

Point-to-Point

Advantages

- Each connection is separate and can use different hardware and technology.
- Provides security and privacy.

Disadvantages

- The number of wires gets unwieldy.
- Connections between buildings are prohibitive.

Shared Communication

- LANs were developed in the late 1960s and early 1970s as alternatives to expensive P-to-P networks.
- Key Idea: Reduce the number of connections by sharing a common network.
 - Computers take turns using the medium to send packets.
 - Computers must synchronize and coordinate their use of the medium.

- LAN technologies reduce cost by reducing the number of connections...
- ...BUT attached computers compete for the use of a shared connection.
- Local communication is almost exclusively LAN.
- LANs connect more computers than any other type of network.

Principle of Locality of Reference

- Spatial locality of reference: Computers are more likely to communicate with nearby computers.
- Temporal locality of reference: Computers are more likely to communicate with the same computers repeatedly.

LAN Topologies

- Star topology
 - hub - an electronic device that accepts data from a sending computer and passes it on to the appropriate destination.
- Ring topology
- Bus topology

Advantages & Disadvantages

- Ring is easier to synchronize...
...but may be disabled if a cable is cut.
- Star is easy to manage and more robust...
...but requires more cables.
- Bus requires fewer cables...
...but may be disabled if the cable is cut.

Ethernet

- A popular LAN technology that uses a shared bus topology.
- Invented at Xerox PARC in the early 1970s.
- Standard defined by Digital Equipment, Intel, and Xerox (the DIX Ethernet standard). Now managed by IEEE.

- The ether refers to the network coaxial cable. Engineers use the term segment.
 - A segment is limited to 500 meters.
 - The minimum separation between connections is 3 meters.
- Original speed was 3 Mbps. Current standard is 10 Mbps. Fast Ethernet operates at 100 Mbps. Gigabit Ethernet operates at 1 Gbps.
- Since all computers are connected to the same medium, only one computer can transmit at a time.

Carrier Sense Multiple Access (CSMA)

- While one computer transmits a frame to another, the other computers must wait their turns.
- Multiple Access - multiple computers are attached and any one can transmit.
- Carrier Sense - the computer waiting to transmit tests the ether for a carrier before transmitting.

Carrier Sense Multiple Access with Collision Detection (CSMA/CD)

- Even with CSMA, two computers might transmit simultaneously.
- The two transmitted signals interfere, called a collision. The resulting signal is garbled.
- Ethernet hardware monitors the outgoing signal and interprets a garbled signal as a collision.

Binary Exponential Backoff

- After a collision, a computer must wait for the ether to be idle before transmitting again.
- If both computers wait the same length of time, a collision will occur again.
- The standard specifies a maximum delay, and both computers choose a random delay less than the maximum.
- The computer with the shorter delay goes first.
- If another collision occurs, the maximum delay is doubled and random delays are chosen again.

Wireless LANs

- Wireless LANs use radio signals at 900 MHz.
- The data rate is 2 Mbps.
- Radio LANs use sharing. All computers use the same frequency, and so must use packets.
- Unlike wire LANs, not all computers may be in contact with each other.

CSMA with Collision Avoidance (CSMA/CA)

- Suppose #1 wants to transmit to #2.
- #1 sends a short control message to #2.
- #2 responds with a short control message reserving a slot for #1.
- The response from #2 is broadcast so that #3 also receives it, even though #3 didn't receive the original transmission from #1.
- #2 may receive simultaneous requests from #1 and #3 resulting in a collision. Both requests are lost, neither #1 nor #3 receive a reservation, and #1 and #3 use random backoff and try again.

LocalTalk

- Developed by Apple and included with all Macintosh computers.
- LAN technology that uses a bus topology.
- Relatively low speed of 230.4 Kbps.
- Easy to install and use.
- Uses CSMA/CD.

IBM Token Ring

- The ring is treated as a single shared medium.
- In order to transmit a packet, a computer must have a token, a special message sent around the ring.
- Since there is only one token, only one computer can transmit at a time.
- The packet circulates around the ring, is copied by the destination computer, and eventually returns to the sender.
- The token is passed on if a computer has no data to send.
- Original speed of 4 mbps. Now 16 Mbps.

Fiber Distributed Data Interconnect (FDDI)

- Uses a token-ring technology.
- Uses fiber optics.
- Transmits at 100 Mbps.
- FDDI uses two concentric rings. In case of fiber or computer failure, the remaining computers reroute the data through the spare ring.
- FDDI is a self-healing network.

Asynchronous Transfer Mode (ATM)

- Uses a star topology.
- Uses fiber optics.
- The hub is an electronic ATM switch.
- Computers get point-to-point connections. Data from the sender is routed directly through the hub switch to the receiver.
- Operates at 155 Mbps and up.