarely found in LANs, mainly because of the complexity of the cabling.

If there are x computers, there will be $(x \times (x-1)) \div 2$ cables in the network. For example, if you have five computers in a mesh network, it will use $5 \times (5 - 1) \div 2$, which equals 10 cables. This complexity is compounded when you add another workstation.

For example, your five-computer, 10-cable network will jump to 15 cables just by adding one more computer. Imagine how the person doing the cabling would feel if you told them you had to cable 50 computers in a mesh network—they'd have to come up with $50 \times (50 - 1) \div 2 = 1225$ cables!

NETWORK TOPOLOGY (CONT.)

Because of its design, the physical mesh topology is very expensive to install and maintain.

Cables must be run from each device to every other device. The advantage you gain from it is its high fault tolerance.

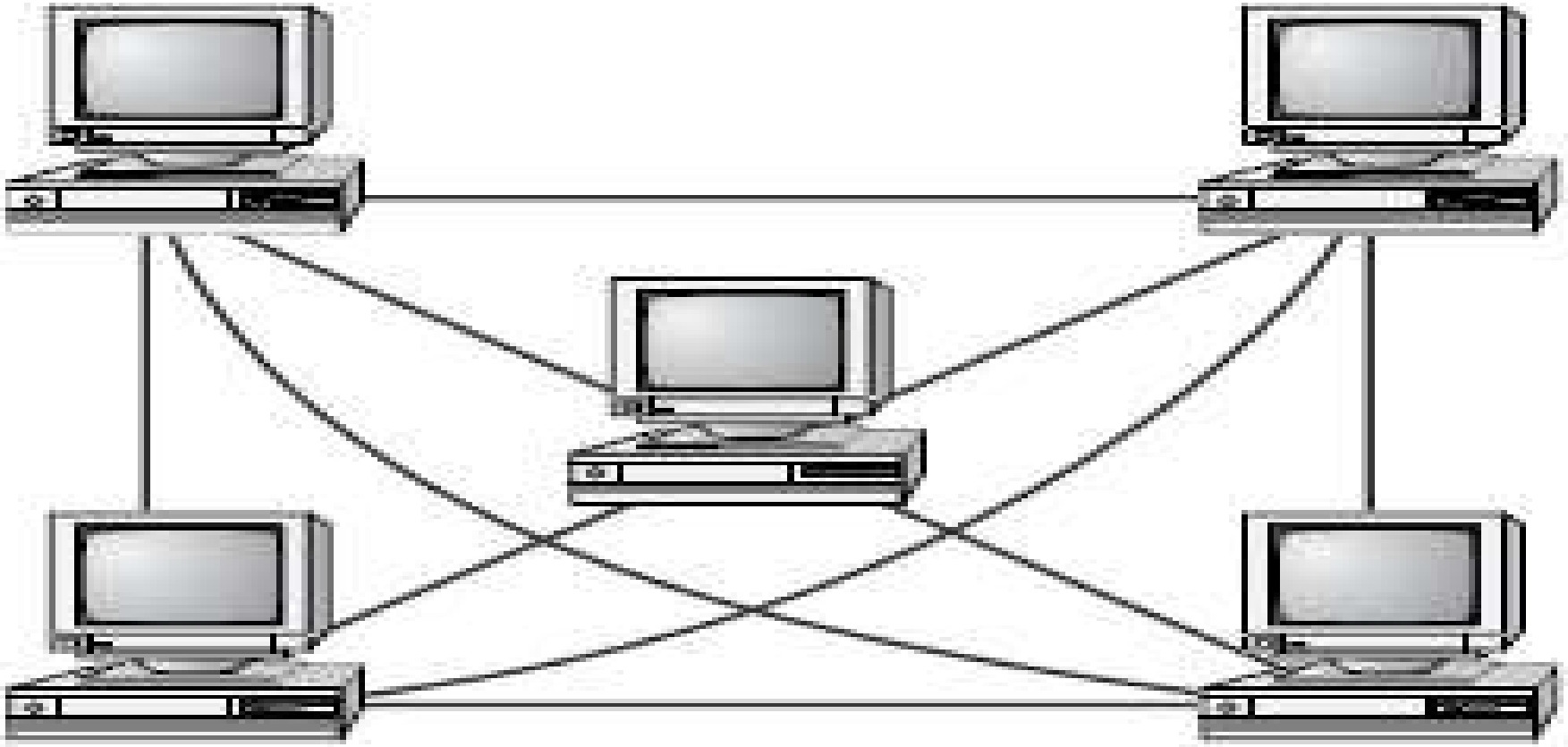
With a logical mesh topology, however, there will always be a way of getting the data from source to destination.

It may not be able to take the direct route, but it can take an alternate, indirect route. It is for this reason that the mesh topology is still found in WANs to connect multiple sites across WAN links. It uses devices called *routers* to search multiple routes through the mesh and determine the best path.

However, the mesh topology does become inefficient with five or more entities.

NETWORK TOPOLOGY (CONT.)

Mesh Topology



NETWORK TOPOLOGY (CONT.)

Advantages and Disadvantages of Network Topologies

Topology	Advantages	Disadvantages
Bus	Cheap. Easy to install.	Difficult to reconfigure. Break in bus disables entire network.
Star	Cheap. Easy to install. Easy to reconfigure. Fault tolerant.	More expensive than bus.
Ring	Efficient. Easy to install.	Reconfiguration difficult. Very expensive.
Mesh	Simplest. Most fault tolerant.	Reconfiguration extremely difficult. Extremely expensive. Very complex.

HARDWARE, SOFTWARE AND NETWORKS DEVICES

Network Interface Card (NIC)

Repeater

Hub

Bridge

Routers

Switch

HARDWARE, SOFTWARE AND NETWORKS PERIPHERALS (CONT.)

Network Interface Card (NIC)

NIC provides the physical interface between computer and cabling.

It prepares data, sends data, and controls the flow of data. It can also receive and translate data into bytes for the CPU to understand.

The following factors should be taken into consideration when choosing a NIC:

1. - Preparing data
2. - Sending and controlling data
3. - Configuration
4. - Drivers
5. - Compatibility
6. - Performance

HARDWARE, SOFTWARE AND NETWORKS PERIPHERALS (CONT.)
PREPARING DATA

In the computer, data moves along buses in parallel, as on a four-lane interstate highway. But on a network cable, data travels in a single stream, as on a one lane highway. This difference can cause problems transmitting and receiving data, because the paths traveled are not the same.

It is the NIC's job to translate the data from the computer into signals that can flow easily along the cable.

It does this by translating digital signals into electrical signals (and in the case of fiber-optic NICs, to optical signals).

HARDWARE, SOFTWARE AND NETWORKS PERIPHERALS (CONT.)
SENDING AND CONTROLLING DATA

For two computers to send and receive data, the cards must agree on several things. These include the following:

- The maximum size of the data frames
- The amount of data sent before giving confirmation
- The time needed between transmissions
- The amount of time needed to wait before sending confirmation
- The amount of data a card can hold
- The speed at which data transmits

In order to successfully send data on the network, you need to make sure the network cards are of the same type and they are connected to the same piece of cable.

CONFIGURATION

The NIC's configuration includes things like a manufacturer's hardware address, IRQ address, Base I/O port address, and base memory address. Some may also use DMA channels to offer better performance.

Each card must have a unique hardware address. If two cards have the same hardware addresses, neither one of them will be able to communicate.

HARDWARE, SOFTWARE AND NETWORKS PERIPHERALS (CONT.)
DRIVERS

For the computer to use the network interface card, it is very important to install the proper device drivers.

These drivers communicate directly with the network redirector and adapter. They operate in the Media Access Control sublayer of the Data Link layer of the OSI model.

COMPATIBILITY

When choosing a NIC, use one that fits the bus type of your PC. If you have more than one type of bus in your PC (for example, a combination ISA/PCI), use an NIC that fits into the fastest type (the PCI, in this case).

This is especially important in servers, as the NIC can very quickly become a bottleneck if this guideline isn't followed.

PERFORMANCE

The most important goal of the network adapter card is to optimize network performance and minimize the amount of time needed to transfer data packets across the network.

There are several ways of doing this, including assigning a DMA channel, use of a shared memory adapter, and deciding to allow bus mastering.

HARDWARE, SOFTWARE AND NETWORKS PERIPHERALS (CONT.)
REPEATERS

Repeaters are very simple devices. They allow a cabling system to extend beyond its maximum allowed length by amplifying the network voltages so they travel farther.

Repeaters are nothing more than amplifiers and, as such, are very inexpensive.

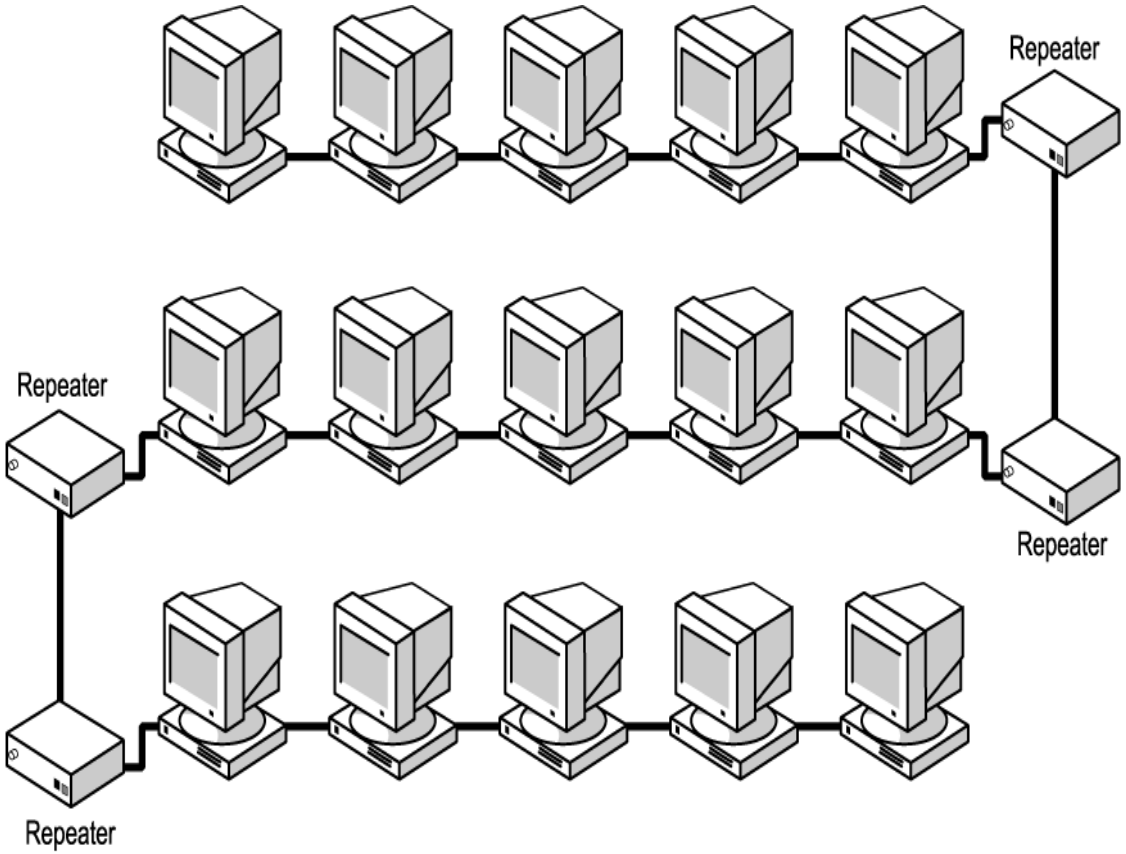
Repeaters can only be used to regenerate signals between similar network segments.

For example, we can extend an Ethernet 10Base2 network to 400 meters with a repeater. But can't connect an Ethernet and Token Ring network together with one.

The main disadvantage to repeaters is that they just amplify signals. These signals not only include the network signals, but any noise on the wire as well.

Eventually, if you use enough repeaters, you could possibly drown out the signal with the amplified noise. For this reason, repeaters are used only as a temporary fix.

HARDWARE, SOFTWARE AND NETWORKS PERIPHERALS (CONT.)
REPEATERS



HARDWARE, SOFTWARE AND NETWORKS PERIPHERALS (CONT.)

HUBS

Hubs are devices used to link several computers together.

They repeat any signal that comes in on one port and copy it to the other ports (a process that is also called *broadcasting*).

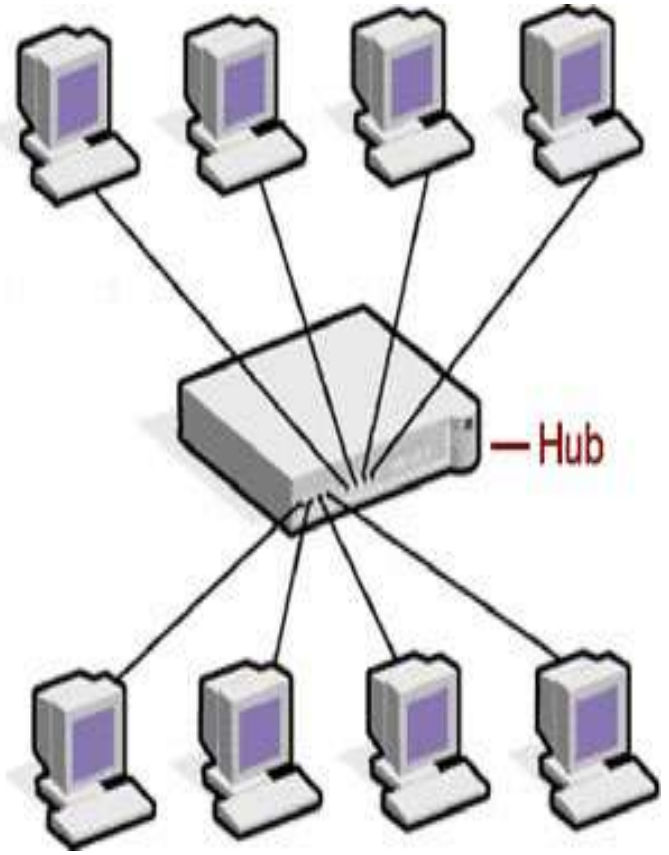
There are two types of hubs: active and passive.

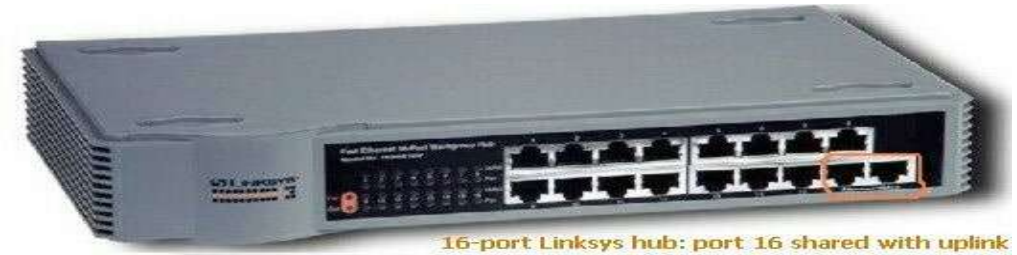
Passive hubs simply connect all ports together electrically and are usually not powered.

Active hubs use electronics to amplify and clean up the signal before it is broadcast to the other ports.

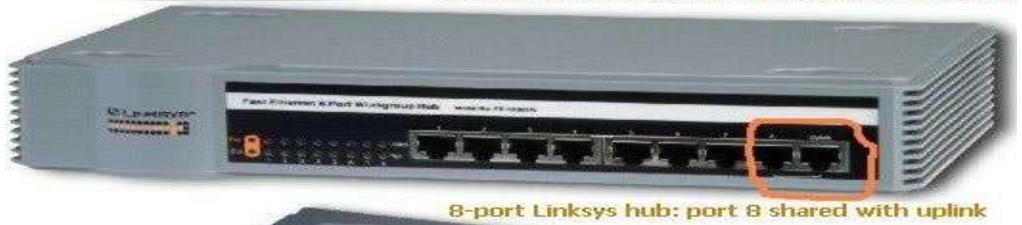
In the category of active hubs, there is also a class called "intelligent" hubs, which are hubs that can be remotely managed on the network.

HARDWARE, SOFTWARE AND NETWORKS PERIPHERALS (CONT.)
HUBS

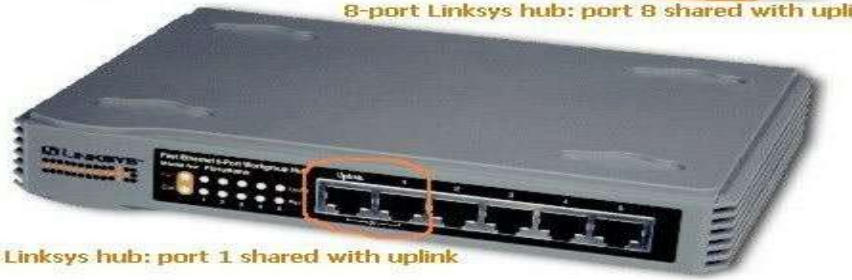




16-port Linksys hub: port 16 shared with uplink



8-port Linksys hub: port 8 shared with uplink



5-port Linksys hub: port 1 shared with uplink

8-port SMC Hub: port 8 shared with uplink

HARDWARE, SOFTWARE AND NETWORKS PERIPHERALS (CONT.)

BRIDGES

They join similar topologies and are used to divide network segments.

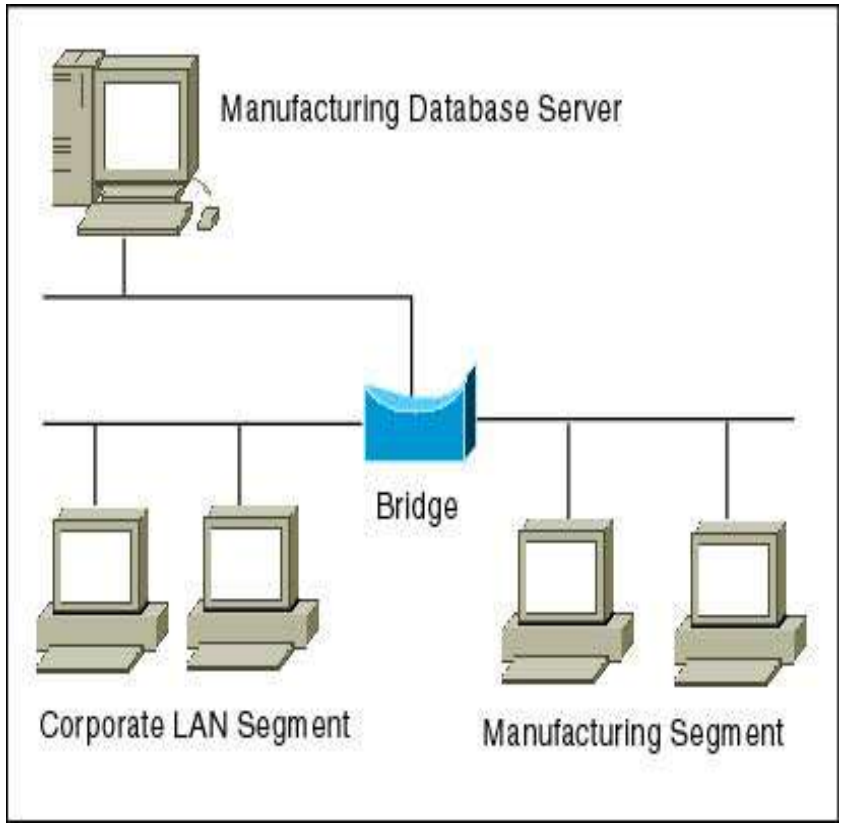
For example, with 200 people on one Ethernet segment, the performance will be ordinary, because of the design of Ethernet and the number of workstations that are fighting to transmit. If you divide the segment into two segments of 100 workstations each, the traffic will be much lower on either side and performance will increase.

If it is aware of the destination address, it is able to forward packets; otherwise a bridge will forward the packets to all segments. They are more intelligent than repeaters but are unable to move data across multiple networks at once.

Unlike repeaters, bridges *can* filter out noise.

The main disadvantage to bridges is that they can't connect different network types or perform intelligent path selection. For that function, we would need a router.

HARDWARE, SOFTWARE AND NETWORKS PERIPHERALS (CONT.)
BRIDGES



HARDWARE, SOFTWARE AND NETWORKS PERIPHERALS (CONT.)

ROUTERS

Routers are highly intelligent devices that connect multiple network types and determine the best path for sending data.

The advantage of using a router over a bridge is that routers can determine the best path that data can take to get to its destination.

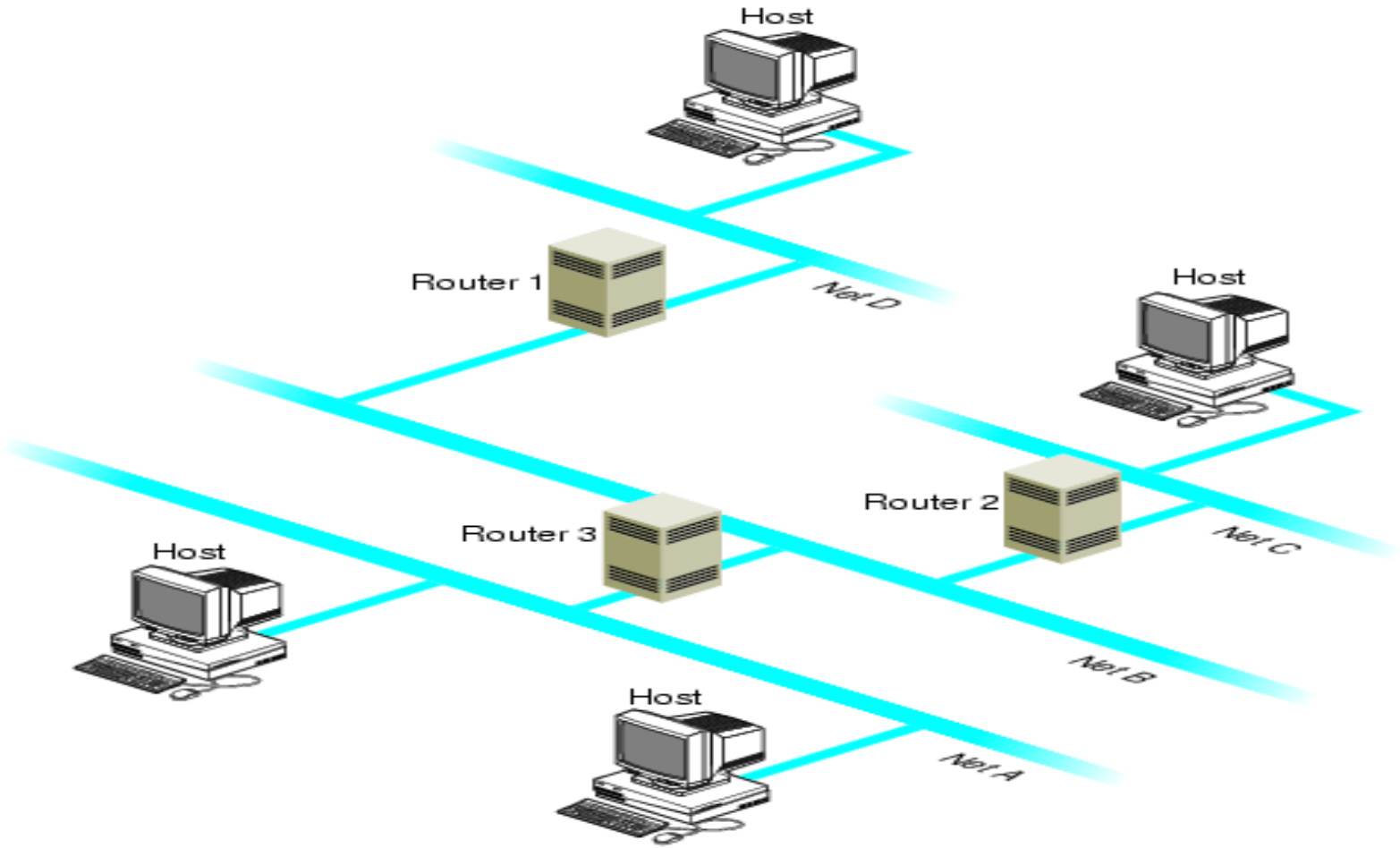
Like bridges, they can segment large networks and can filter out noise.

However, they are slower than bridges because they are more intelligent devices; as such, they analyze every packet, causing packet-forwarding delays. Because of this intelligence, they are also more expensive.

Routers are normally used to connect one LAN to another.

Typically, when a WAN is set up, there will be at least two routers used.

HARDWARE, SOFTWARE AND NETWORKS PERIPHERALS (CONT.)
ROUTERS



HARDWARE, SOFTWARE AND NETWORKS PERIPHERALS (CONT.)

SWITCH

A **network switch** is a computer networking device that connects network segments.

Low-end network switches appear nearly identical to network hubs, but a switch contains more "intelligence" (and a slightly higher price tag) than a network hub.

Network switches are capable of checking data packets as they are received, determining the source and destination device of that packet, and forwarding it correctly.

By delivering each message only to the connected device it was intended for, a network switch protects network bandwidth and offers generally better performance than a hub.

A **vital difference** between a **hub** and a **switch** is that all the nodes connected to a hub share the bandwidth among themselves, while a device connected to a switch port has the **full bandwidth** all to itself.

For example, if 10 nodes are communicating using a hub on a 10-Mbps network, then each node may only get a portion of the 10 Mbps if other nodes on the hub want to communicate as well. .

But with a switch, each node could possibly communicate at the full 10 Mbps.

HARDWARE, SOFTWARE AND NETWORKS PERIPHERALS (CONT.)
SWITCH