Local Area Networks – Internetworking

Internetworking devices

Increasing power and complexity

- Hubs
- Bridges
- Switches
- Routers

Why Interconnect?

- To separate / connect one corporate division with another.
- To connect two LANs with different protocols.
- To connect a LAN to the Internet.
- To break a LAN into segments to relieve traffic congestion.
- To provide a security wall between two different types of users.
- To connect WLAN to LAN

Introduction

Many times it is necessary to connect a LAN to another LAN or to a WAN.

Computers within a LAN are often connected using a hub

LAN to LAN connections are often performed with a bridge.

Segments of a LAN are usually connected using a switch.

LAN to WAN connections are usually performed with a router.

Hubs

A hub interconnects two or more workstations into a local area network.

When a workstation transmits to a hub, the hub immediately resends the data frame to all connecting links.

Hubs expand one Ethernet connection into many. For example, a four-port hub connects up to four machines

Hubs

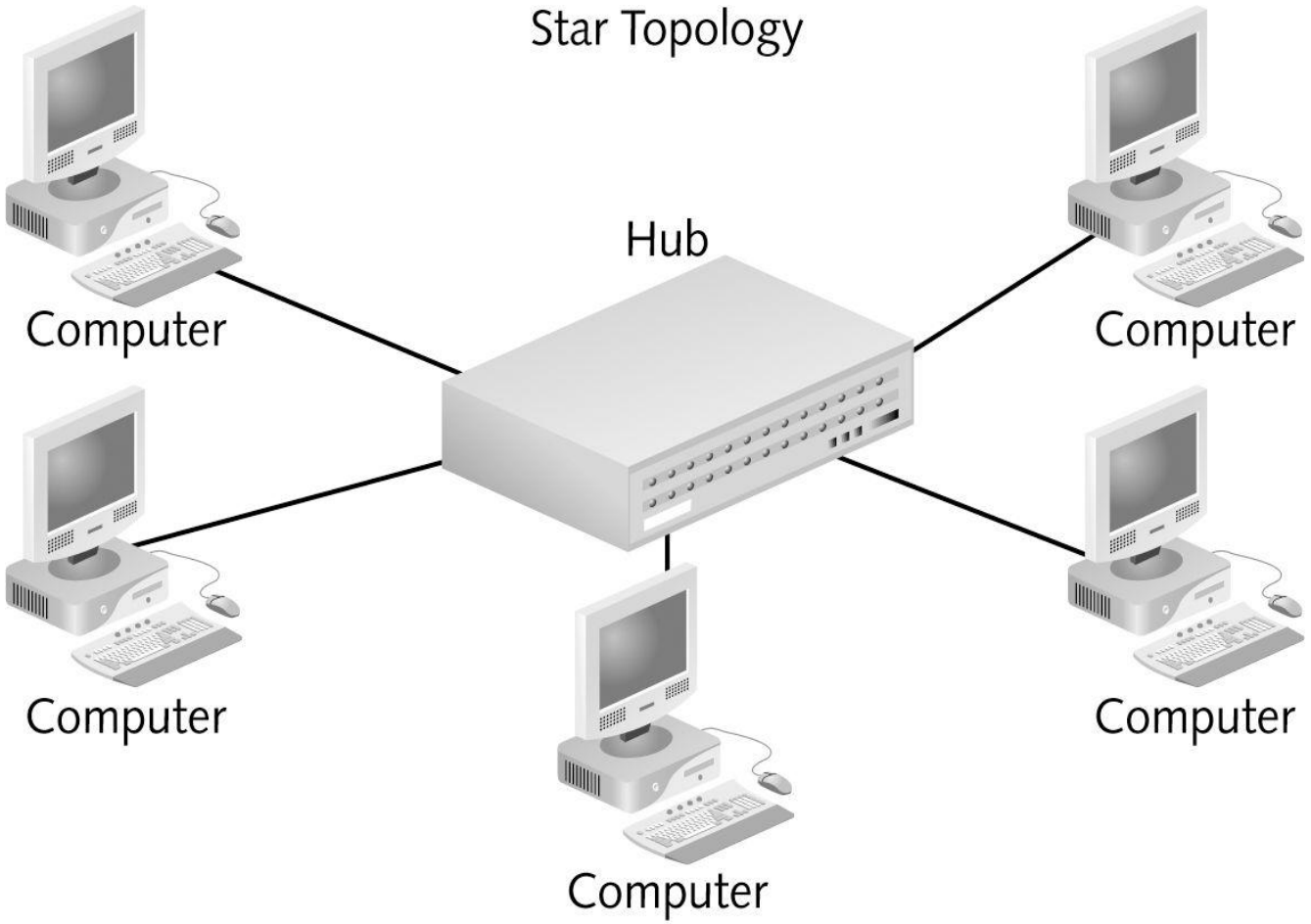
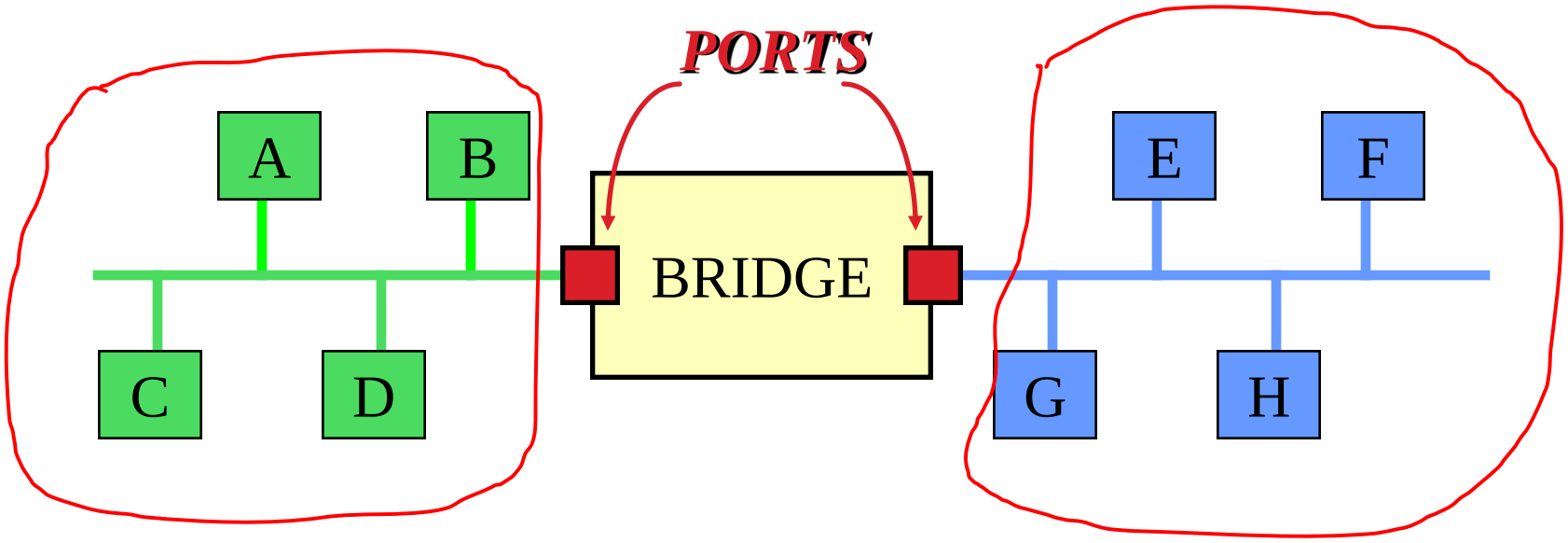


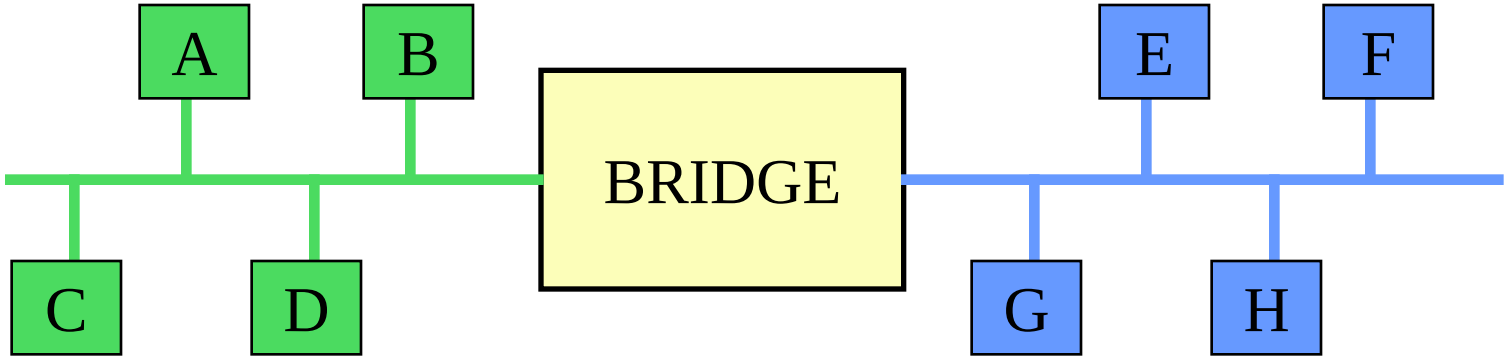
Figure 2-3 Star topology

Bridge

- A bridge connects networks and forwards frames from one network to another.



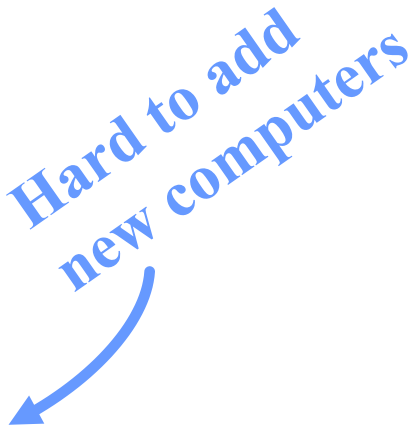
Selective Forwarding



- If A sends a frame to E – the frame must be forwarded by the bridge.
- If A sends a frame to B – there is no reason to forward the frame.

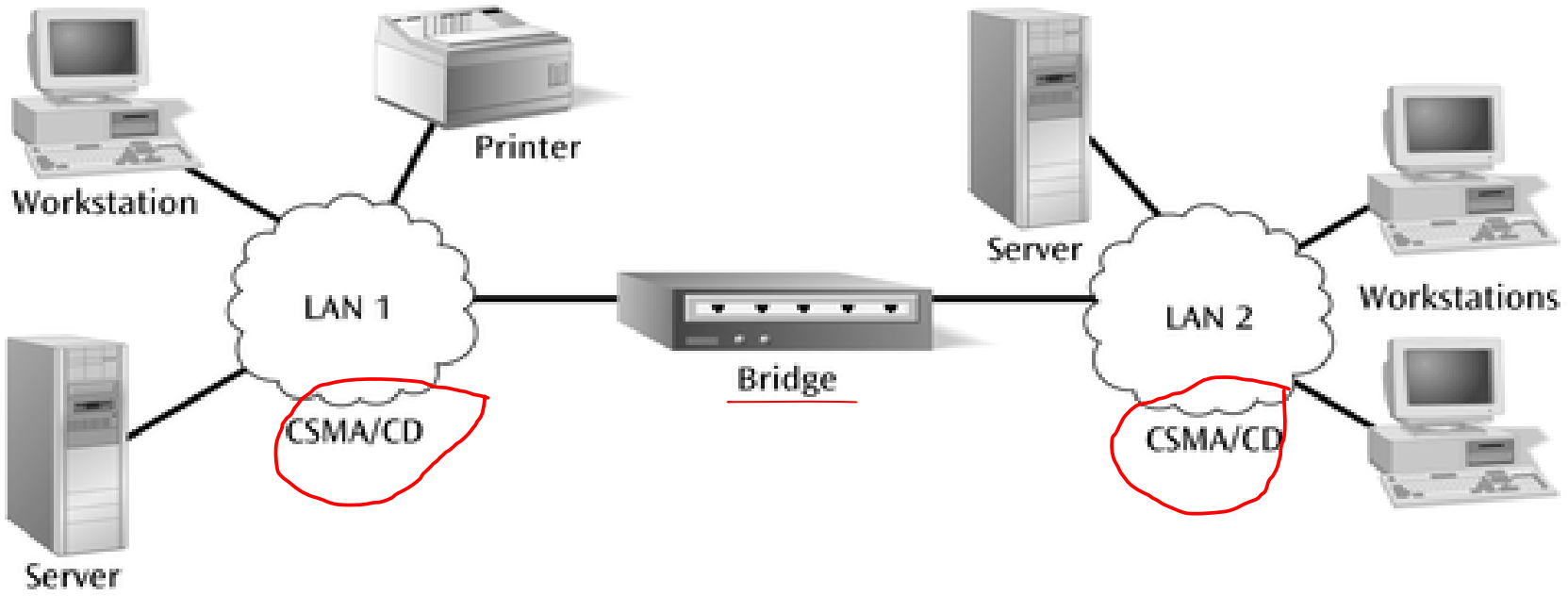
Bridge Database

- The bridge needs a database that contains information about which hosts are on which network.
- The realistic options are:
  - The system administrator can create and maintain the database.
  - The bridge can acquire the database on the fly.

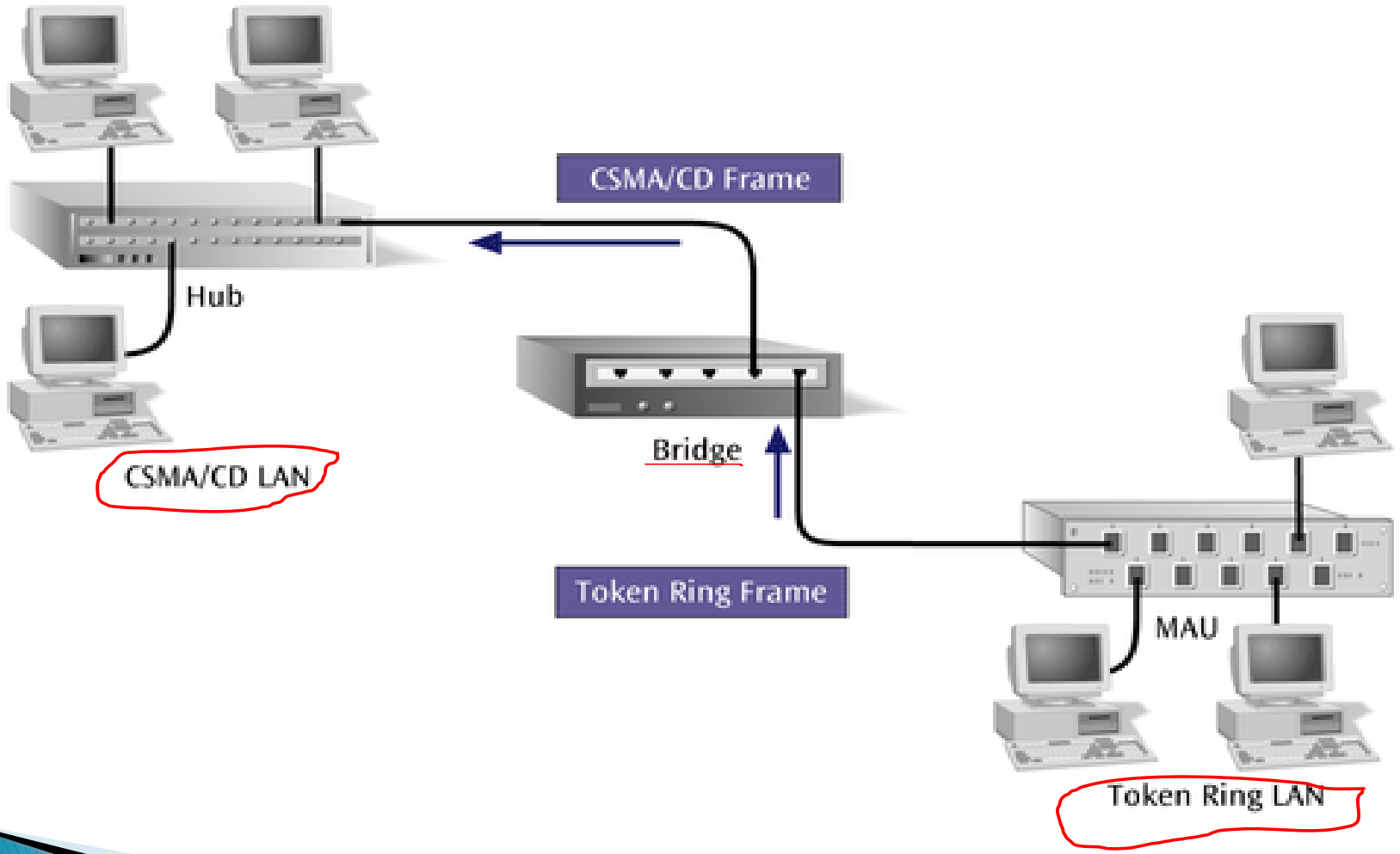


Some loss of efficiency

Bridge interconnecting two identical LANs



A bridge interconnecting two dissimilar LANs



Learning the host mapping

- The bridge forwards packets for which it does not know network destination.
- Every time the bridge forwards a packet it records the network on which the sender is located.

Transparent Bridges

A transparent bridge does not need programming but observes all traffic and builds routing tables from this observation.

This observation is called backward learning.

Each bridge has two connections (ports) and there is a routing table associated with each port.

A bridge observes each frame that arrives at a port, extracts the source address from the frame, and places that address in the port's routing table.

A transparent bridge is found with CSMA/CD LANs.

Source-routing Bridges

A source-routing bridge is found with token ring networks.

Source-routing bridges do not learn from watching tables.

When a workstation wants to send a frame, it must know the exact path of network / bridge

If a workstation does not know the exact path, it sends out a discovery frame.

The discovery frame makes its way to the final destination, then as it returns, it records the path.

Remote Bridges

A remote bridge is capable of passing a data frame from one local area network to another when the two LANs are separated by a long distance and there is a wide area network connecting the two LANs.

A remote bridge takes the frame before it leaves the first LAN and encapsulates the WAN headers and trailers.

When the packet arrives at the destination remote bridge, that bridge removes the WAN headers and trailers leaving the original frame.

Bridges vs Routers

Bridge: A bridge is a device that connects two segments of the *same* network. The two networks being connected can be alike or dissimilar.

Bridges are *protocol-independent*. They simply forward packets without analyzing and re-routing messages.

Router: A router is a device that connects two *distinct* networks. Routers are similar to bridges, but provide additional functionality, such as the ability to filter messages and forward them to different places based on various criteria.

The Internet uses routers extensively to forward packets from one host to another.

Switches

A switch is a combination of a hub and a bridge.

It can interconnect two or more workstations, but like a bridge, it observes traffic flow and learns.

When a frame arrives at a switch, the switch examines the destination address and forwards the frame out the one necessary connection.

Switches

Major role: isolating traffic patterns and providing multiple access. This design is usually done by the network manager.

Switches are easy to install and have components that are hot-swappable.

Switches

The backplane of a switch is fast enough to support multiple data transfers at one time.

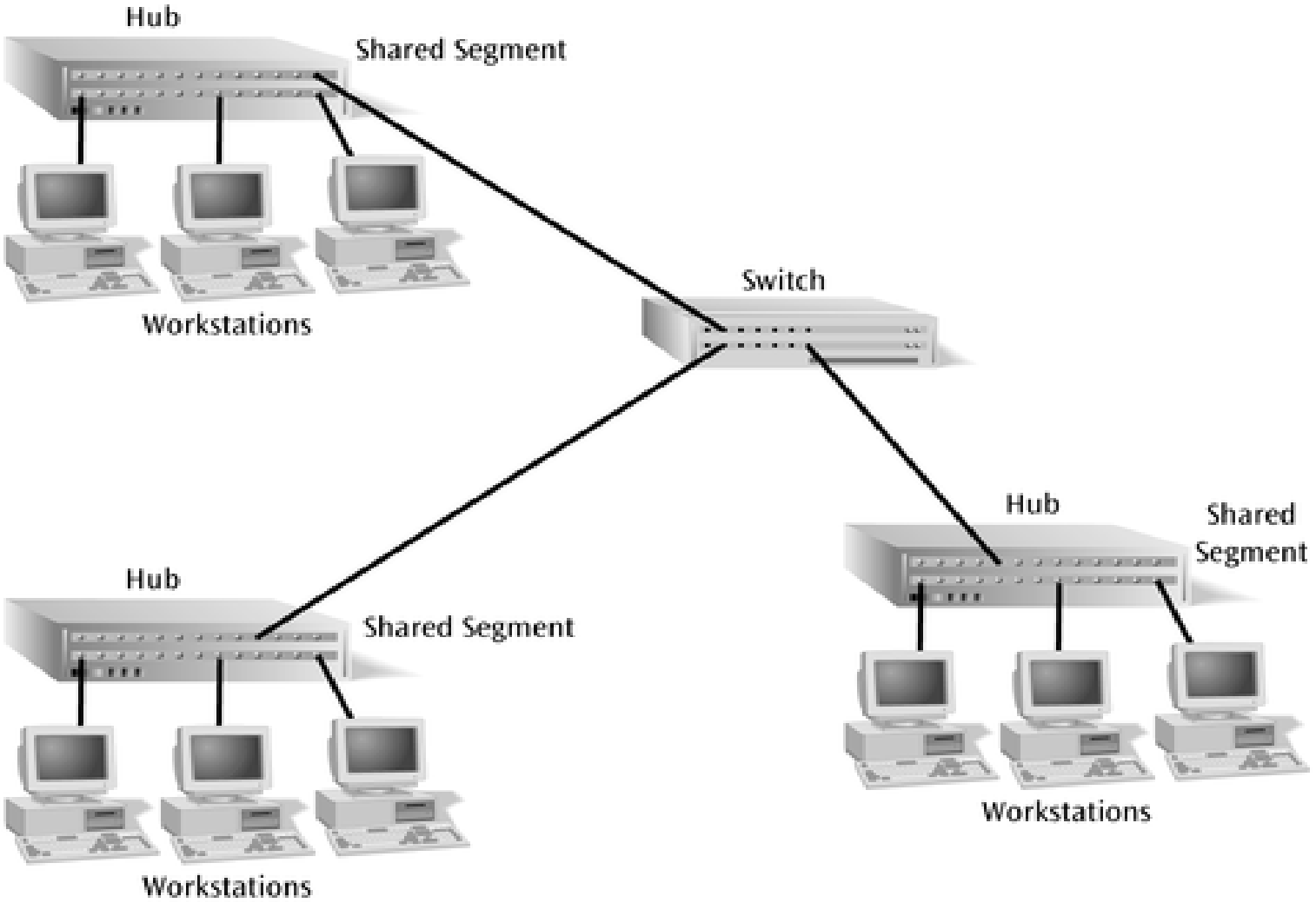
Multiple workstations connected to a switch use dedicated segments. This is a very efficient way to isolate heavy users from the network.

Switches vs routers

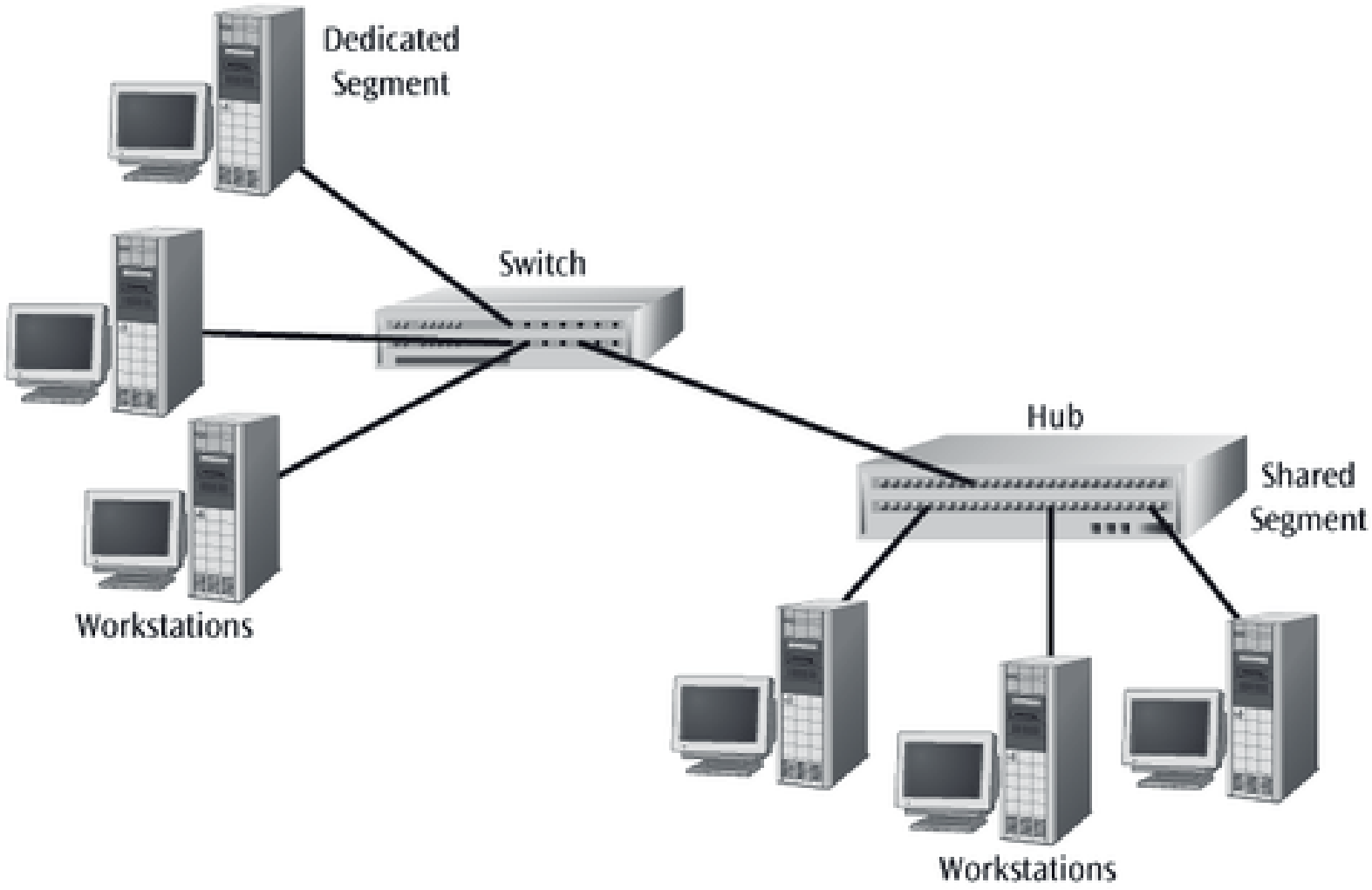
- Switches are considered layer-two devices, using MAC addresses to forward frames to their proper destination. Routers, layer-three devices, are much more complex, using microprocessor-based circuitry to route packets between networks based on their IP address. Routers provide the following services: route discovery; selection of the best route to a destination; adaptation to changes in the network; translation from one technology to another, such as Ethernet to token ring; packet filtering based on IP address, protocol, or UDP/TCP port number; and connection to a WAN.

- Because of the additional processing required for each packet, a router has a higher latency than a switch. In addition, a router requires an initial set-up sequence, in which the ports are programmed and certain protocols and characteristics are enabled or disabled. A switch may be simply plugged into the network, automatically learning how to forward frames as the network is used. Note that some protocols (e.g., NetBEUI) can't be routed; instead, they will pass through a switch. Finally, switches are used within networks to forward local traffic intelligently. Routers are used between networks to route packets between networks in the most efficient manner.

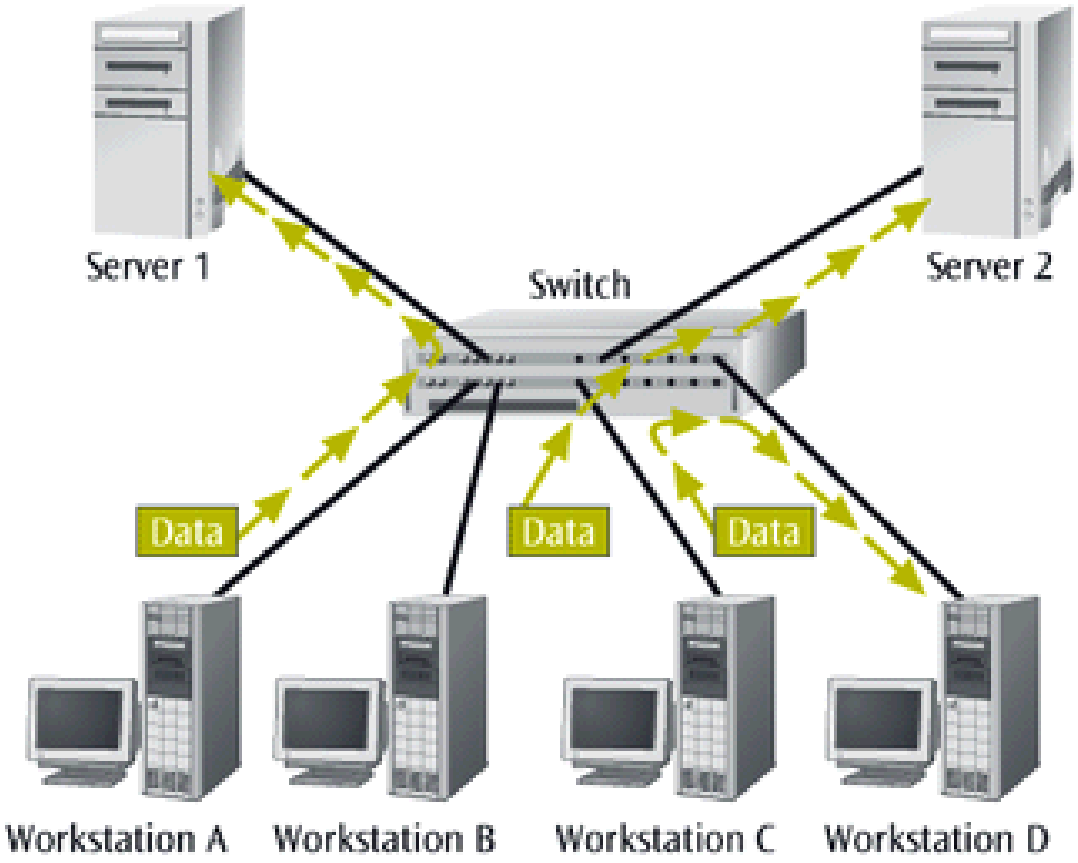
Workstations connected to a shared segment of a LAN



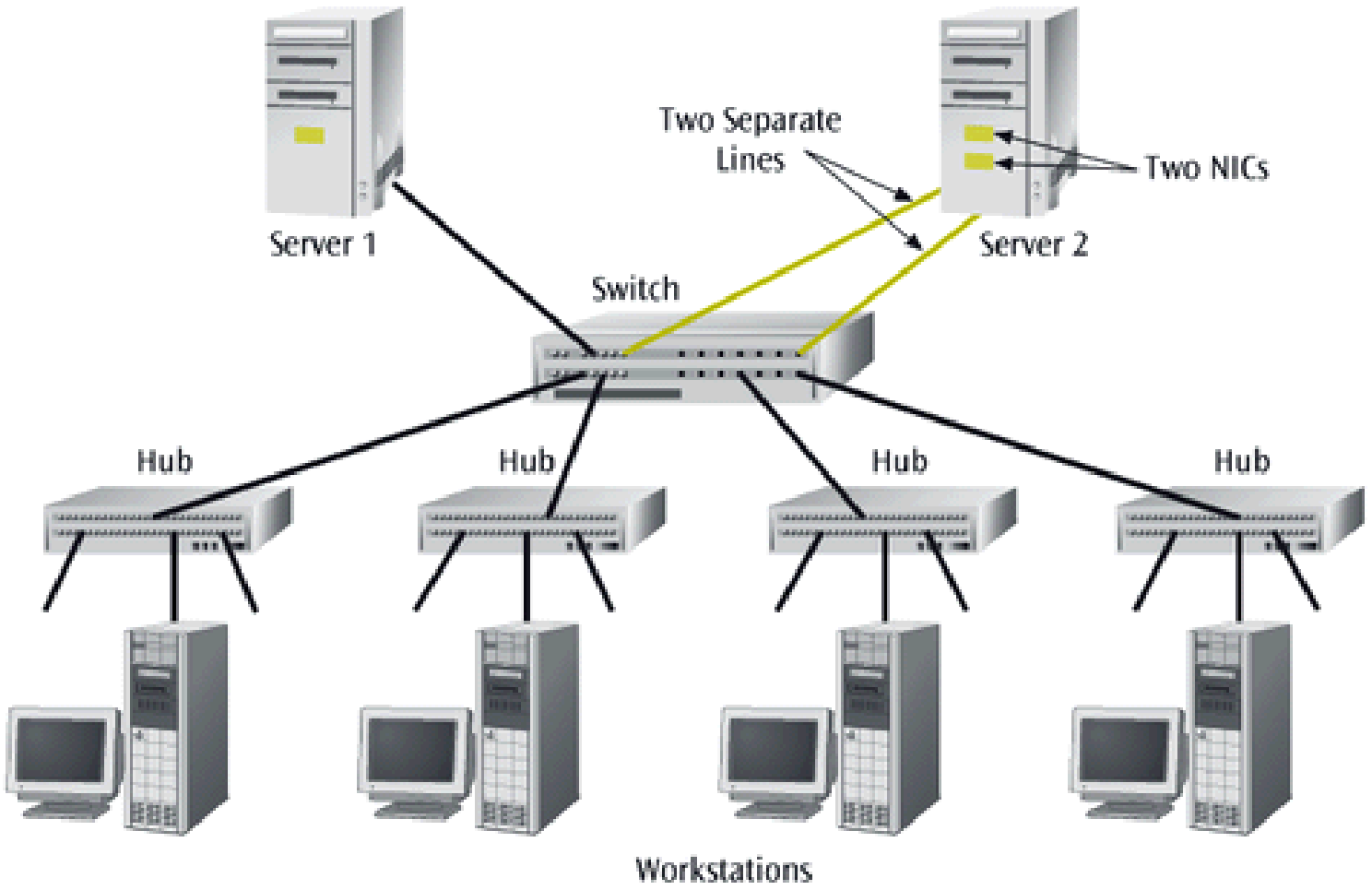
Workstations connected to a dedicated segment of a LAN



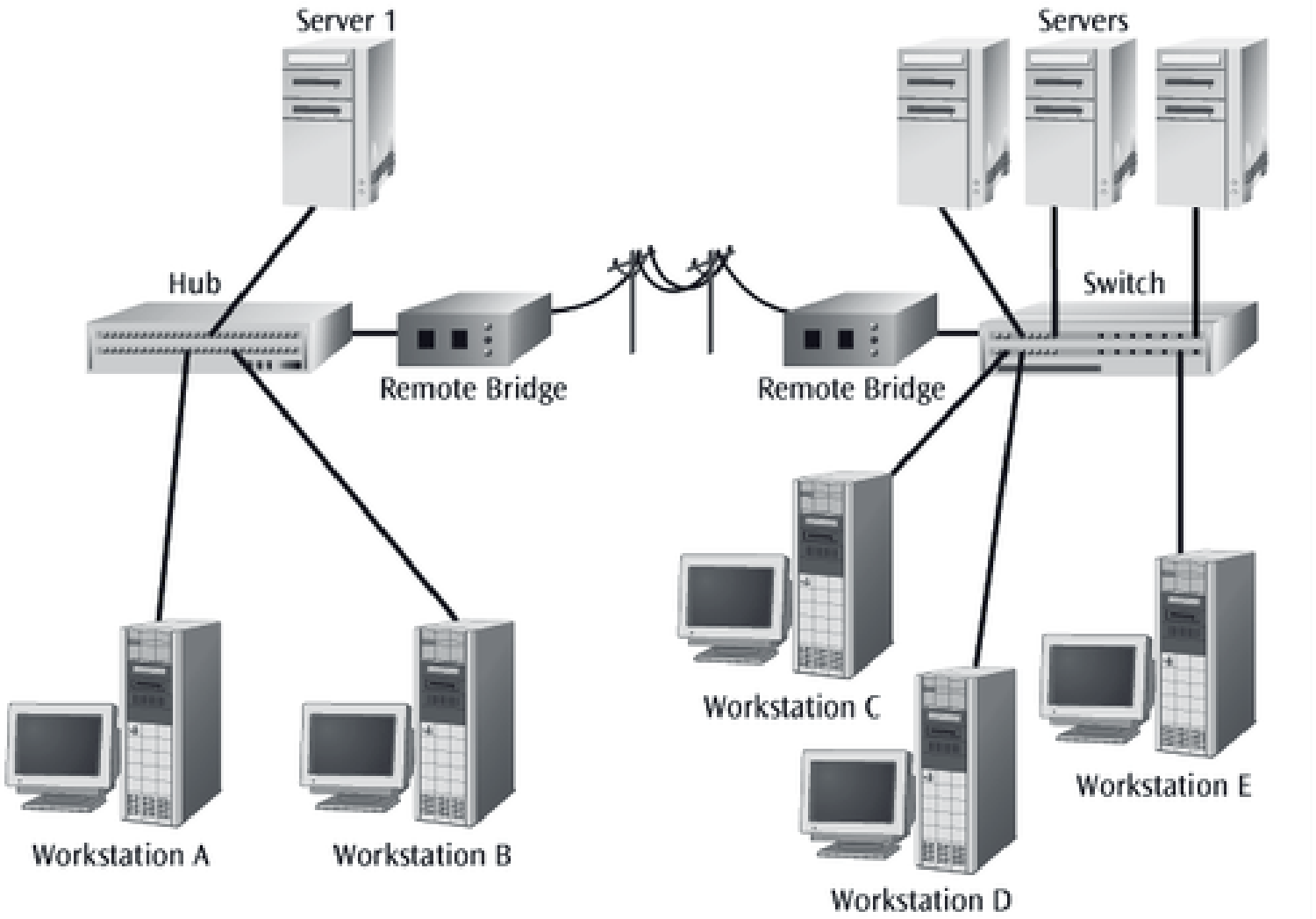
A Switch with Two Servers Allowing Simultaneous Access to Each Server



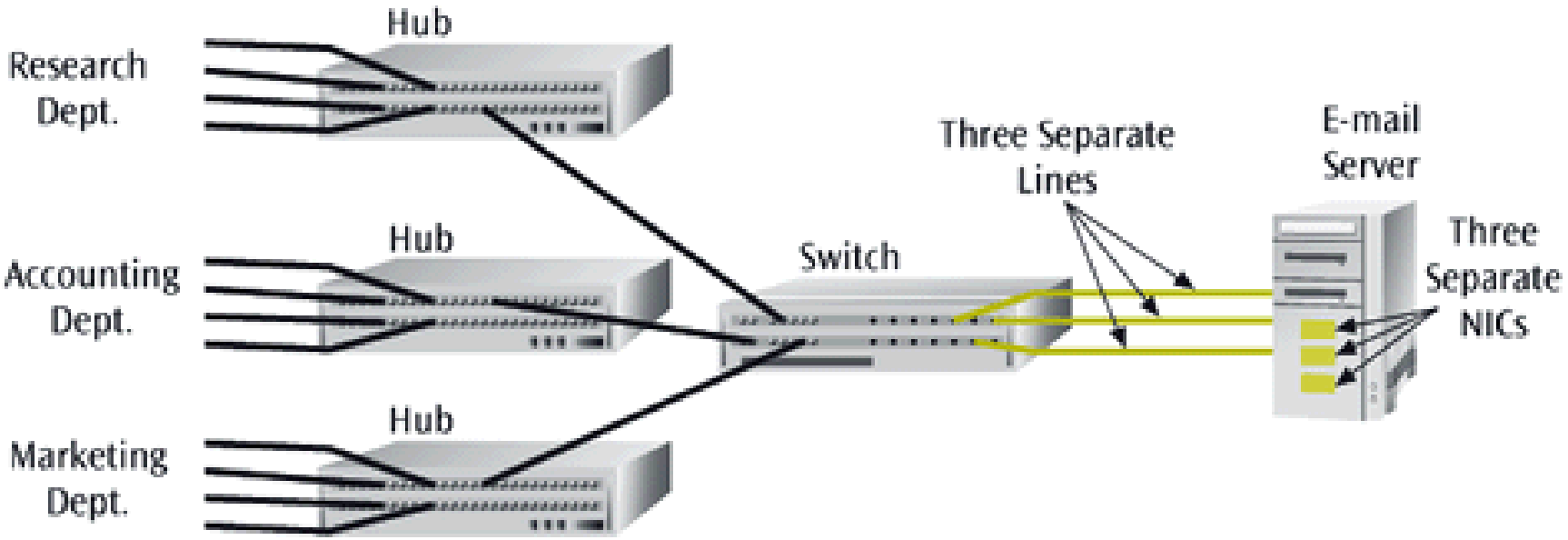
A server with two NICs and two connections to a switch



A pair of remote bridges and switch combination designed to isolate network traffic



Switch providing multiple access to an e-mail server



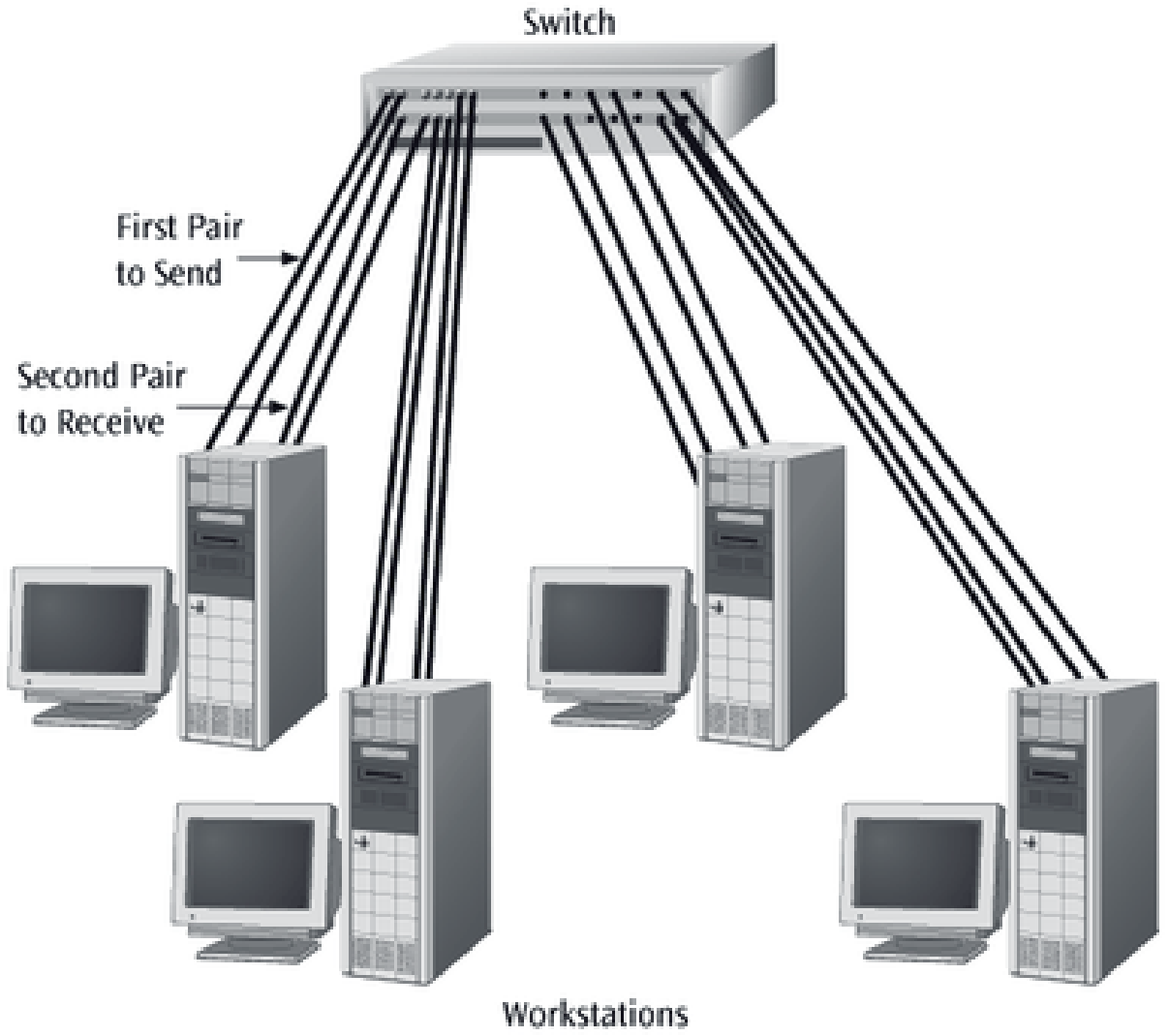
Full Duplex Switches

A full duplex switch allows for simultaneous transmission and reception of data to and from a workstation.

This full duplex connection helps to eliminate collisions.

To support a full duplex connection to a switch, two sets of wires are necessary - one for the receive operation and one for the transmit operation.

Full duplex connection of workstations to a LAN switch



Network Servers

Network servers provide the storage necessary for LAN software.

They are usually the focal point for the network operating system.

Increasingly, network servers are functioning as bridges, switches, and routers. By adding the appropriate card, a server can assume multiple functions.

Routers (really specialized computers)

The device that connects a LAN to a WAN or a WAN to a WAN (the INTERNET! – uses IP addresses).

A router accepts an outgoing packet, removes any LAN headers and trailers, and encapsulates the necessary WAN headers and trailers.

Because a router has to make wide area network routing decisions, the router has to dig down into the network layer of the packet to retrieve the network destination address.

Routers

Thus, routers are often called “layer 3 devices”. They operate at the third layer, or OSI network layer, of the packet.

Routers often incorporate firewall functions.

An example of a router’s operation is shown on the next slide.

Wireless connections: Access Point as a Bridge

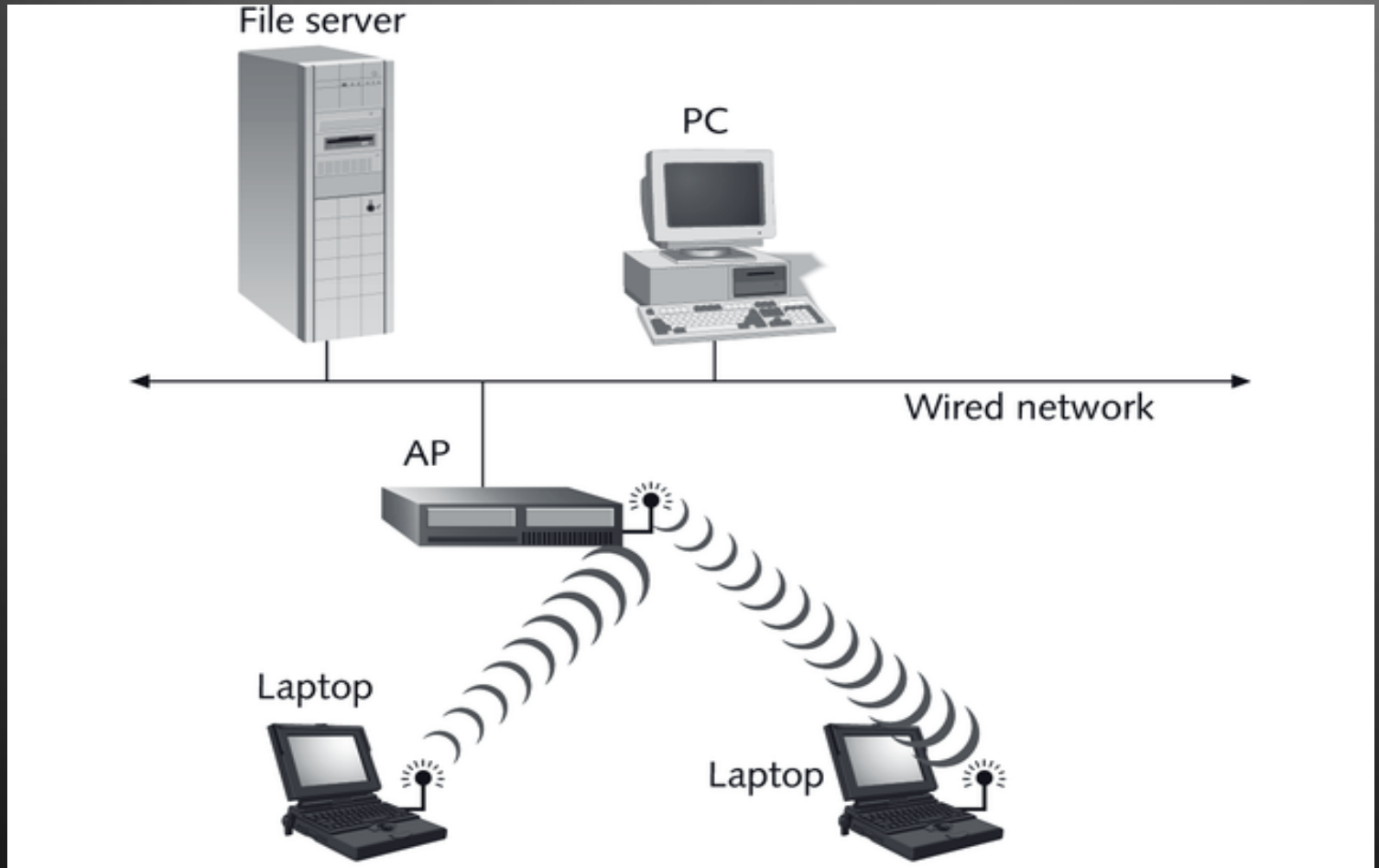


Figure 6-7 Access point as a bridge

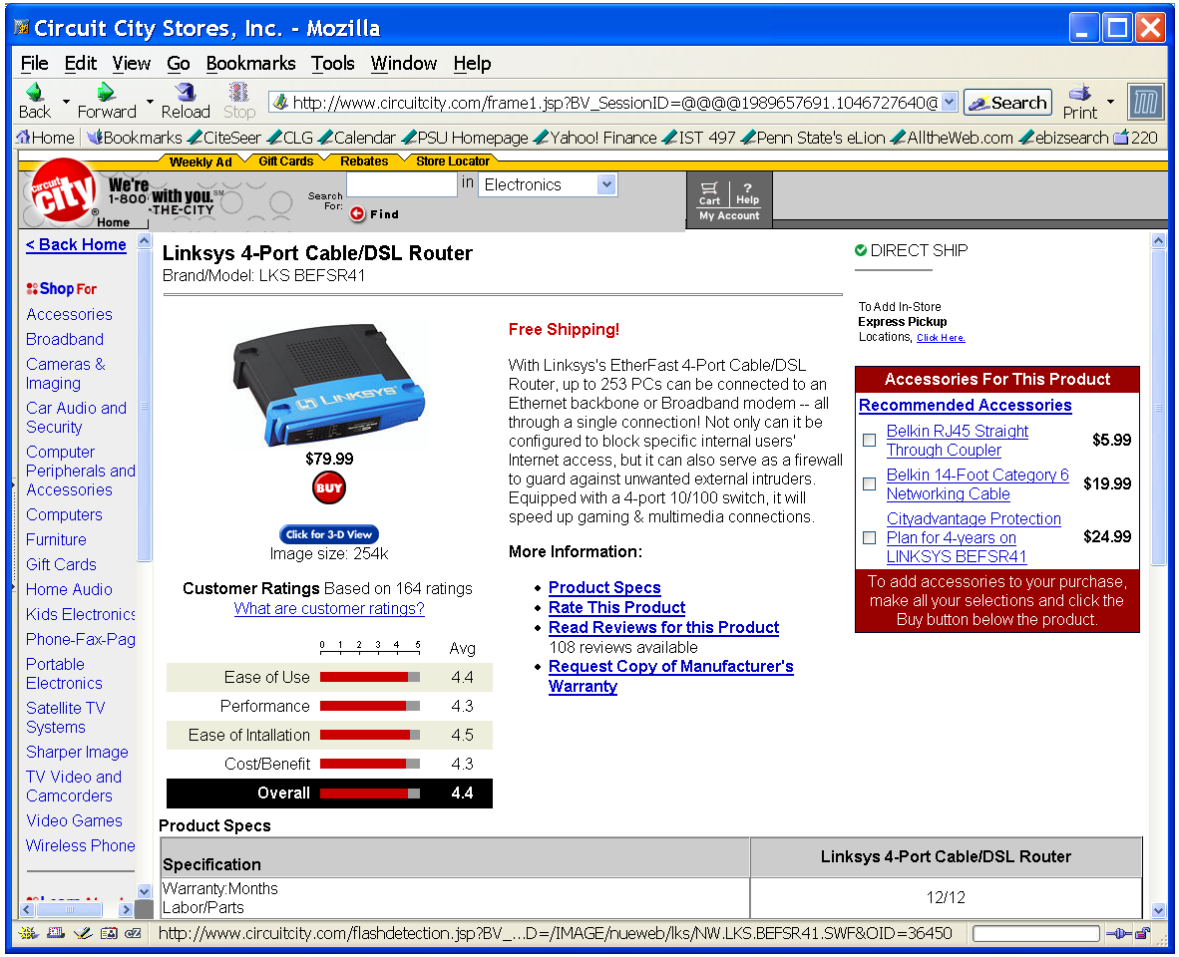
Connections (in general)

Bridges for LANs and hubs.

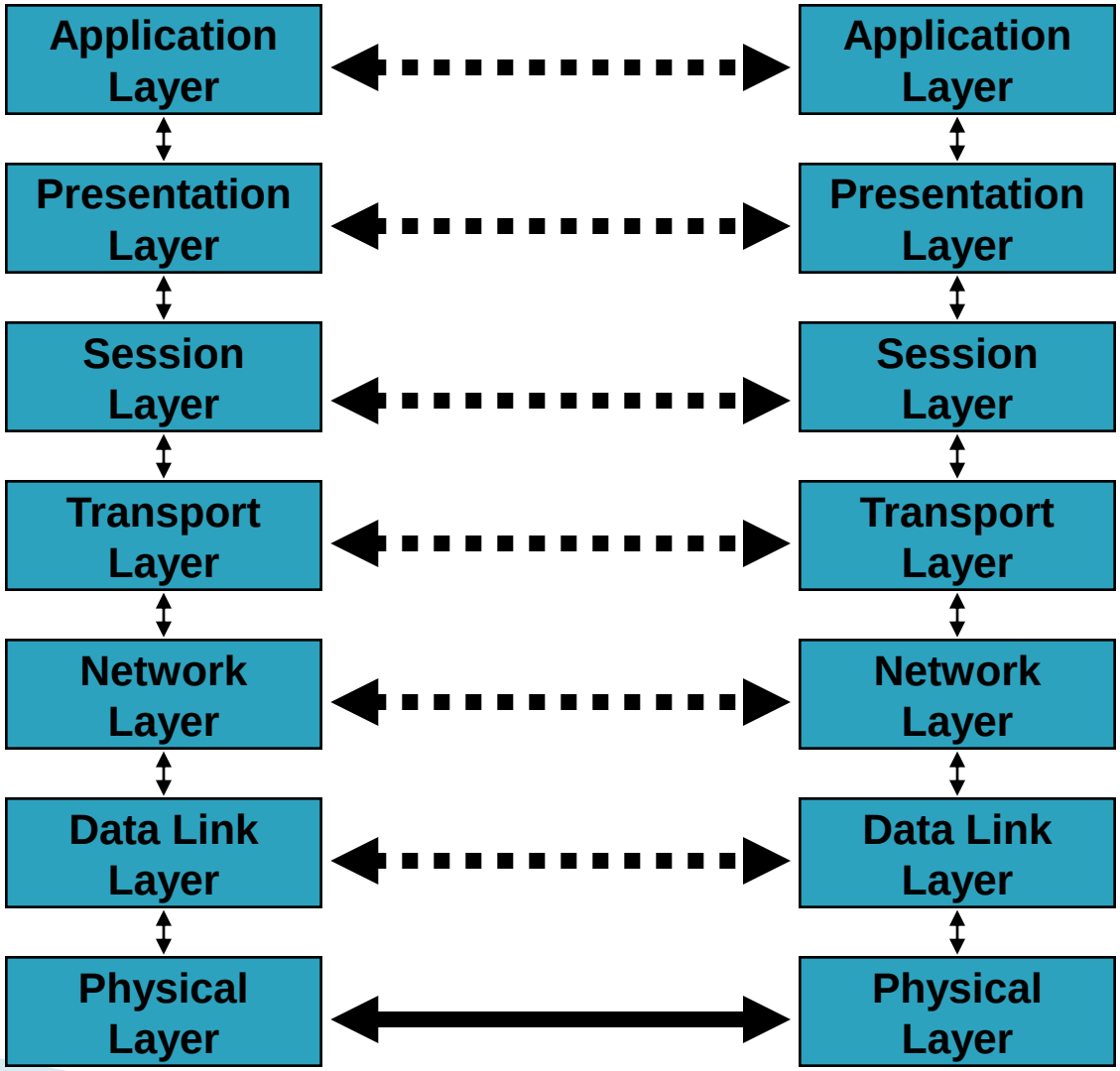
Switches for LANs and workstations.

Routers for LANs and WANs (the Internet).

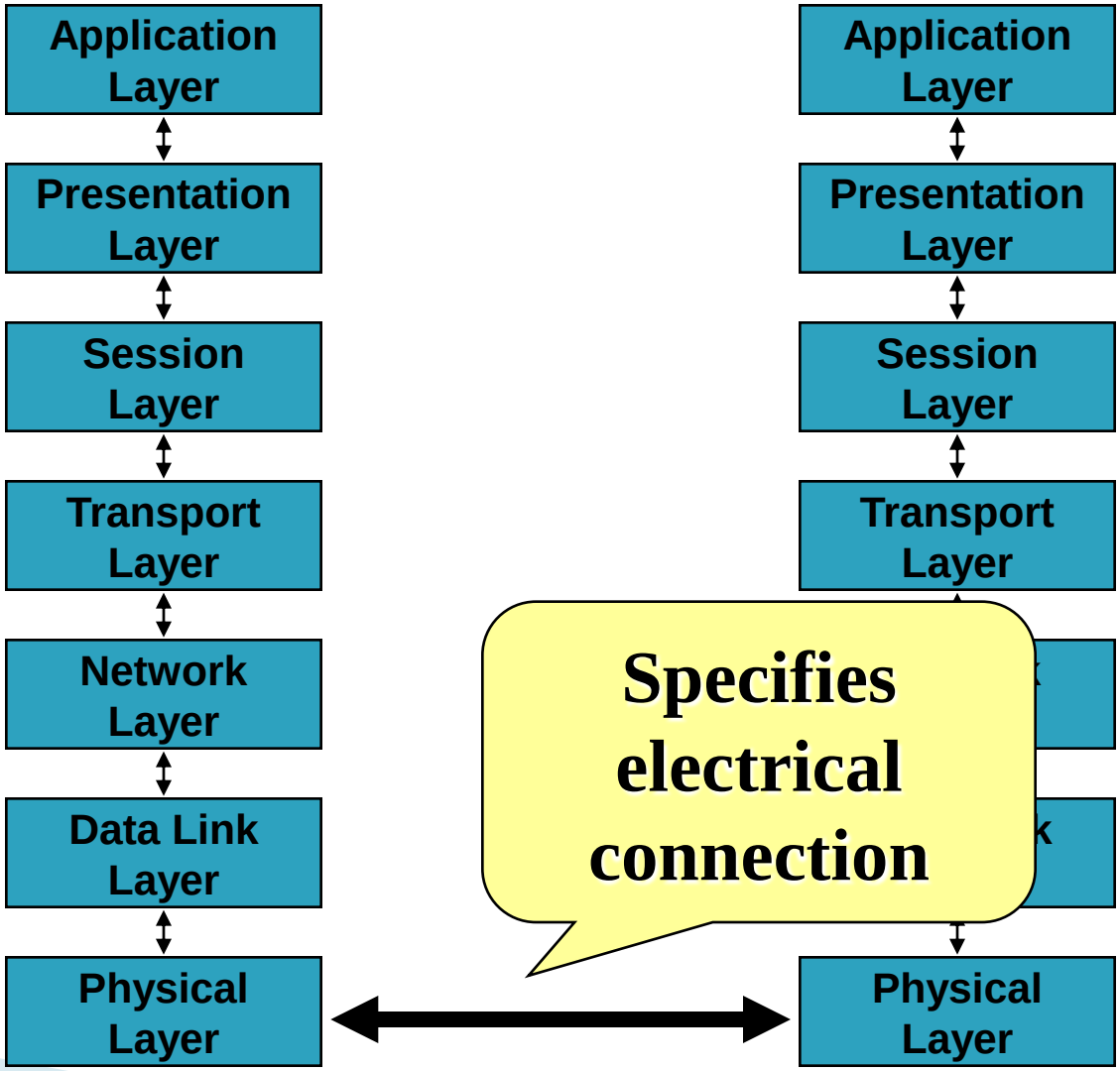
Linksys Router for Home Network



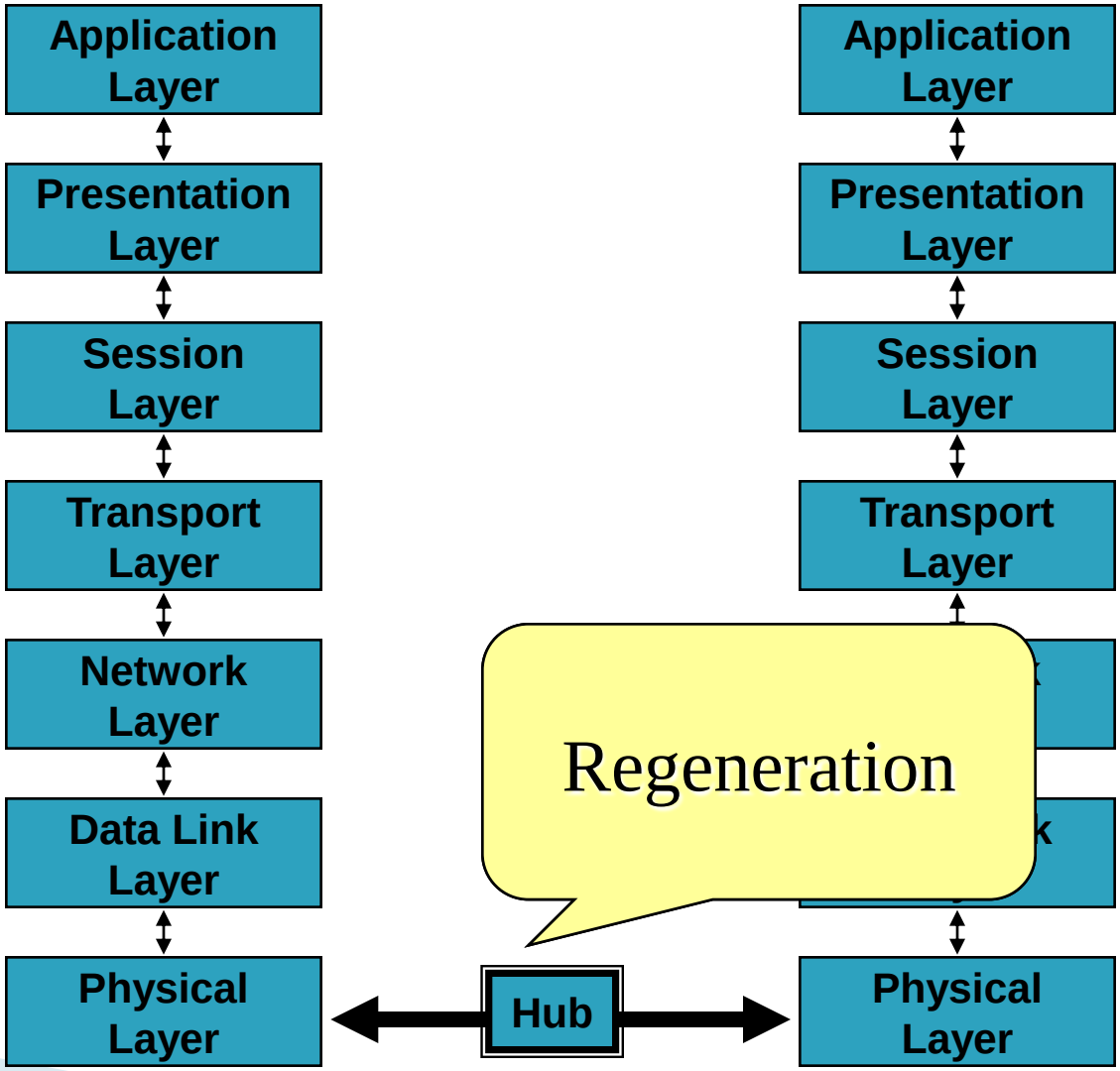
The OSI Reference Model



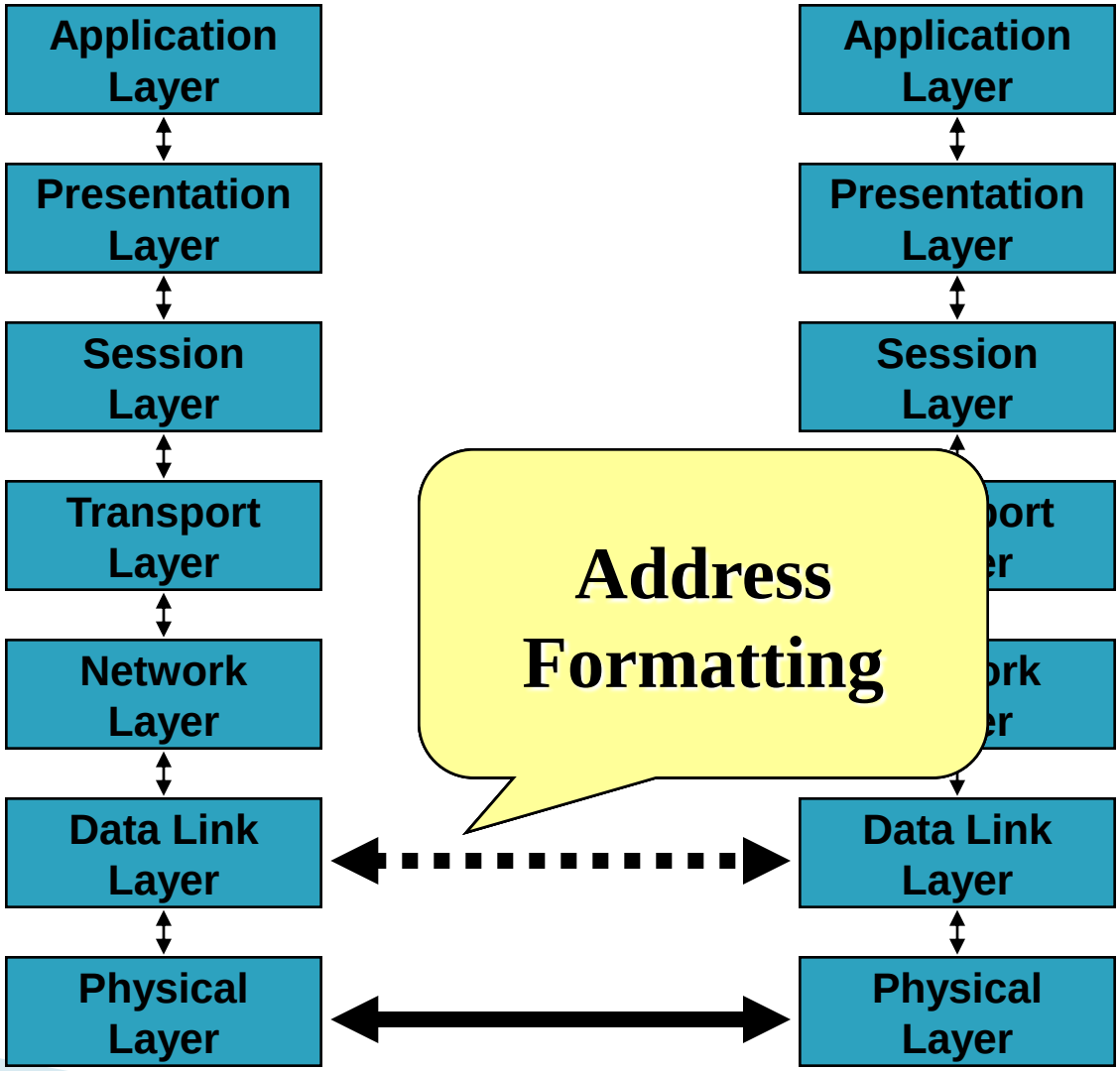
The Physical Layer Connection



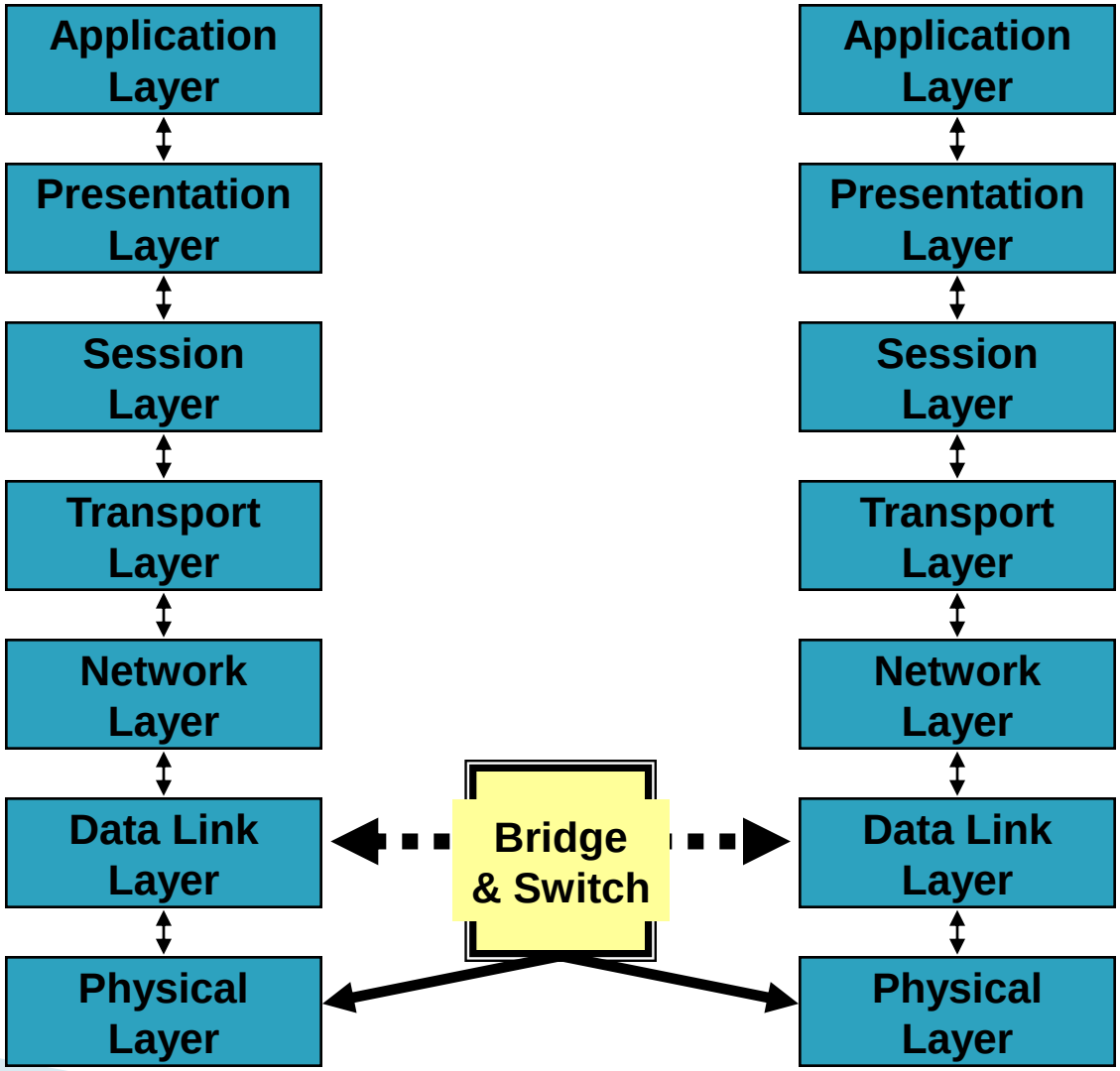
The Physical Layer Connection



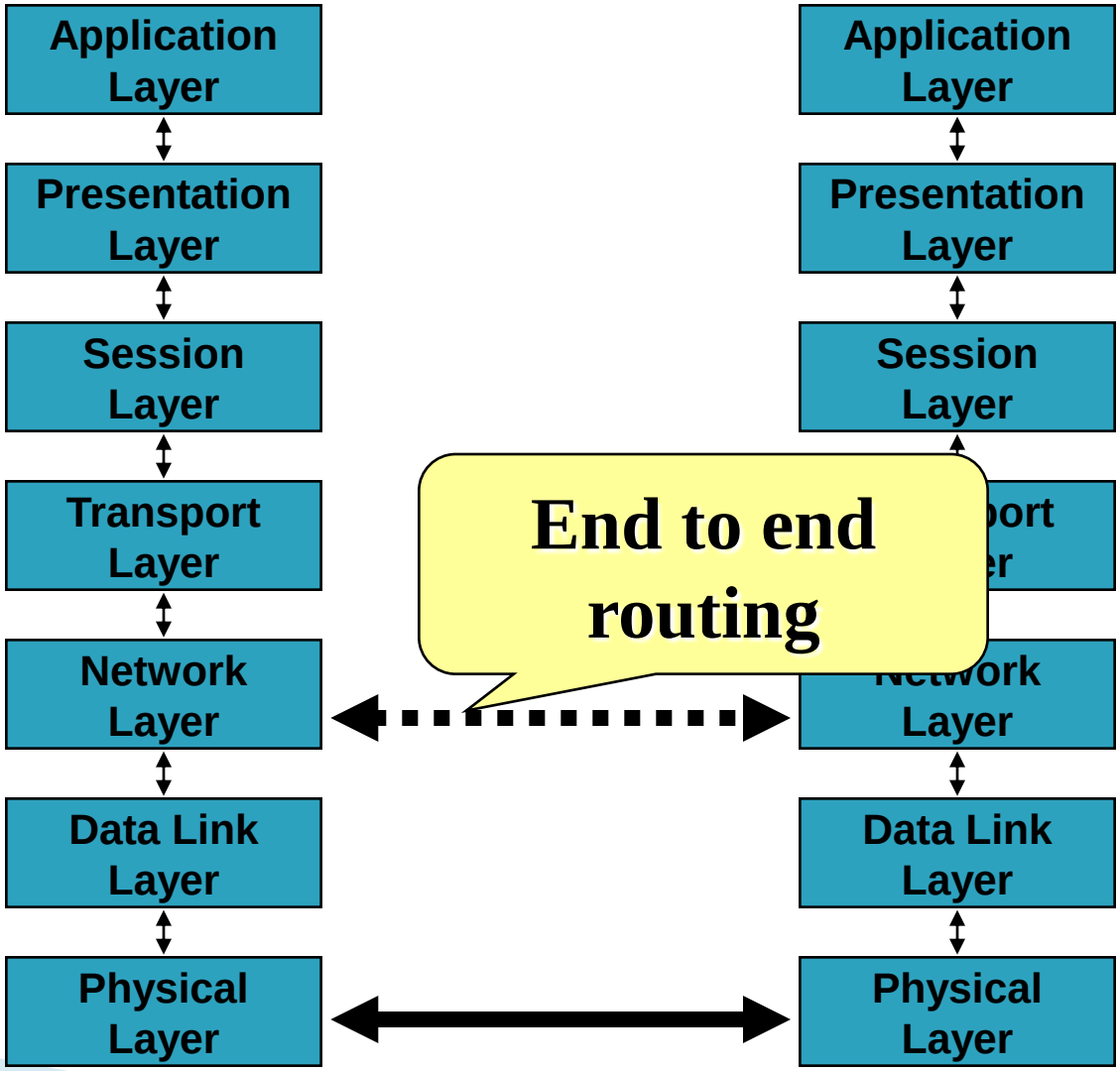
The Data Link Connection



The Data Link Connection



The Network Layer Connection



The Network Layer Connection