MIS 131: Information Systems Administration

Part VI: Networks

Section A: Introduction, History, and the OSI Reference Model

Networks and Communication

- Network (of computers)
  - Consists of machines that, regardless of their physical location, communicate with each other
- Data communications
  - Electronic collection, exchange, and processing of data or information digitally coded and intelligible to a variety of electronic machines
- Telecommunications
  - Refers to all types of long-distance communication through the use of common carriers such as telephone, satellite, and radio

A Brief History: Early Days

- Mainframe systems
- Input: punch card/tape readers
- Console (operators), data entry terminals (professionally-trained encoders)
- Users isolated from machine

A Brief History: The 70's

- Mainframe or minicomputer system
- Use of dumb terminals located on user area
- Proprietary network
- Processing power still provided by mainframe

A Brief History: The 80's

- Microcomputers (DOS)
- Initially, two machines → terminal emulator on PC
- First generation of LANs

A Brief History: Modern Era

- Widespread use of LANs and WANs
- Move to more open environment
  - Interconnectivity
  - Interoperability
- Internet, intranets, and extranets

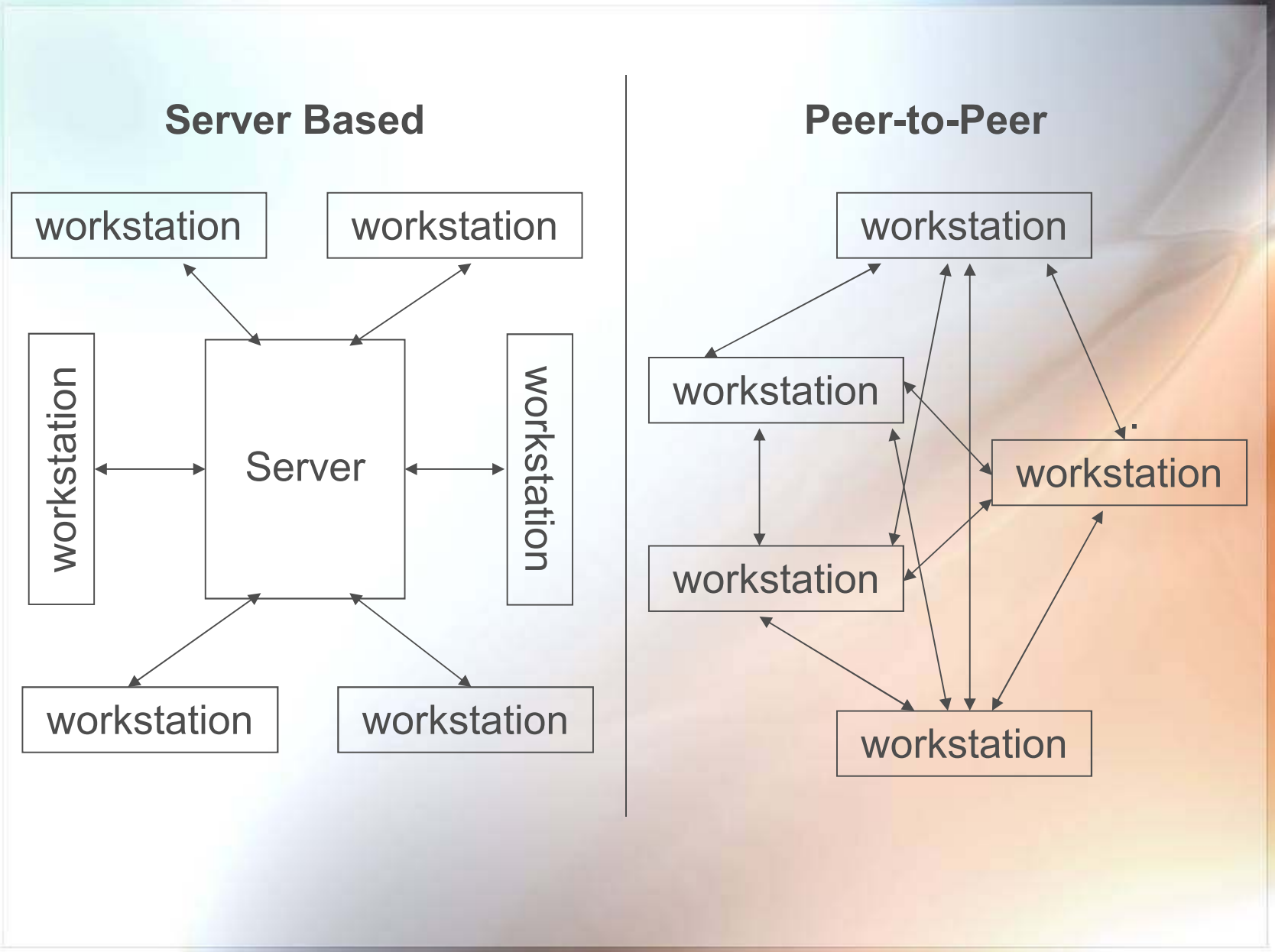
Types of Networks

- Local Area Network (LAN)
- Metropolitan Area Network (MAN)
- Wide Area Network (WAN)
- Personal Area Network (PAN)
- Storage Area Network (SAN)

LANs Form the Basis

- Local Area Network – network of personal computers spanning a limited geographical area for purposes of electronic communication
- Most common LAN services
  - Access to remote information
  - Application/device sharing
  - Load distribution
  - Electronic mail

Basic LAN Configurations



Network Components

- Servers
- Server O/S
- Workstations (clients)
- Workstation O/S
- Network Interface Card (NIC)
- Shared hardware (e.g. network printers)
- Data communications media
- Protocol
- Topology
- Application software

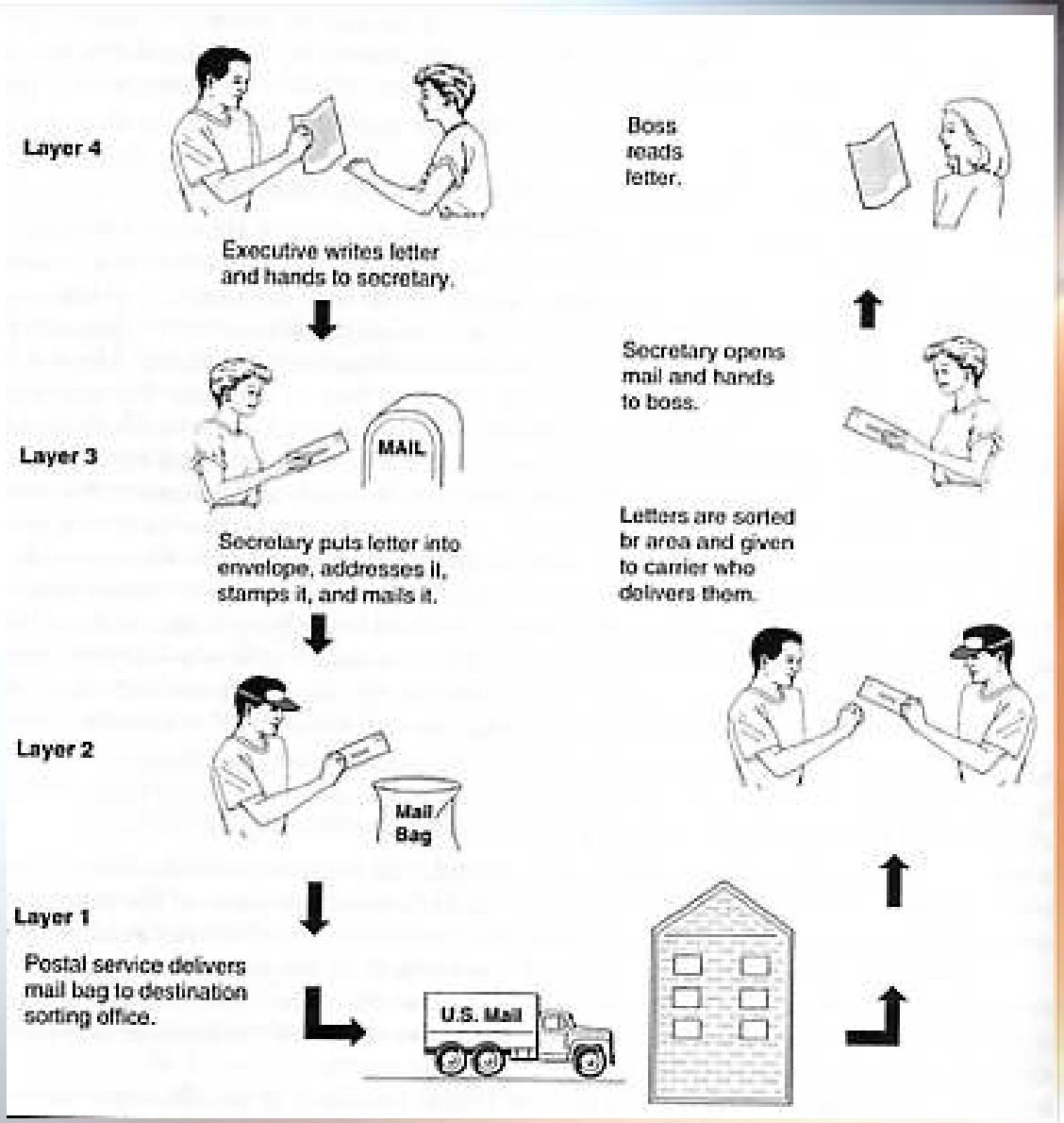
The Network Server

- Common tasks
  - Handles request from users
  - Distributes resources
  - Acts as traffic manager
- Can be a mainframe, mini, or micro
- Common types
  - File server
  - Print server
  - Database server
  - Communications server

The OSI Reference Model

- OSI – Open Systems Interconnection
- Theoretical construction that separates network communications into 7 layers
- Collectively: protocol stack or networking stack
- Implements “encapsulation”

OSI Analogy


Layer 4
Executive writes letter and hands to secretary.
Boss reads letter.
Layer 3
MAIL
Secretary puts letter into envelope, addresses it, stamps it, and mails it.
Secretary opens mail and hands to boss.
Layer 2
Mail Bag
Letters are sorted by area and given to carrier who delivers them.
Layer 1
Postal service delivers mail bag to destination sorting office.
U.S. Mail

OSI Structure

Layer	Name	Job	Protocol Examples
7	Application Layer	Interface to application	HTTP, X.500, X.400, ODA, PC LAN Manager, Postscript
6	Presentation Layer	Translates data to and from language in Layer 7	NetBIOS
5	Session Layer	Controls dialog, acts as moderator for a session	SSL (Secure Sockets Layer)
4	Transport Layer	Controls flow, ensures reliable packet delivery	TCP
3	Network Layer	Addresses and routes packets	IP, X.25, Packet level Protocol
2	Logical Link Layer	Makes sure no data is lost or garbled	Ethernet, Token Ring, FDDI, ISDN, ATM, Frame Relay
1	Physical Layer	Defines physical connection to network	Ethernet 50 ohm coaxial cable, 10 Base-T, twisted pair, fiber optic cable

Layer 1: The Physical Layer

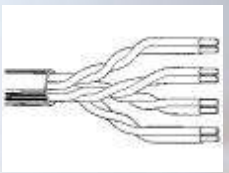
- Defines actual medium used to carry data from one computer to another
- Includes
  - Technology used to carry the data
  - Specifications how to install the equipment
  - Nature of signals used to encode data

Data Communications Media

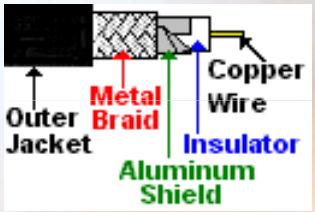
- Bounded media (cable)
  - Co-axial
  - Shielded/Unshielded twisted pair (STP/UTP)
  - Fiber optic
- Unbounded media (air and light)
  - Radio
  - Microwave
  - Satellite
  - Infrared or laser
- Bandwidth: transmission speed (bits/sec)

Types of Cable

- Twisted Pair
  - Copper wires twisted to minimize interference
  - Can be shielded or unshielded



- Coaxial
  - One wire called central carrier surrounded by insulator
  - Can be thin or thick



- Fiber Optic
  - Core made of glass or plastic
  - Immune to electromagnetic forces

Comparison of Network Cables

	Twisted Pair	*Coaxial*	*Fiber*
Cost	Low	Moderate	High
Bandwidth	Moderate	High	Very high
Max Length	100 Meters	500 Meters	2,000 M
Immunity to Interference	Low	Moderate	Very high
Connection Ease	Simple	Variable	Difficult
Installation Ease	Simple	Variable	Difficult
Reliability	High	Variable	Very high
Limitations	Distance	Distance	Pt.-to-pt.

Layer 2: The Data Link Layer

- Defined as the mechanism that regulates access to the shared network medium
- Concerned with getting the data to its next destination in the LAN and make sure it is not garbled
- Arbitrates access to the network medium using a process called media access control (MAC)
- Includes elements of the physical layer in their specification (e.g. cables supported by a protocol)

Network Interface Card (NIC)

- Determines cable access method
- Governs data transmission rate
- Determines data link layer protocol
  - Ethernet
  - Token ring
  - Fiber Distributed Data Interface (FDDI)

Network Interface Card (NIC)

- Convert signals from digital to matter suitable for network medium (e.g. binary to electrical impulses, binary to light pulses)
- Breaks requests into packets and reconstructs them at destination
- A packet is a variable group of formatted data which includes user information, address of sender and/or destination, packet size, type of transmission; format depends on protocol

Data Link Layer Protocols

	Ethernet	*Token Ring*	*FDDI*
Developed By	Digital, Intel, Xerox	IBM	AT&T
Cables	All types	Twisted Pair Fiber	Fiber Twisted Pair
Speeds	10 Mbps 100 Mbps 1000 Mbps	4/16 Mbps 100 Mbps	100 Mbps
MAC	CSMA/CD (Party Line Method)	Token Passing	Token Passing

The FDDI Difference

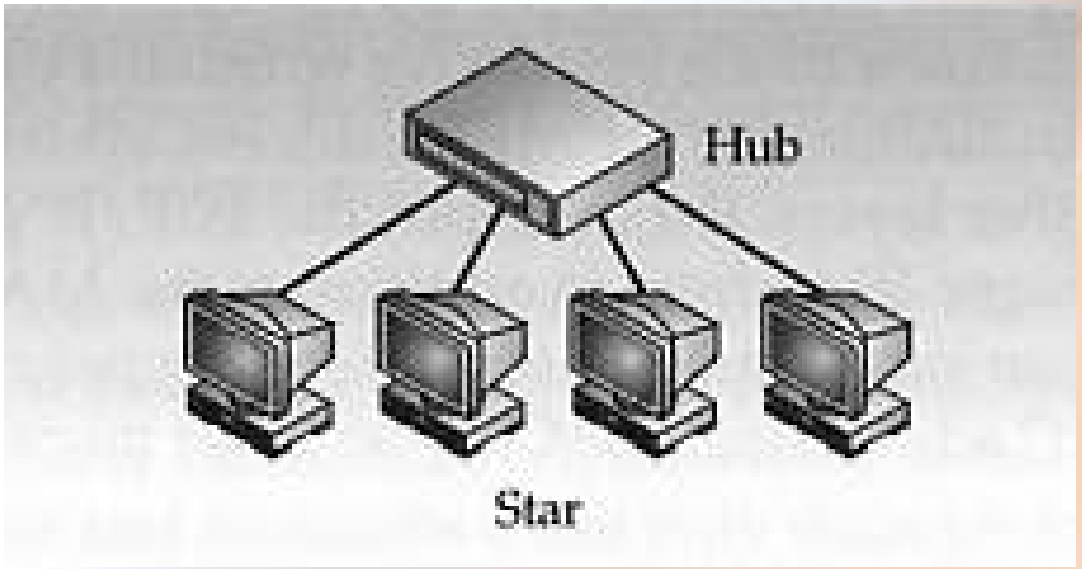
- First to achieve 100 Mbps speed
- Larger packet size
- Original FDDI specs required physical ring topology
- Ideal *backbone* protocol but may also run to desktops (expensive)

Network Topology

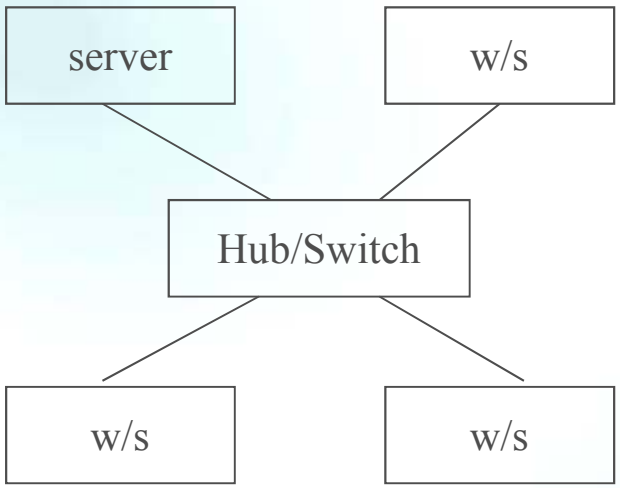
- Refers to the way computers on a network are cabled together
- Basic types
  - Star
  - Ring
  - Bus
- May be:
  - Physical - physical structure of network; how terminals are connected to each other
  - Logical - bounded to network protocols that direct how the data moves across the network

Star Topology

- Cable connection to each component radiating from central point
- Requires more cable



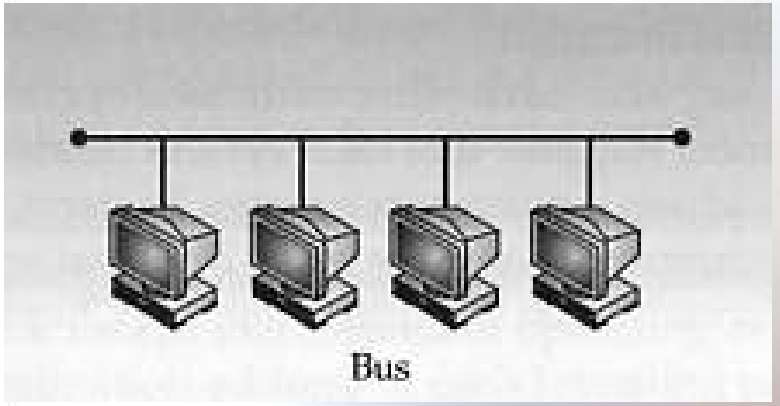
Hubs and Switches

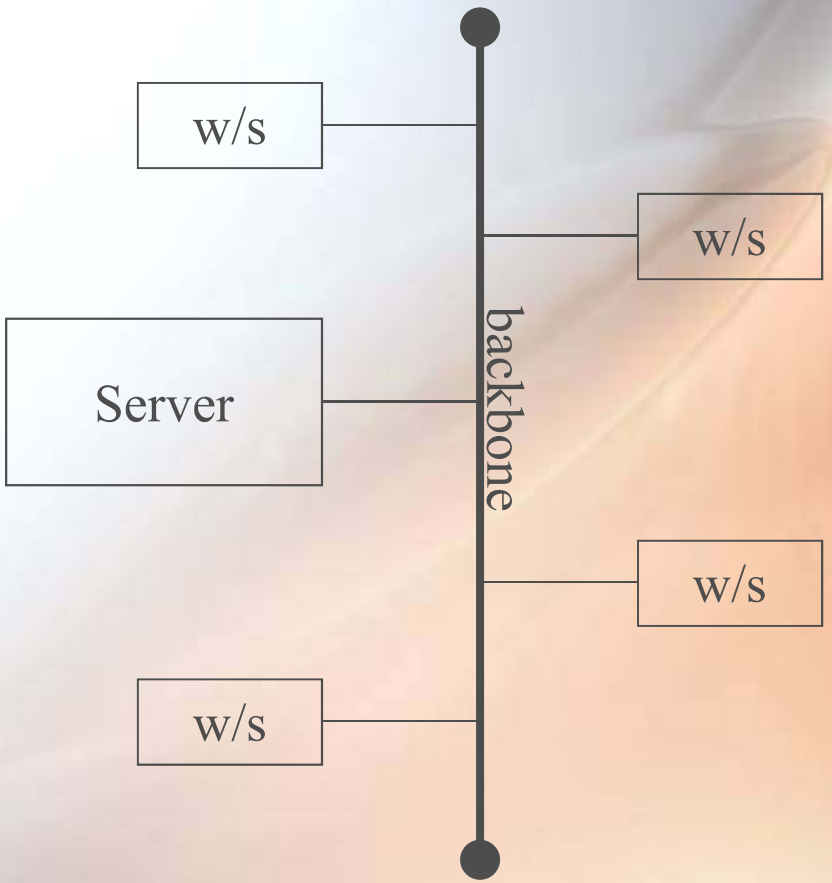


- Cabling nexus
- Used in star topology
- Amplifies signals (multiport repeater)
- A *switch* is more intelligent

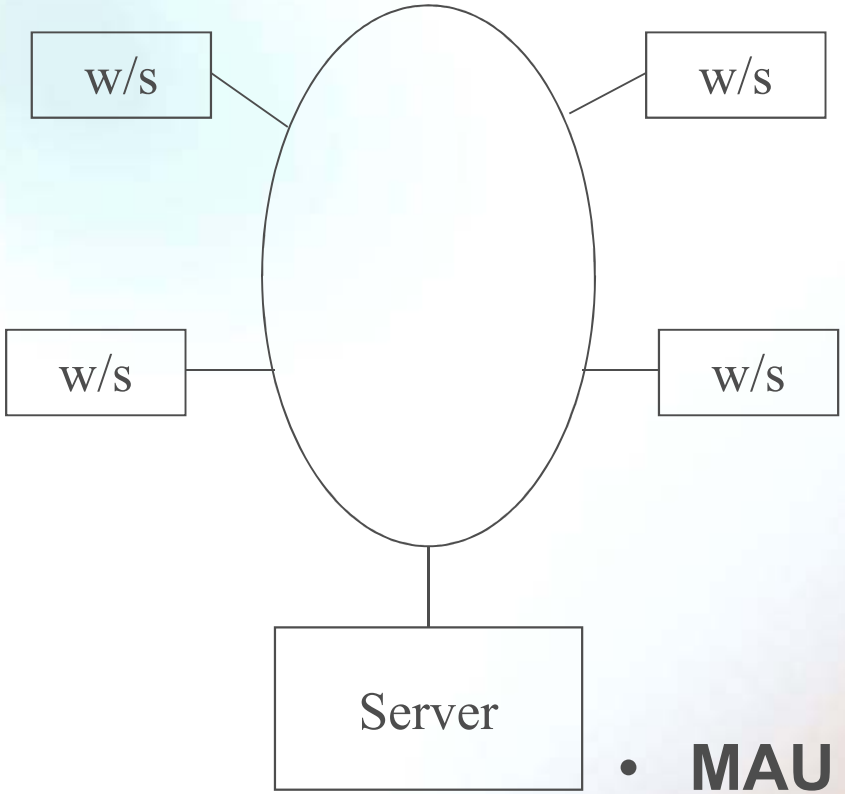
Bus Topology

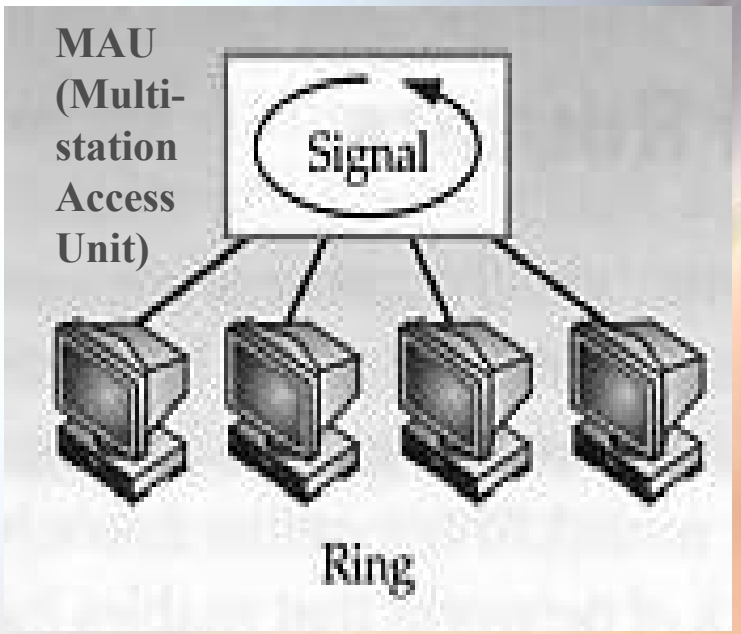
- A single cable connects all devices
- A break in the cable splits network into two
- *Backbone* – a separate cable segment that carries traffic between components





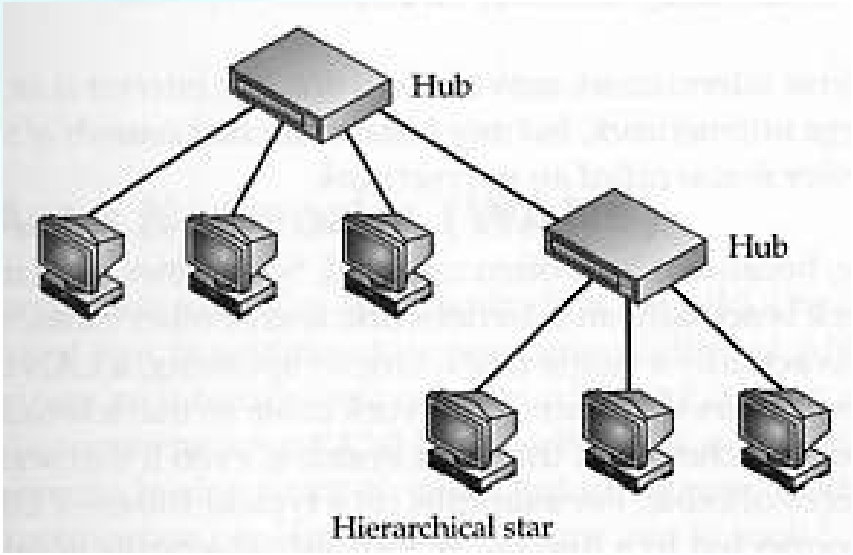
Ring Topology



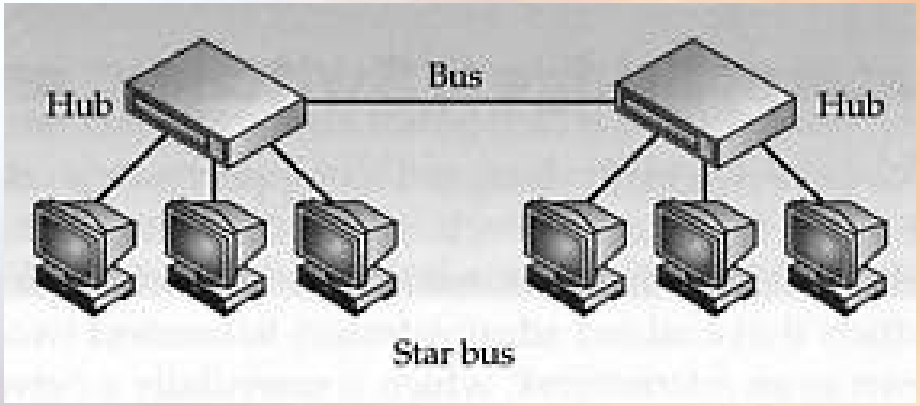


- MAU is a “collapsed ring”
- Physically a star but implements token passing

Hybrid Topologies

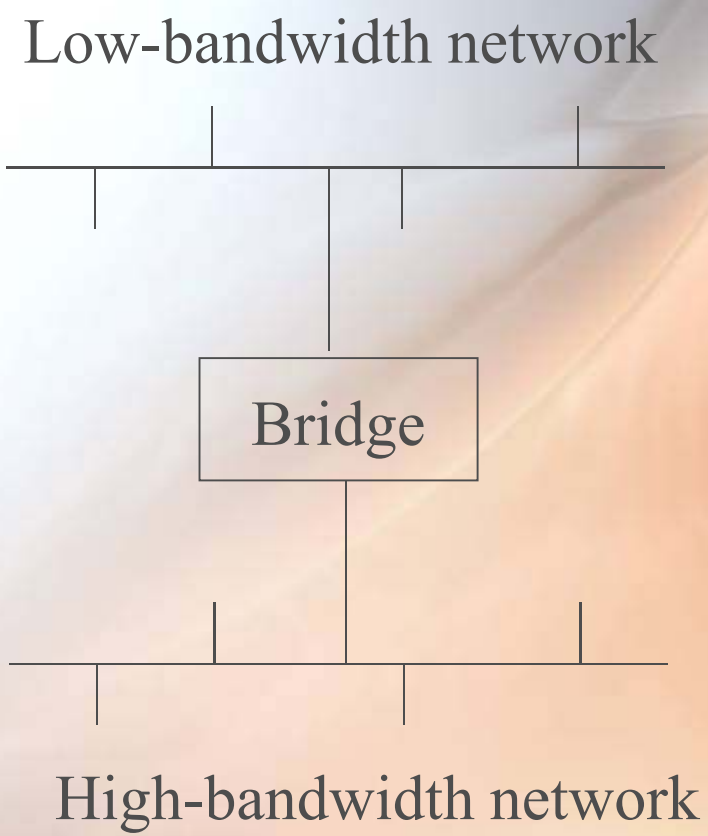


- Combination of basic topologies



Bridge

- Divides the network into segments but does not create multiple LANs
- Also amplifies signals
- Does not prevent broadcast messages from being propagated across cable segments

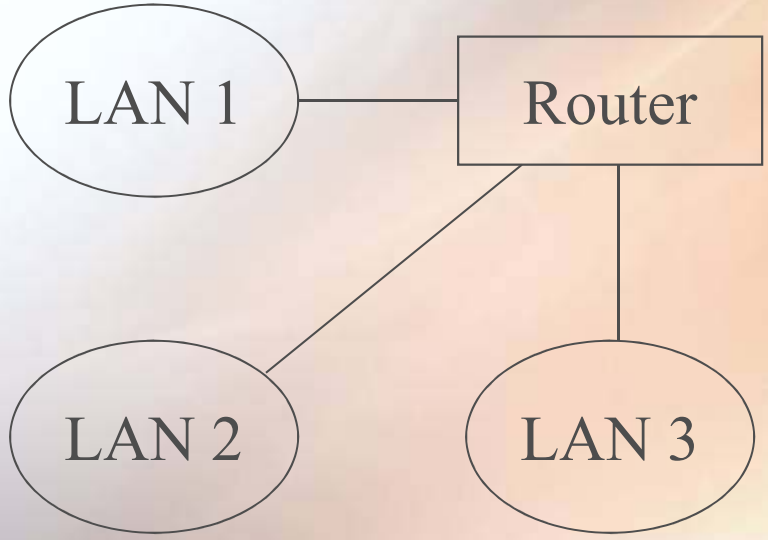


Layer 3: The Network Layer

- Responsible for the packet's entire journey from the source system to its ultimate destination (end-to-end addressing)
- Logical envelope within the data link layer opened only at the final destination
- Popular protocols
  - IP (Internet Protocol)
  - IPX (Internetwork Packet Exchange)

Routers

- Connects two or more LANs (may be two different types of networks)
- Only forwards traffic to destination segment
- Does not forward broadcast messages



Layer 4: The Transport Layer

- No longer concerned with getting packets from source to destination
- Concerned with such functions as guaranteed delivery, end-to-end error checking, etc.
- Popular protocols
  - TCP (Transmission Control Protocol)
  - SPX (Sequenced Packet Exchange)

Data Transfer Protocols

- Non-proprietary
  - TCP/IP (Internet Standard)
- Proprietary
  - SPX/IPX
  - NetBEUI

Other Data Communication Devices

- Repeater – extends cabling distance limit
- Modem – to modulate/demodulate (change from analog to digital signals and vice versa)