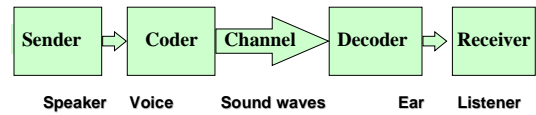


Computer Networking

- Network
 - ◆ A system of interconnections
- Networking
 - ◆ Communication utilizing a Network
- Computer Networking
 - ◆ Computers communicating on Network

1

The Basic Communication Model



2

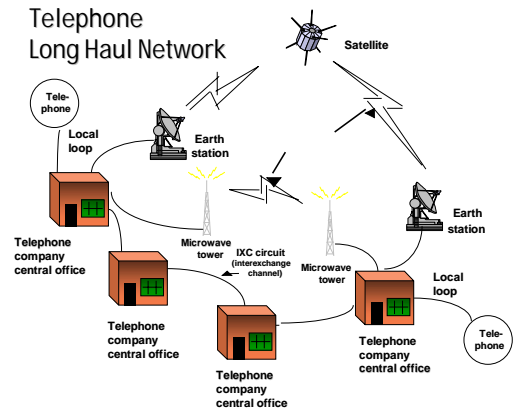
Telephone Communications



- Telephone converts sound to analog signal
- Channel
 - ◆ Telephone Lines
 - ◆ Central Office
 - ◆ A/D Send D/A Receive conversion
 - ◆ Long Haul Network
 - ◆ Routing through channel switching

3

Telephone Long Haul Network



Computer-based Data Communications

- Data communications definition: *The movement of coded data and information from one point to another by means of medium.*
- Media Definition: *Electrical or electromagnetic devices, fiber-optical cables, or microwave signals.*

5

Data Communications Schematic



- Terminal (Client) or Computer
- Modem (Modulate, D/A)
- Channel (Telephone Lines, Network)
- Modem (Demodulate, A/D)
- Computer (Server)

6

Types of Computer Networks

- WAN (wide area network)
 - ◆ Covers a large geographic area
 - ◆ Includes a wide variety of circuits
 - ◆ Usually includes host computers
- LAN (local area network)
 - ◆ Limited area but could include up to 100 microcomputers
 - ◆ Facilitates office automation
 - ◆ Sharing of software, data, peripherals

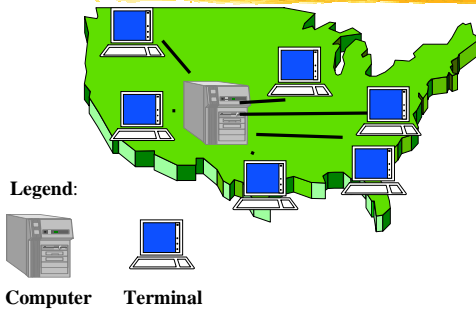
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Wide Area Network

- WAN Approaches
 - ◆ Centralized Computing (Timesharing)
 - ◆ Distributed processing
- WAN Components
 - ◆ Local Loop Media
 - ❖ Twisted pair (4 wires)
 - ❖ Coax (buried)
 - ◆ IXC (interexchange circuit)
 - ❖ Uses Telephone Long Distance Transmission Trunk
 - Microwave
 - Fiber-optical cable
 - Satellite

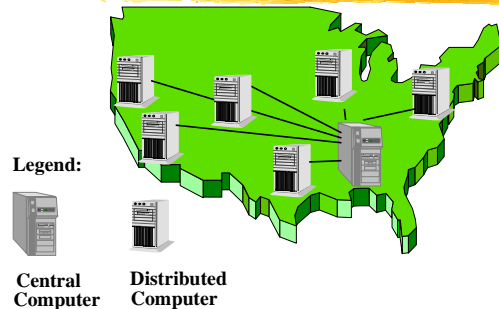
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WAN – Centralized Computing Network



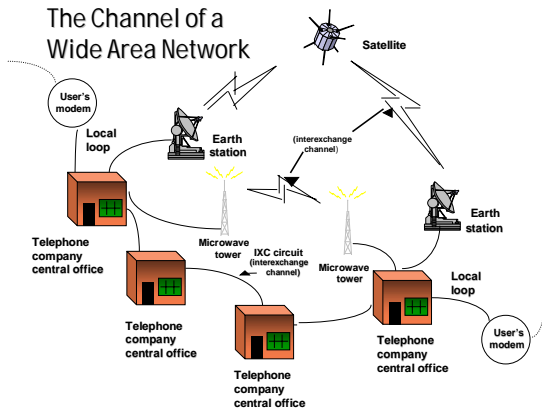
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WAN - Distributed Processing Network



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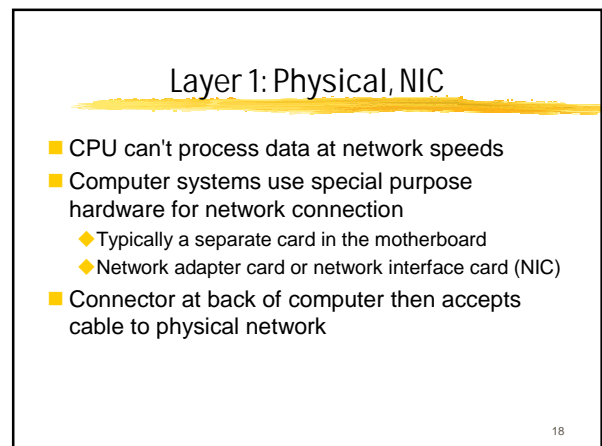
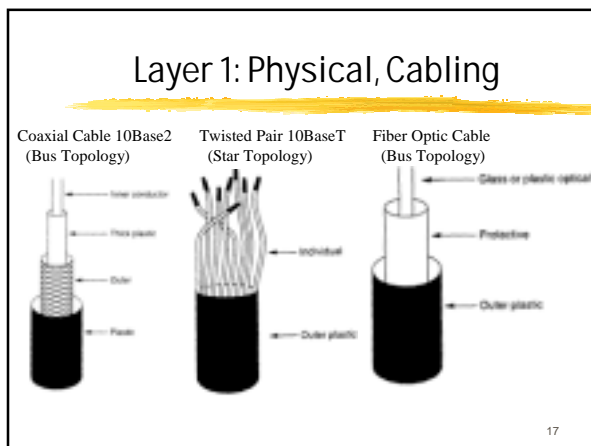
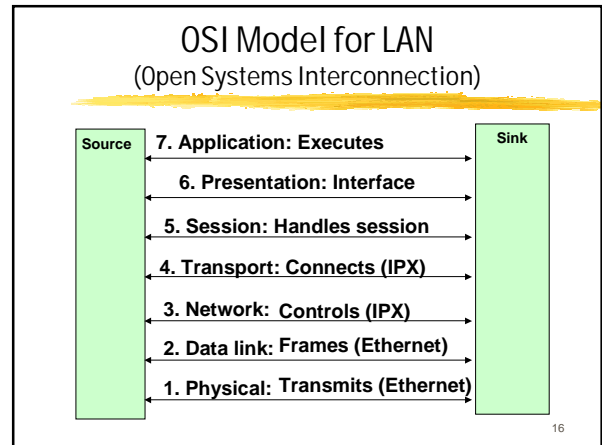
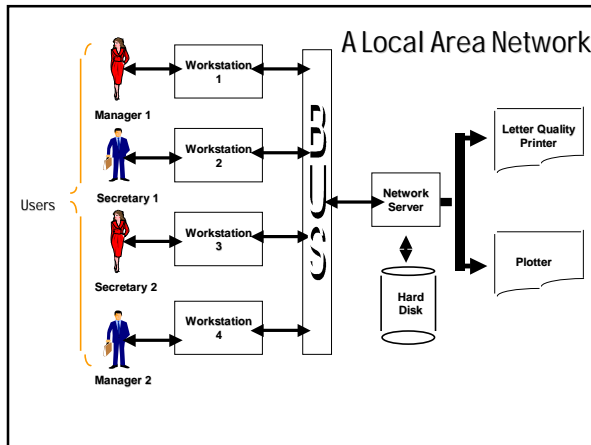
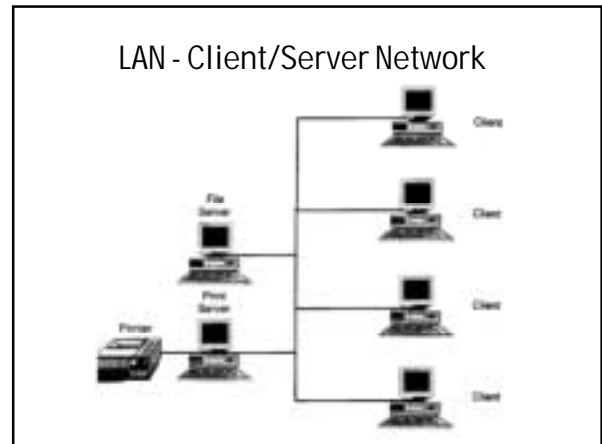
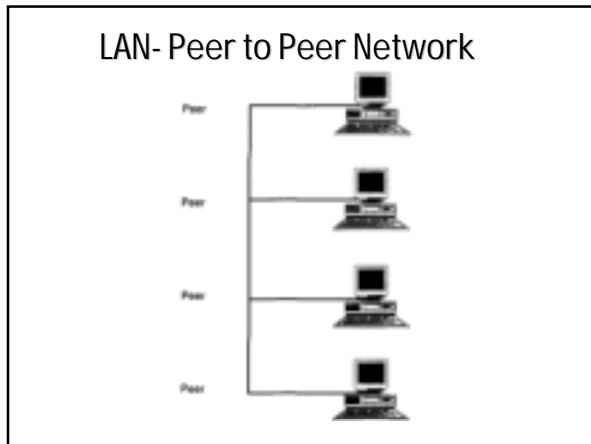
The Channel of a Wide Area Network

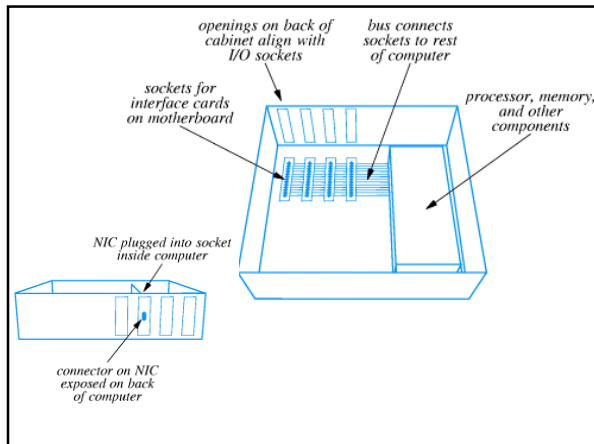


Local Area Network Approaches

- Peer to Peer Approach
- Client/server Approach
 - ◆ Clients are users, typically using LANs (Some processing is best done locally)
 - ◆ Server is mainframe or microcomputer (Global processing)

12





Layer 1: Physical, Ethernet

- Most Widely used LAN technology
 - ◆ Invented at Xerox PARC in 1970s
 - ◆ Standard now managed by IEEE defines frame formats, voltages, and cables
- Three Physical Layer 1 formats available:
 - ◆ 10Base5: Thick-net, Original, (Archaic)
 - ◆ 10Base2: Thin-net, Thinner flexible Coax
 - ◆ 10Base-T: Twisted Pair wires to Hub

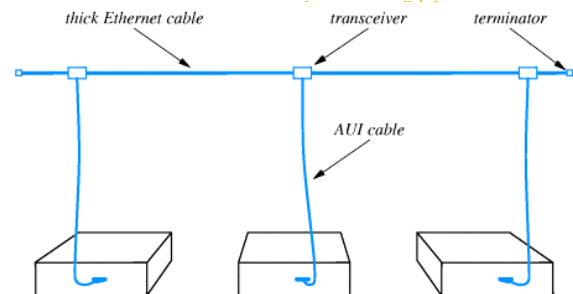
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LAN: 10Base5 Ethernet

- Uses thick coax cable
- AUI cable
 - ◆ Connects from computer to transceiver
 - ◆ AUI cable carries digital signal
- Transceiver generates analog signal on coax
- Thick Ethernet requires termination to avoid signal reflectance

21

LAN: 10Base5 Ethernet



22

LAN: 10Base2 Ethernet

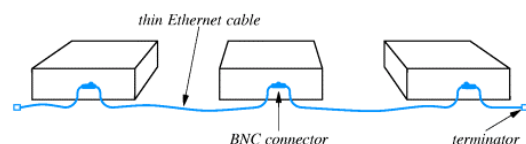
- Uses thin coax that is cheaper and easier to install than thick-net Ethernet coax
- Transceiver electronics built into NIC
- NIC connects directly to network medium
- Coax cable uses standard BNC connector



23

LAN: 10Base2 Connections

- Coax runs directly to back of each connected computer
- T connector attaches directly to NIC
- A broken wire will bring network down



24

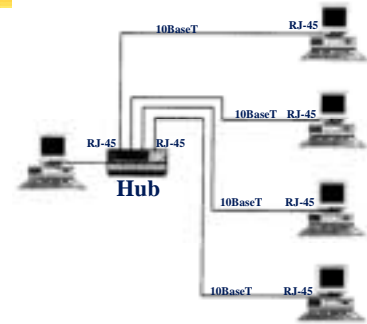
LAN: 10Base-T Ethernet

- Uses twisted pair wires connected to Hub
- Replaces AUI cable with twisted pair cable
- Replaces thick coax with hub
- Uses RJ45 jacks at NIC and Hub



LAN: 10Base-T Ethernet

- Hub contains the bus
- Effectively a very short bus with very long AUI cables



Comparison of wiring schemes

- 10Base5: Separate transceiver allows computer to be disconnected from network without disrupting other communication
 - ◆ Finding bad transceiver can be difficult
- 10Base2: Thin coax requires minimum of cable
 - ◆ Disconnecting one computer can disrupt entire network
- 10Base-T: Hub wiring centralizes electronics and connections, making management easier

27

Layer 1: Ethernet Limitations

- Cable Lengths
 - ◆ Limited to 500 meters in length
 - ◆ Minimum separation is 3 meters
- Speed
 - ◆ Originally 3Mbps
 - ◆ Current standard is 10Mbps
 - ◆ Fast Ethernet operates at 100Mbps

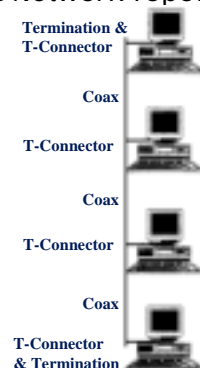
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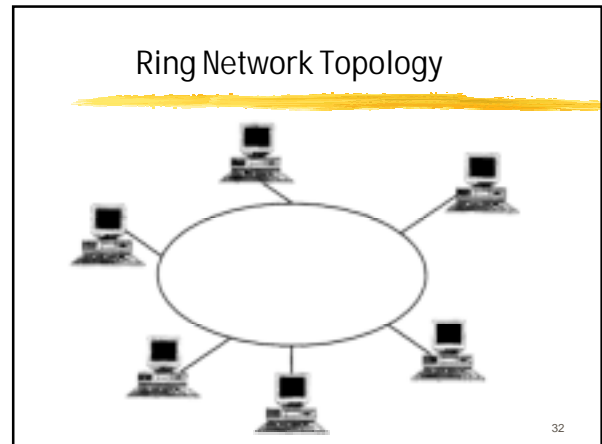
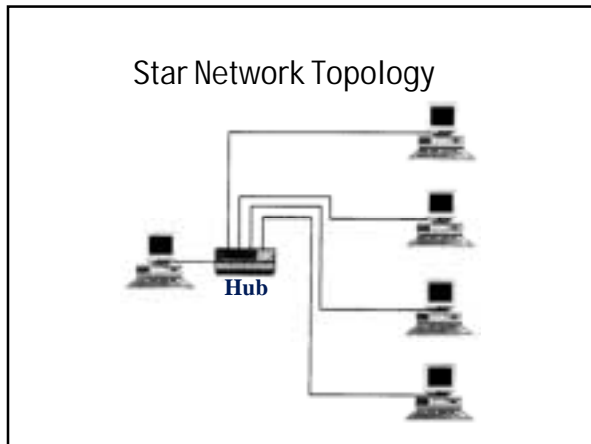
LAN: Layer 2, Data Link

- Dependent on Network Topology Used
 - ◆ Bus Topology: Ethernet
 - ❖ Contention-based
 - ❖ First-come, first-served
 - ❖ Collisions occur when load is heavy
 - ◆ Star Topology: AT&T STARLAN
 - ◆ Ring Topology: IBM Token Ring
 - ❖ Token required to send a message

29

Bus Network Topology





Ethernet Protocol OSI Layer 2

- All wiring technologies use identical Layer 2 OSI specification
 - Same frame format
 - Same CSMA/CD algorithms
- Layer 2 OSI Protocol software can't differentiate among wiring technologies
- Some NICs can provide all three wiring technologies

The diagram shows three connector types in a vertical box:

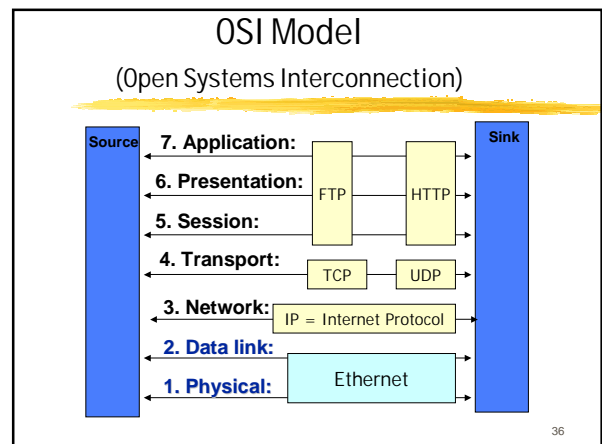
- RJ-45 connector for 10Base-T**: A standard 8-pin connector.
- AUI connector for Thicknet**: A 15-pin D-sub connector.
- BNC connector for Thinnet**: A circular connector with a central pin.

Packets

- Most networks divide into small blocks called *packets* for transmission
- Each packet sent individually
- Such networks are called *packet networks* or *packet switching networks*

Packet Switching Motivation

- Coordination - helps transmitter and receiver determine which data have been received correctly and which have not
- Resource sharing - allows multiple computers to share network infrastructure
- Networks enforce *fair use* - each computer can only send one packet at a time



LAN: Layer 3, Network Protocol

- Dependent on Network Protocol
 - ◆ IPX
 - ◆ NetBEUI
 - ◆ IP

37

ARPANET

- Developed with Government Funding
- Specification made Available to Public
 - ◆ Open System
 - ◆ Any company could build compatible system
 - ◆ ARPANET Internetworking Protocol = TCP/IP
- TCP/IP becomes the standard
 - ◆ Connecting LANs and WANs
- ARPANET is now called the Internet

38

TCP/IP Protocol Suite

- Combination of two Protocols
- IP = Internet Protocol
 - ◆ Provides basic end to end communication
 - ◆ Layer 3: Network Layer of OSI Model
- TCP = Transmission Control Protocol
 - ◆ Provides Reliable data transport
 - ◆ Layer 4: Transport Layer of OSI Model

39