LAN Topologies, Access methods

(Week 1, Wednesday 1/10/2007)

Learning Objectives

- Describe LAN topologies
- Describe major LAN access methods (Ethernet, Token ring, and FDDI)

Network Topologies

- Physical topology is different than Logical topology
- Physical topology = Shape of the network
  - How computers connect to each other in the network
- Logical topology
  - How actually messages are transmitted in the LAN
- Three main topologies
  - Bus
  - Ring
  - Star
- Topologies differ in terms of:
  - Cost (both to install and maintain)
  - Performance and Reliability

Bus Topology

- Built by connecting nodes (PCs or Servers) to a Bus using patch cable
- Terminators signal the physical end to the segment
- 10Base2 & 10Base5 Ethernet are the most prevalent bus networks.

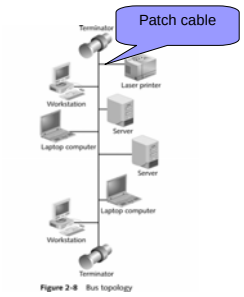

Figure 2-8 Bus topology

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Advantages of Bus Topology

- Works well for small networks
- Relatively inexpensive to implement

Disadvantage of Bus Topology

- Potential for congestion with network traffic

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Ring Topology

- Logical network arrangement
- Nodes (workstations and servers) attached at points around the ring
- Data goes around the ring from node to node
- Implemented using a MAU (Multistation Access Unit)

Figure 2-9 Ring topology

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Advantages of Ring Topology

- Well-suited for transmitting signals over long distances on a LAN
- Enables reliable communication

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Disadvantages of Ring Topology

- Expensive
- Not used as widely as bus topology
  - Fewer equipment options
  - Fewer options for expansion to high-speed communication

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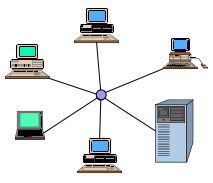
Star Topology

- Most common physical network design
- Multiple nodes attached to a central wiring point



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Advantages of Star Topology

- Low startup costs
- Offers opportunities for expansion
- Most popular topology in use; wide variety of equipment available

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Disadvantages of Star Topology

- Single point of failure (Hub, etc.)
- Requires more cable than Bus topology

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LAN Access Methods

- Access Method = Set of rules governing how computers access the network
- Ethernet
  - IEEE 802.3 specifications
- Token ring
  - IEEE 802.5 specifications
- FDDI (Fiber Distributed Data Interface)
  - ANSI X3T9.5 (High-speed variation of token ring)

Most Common Access methods used in LAN

IEEE = Institute of Electrical and Electronic Engineers

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Ethernet

- Many Ethernet (IEEE 802.3) standards
- Uses CSMA/CD access method for data transmission on a network
- CSMA/CD* :

1) All computers (“carriers”) listen (“sense”) for traffic on the LAN
2) If no traffic, computer that wishes to transmit may transmit
3) If collision occurs, computers must wait a random amount of time
4) The computer with smallest random number send again first.

* Carrier Sense Multiple Access with Collision Detection

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Ethernet (CSMA/CD)

- CSMA/CD rules are:
  - Carrier Sense Multiple Access (CSMA)
    1) If a NIC wishes to transmit, it must listen for traffic
       - If there is no traffic, the NIC may transmit
       - If there is traffic, the NIC must wait until there is no traffic
  - Collision Detection (CD)
    2) If there is a collision (by two or more stations transmitting at the same time),
       - All NICs stop transmitting and wait for a random amount of time
       - The first NIC that finishes its wait may transmit
         - but only if there is no traffic!
         - If there is traffic, the NIC must wait until there is no traffic
  - Collision Detection (CD)
    3) If there are multiple collisions,
       - The random wait is increased each time
       - After 16 attempts to transmit, the sending NIC discards the frame

Source: Panko (2002:116)

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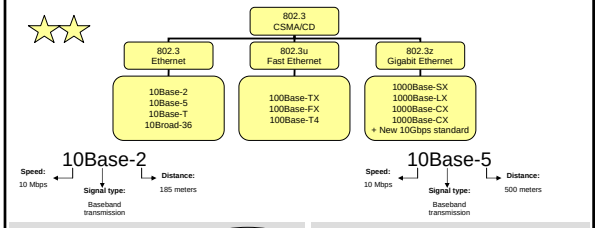
Ethernet (IEEE 802.3) standards



- Speed: 10 Mbps
- Signal type: Baseband w coaxial cable
- Distance: 185 meters/segment
- No more than 30 nodes (computers, printers, etc.) per segment
- Nodes must be spaced at least 0.5 meters apart

10Base-2

Thin Ethernet or Thinnet

- Speed: 10 Mbps
- Signal type: Baseband w coax. cable
- Distance: 500 meters/segment
- No more than 100 nodes per segment
- Nodes must be spaced at least 2.5 meters intervals

10Base-5

Thick Ethernet or Thicknet

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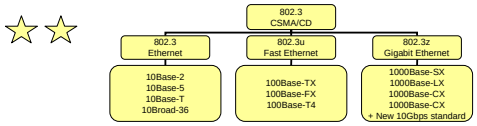
Ethernet (IEEE 802.3) standards



10Base-T

- Speed: 10 Mbps
- Signal type: Baseband
- Distance: 100 meters between the Hub/Switch and the node
- No more than 1024 nodes per Hub/Switch
- Star topology: physical star, logical bus
- Uses CAT3 or better UTP with RJ-45 connectors

100Base-TX: Two Twisted-pairs of Category 5 UTP or STP
100Base-FX: Fiber-optic cabling using 2-strand cable
100Base-T4: Four Twisted-pairs of Category 3,4, or 5 UTP

1000Base-CX: Uses special shielded cable called Twinaxial cable
1000Base-LX: Uses single-mode Fiber-optic cable (5 km)
1000Base-T: Four Twisted-pairs of Category 5 UTP in full-duplex

http://grouper.ieee.org/groups/802/index.html

http://standards.ieee.org/getieee802/802.3.html

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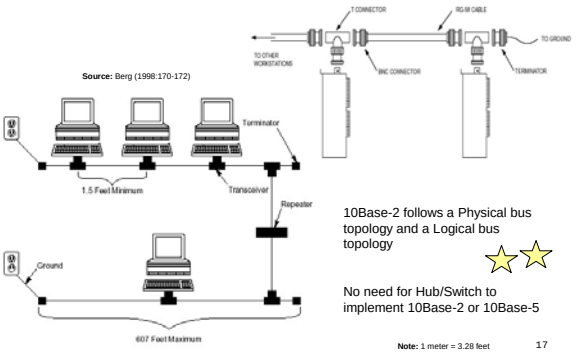
10Base-2 Ethernet



10Base-2 follows a Physical bus topology and a Logical bus topology

No need for Hub/Switch to implement 10Base-2 or 10Base-5

Note: 1 meter = 3.28 feet

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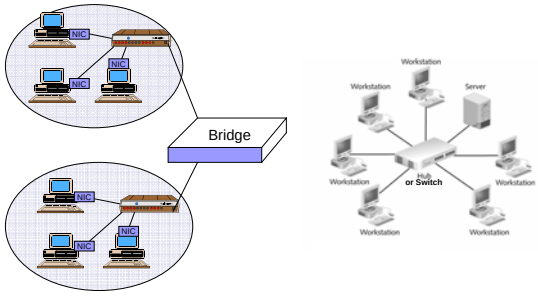
10Base-T Ethernet



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Ethernet frame

Preamble	SFD	Destination address	Source address	Length	Data and pad	FCS
56	8	16 or 48	16 or 48	16	368-12,000	32

Figure 2-11 The 802.3 frame format in bits

Preamble and SOF	Destination address	Source address	Type	Data	FCS
64	48	48	16	368-12,000	32

Figure 2-12 The Ethernet II (DIX) frame format in bits

Preamble: used for synchronization between stations
SOF (Start Of Frame): Signal the receiving station that the next field is coming
Destination Address: Receiver's MAC address
Source Address: Sender's MAC address
Length: Number of bytes in the Data field (**Length** used if number < 1518)
Type: Type of protocol data being carried in data field (**Type** used if data field >= 1518 bytes)
Pad: Data field must be 36+ bytes. If data field < 36 bytes, padding is added to reach 36 bytes
FCS (Frame Check Sequence) or CRC (Cyclical redundancy Check): Prevents transmission error

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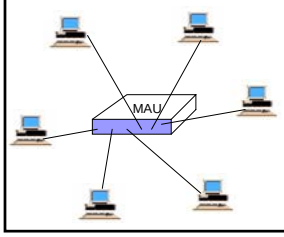
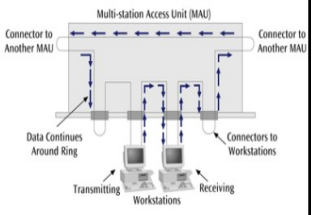
Token Ring (IEEE 802.5)

- Developed by IBM in the 1970s
- Each node connects to a central wiring point called MAU (Multistation Access Unit)
- Employs physical star topology, but logical ring topology
- Common speed: 4 Mbps and 16 Mbps





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Token Ring operation

- Each node communicates directly with 2 neighbor nodes
- Nodes only transmit when they receive a special packet called a "Token"
- No collisions occur

Start delimiter	Access control	Frame control	Dest. Address	Source Address	Data	Frame check sequence	End delimiter	Frame status

Passing Data on Token Rings

1. A computer in the ring capture the token
2. If the computer has data to transmit, it holds the token and transmit a data frame
3. Each computer checks the Destination address to see whether it is the intended recipient of the frame
4. When the frame reaches the destination address, the recipient copies the frame to a buffer, updates the Frame Status field, and puts the frame back to the ring
5. When the original sender receives the frame, it acknowledges a successful transmission, takes the frame off the ring, and places the token back on the ring

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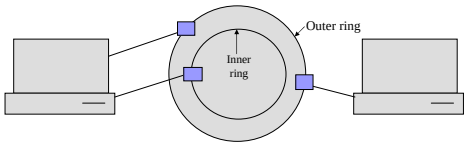
FDDI (Fiber Distributed Data Interface)

- Based on Token ring
- Designed for transmission at 100 Mbps using Optical fiber (over up to 100 kilometers; i.e. 60 miles)
- Possible interconnection of 500 stations
- Allows for two concentric rings (Class A FDDI)



Note: later versions of FDDI use Cat. 5 UTP over much shorter distances.

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Summary Questions

- What occurs when two devices on the same Ethernet network transmit at the same time?
- What device is used to join each node in a Token Ring network?
- FDDI supports a data throughput rate of _____Mbps.

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Summary Questions

- What are the three main LAN topologies?
- From the name 100BaseT, you can know which of the following statement are true?
  a. It is a broadband network
  b. It uses twisted-pair cable
  c. It operates at 0.1 Gbps
- T or F: A token ring network is logically and physically arranged in a ring configuration
- T or F: 1000BaseT networks require fiber optic.

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Summary Questions

- Which of the following are possible Ethernet speeds?
  a. 10 Gbps
  b. 1 Gbps
  c. 100 Mbps
  d. All of the above
- An Ethernet network uses which of the following topologies?
  a. Bus
  b. Ring
  c. All of the above

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