Network Lecture # 5

CHAPTER 15: LOCAL AREA NETWORK OVERVIEW
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Review Questions

15.1. How do the key requirements for computer room networks differ from those for personal computer local networks?
Computer room networks require very high data rates and usually are concerned with transfer of large blocks of data.

15.2. What are the differences among backend LANs, SANs, and backbone LANs?
- **Backend LAN:** Backend networks are used to interconnect large systems such as mainframes, supercomputers, and mass storage devices. The key requirement here is for bulk data transfer among a limited number of devices in a small area. High reliability is generally also a requirement.
- **SAN:** A SAN is a separate network to handle storage needs. The SAN detaches storage tasks from specific servers and creates a shared storage facility across a high-speed network.
- **Backbone LAN:** A backbone LAN is a high-capacity LAN used to interconnect a number of lower capacity LANs.

15.3. What is network topology?
Network topology refers to the way in which the end parts or stations attached to the network are interconnected.

15.4. List four common LAN topologies and briefly describe their methods of operation.
- **Bus:** all stations attach, through appropriate hardware interfacing known as a tap, directly to a linear transmission medium, or bus. Full-duplex operation between the station and the tap allows data to be transmitted onto the bus and received from the bus. A transmission from any station propagates the length of the medium in both directions and can be received by all other stations. At each end of the bus is a terminator, which absorbs any signal, removing it from the bus.
- **Tree:** a generalization of the bus topology. The transmission medium is a branching cable with no closed loops. The tree layout begins at a point known as the headend. One or more cables start at the headend, and each of these may have branches. The branches in turn may have additional branches to allow quite complex layouts. Again, a transmission from any station propagates throughout the medium and can be received by all other stations.
- **Ring:** the network consists of a set of repeaters joined by point-to-point links in a closed loop. Each station attaches to the network at a repeater and can transmit data onto the network through the repeater.
- **Star:** each station is directly connected to a common central node. Typically, each station attaches to a central node via two point-to-point links, one for transmission and one for reception.

15.5. What is the purpose of the IEEE 802 committee?
To develop LAN standards.
15.6. Why are there multiple LAN standards?
No single technical approach will satisfy all requirements. Requirements with respect to cost, data rate, and range dictate a variety of technical alternatives.

15.7. List and briefly define the services provided by LLC.

**Unacknowledged connectionless service:** This service is a datagram-style service. It is a very simple service that does not involve any of the flow- and error-control mechanisms. Thus, the delivery of data is not guaranteed.

**Connection-mode service:** This service is similar to that offered by HDLC. A logical connection is set up between two users exchanging data, and flow control and error control are provided.

**Acknowledged connectionless service:** This is a cross between the previous two services. It provides that datagrams are to be acknowledged, but no prior logical connection is set up.

15.8. List and briefly define the types of operation provided by the LLC protocol.

**Type 1 operation** supports unacknowledged connectionless service. There is no acknowledgment, flow control, or error control.

**Type 2 operation** supports connection-mode service, using mechanisms similar to HDLC.

**Type 3 operation** supports acknowledged connectionless service. Each transmitted PDU is acknowledged using a stop-and-wait technique.

15.9. List some basic functions performed at the MAC layer.

1. On transmission, assemble data into a frame with address and error-detection fields.
2. On reception, disassemble frame, and perform address recognition and error detection.
3. Govern access to the LAN transmission medium.

15.10. What functions are performed by a bridge?

For a bridge that connects LANs A and B:

1. Read all frames transmitted on A and accept those addressed to any station on B.
2. Using the medium access control protocol for B, retransmit each frame on B.
3. Do the same for B-to-A traffic.

15.11. What is a spanning tree?

For any connected graph, consisting of nodes and edges connecting pairs of nodes, there is a spanning tree of edges that maintains the connectivity of the graph but contains no closed loops.

15.12. What is the difference between a hub and a layer 2 switch?

With a hub, only one attached station may transmit at a time. A switch can accommodate multiple simultaneous transmissions.

15.13. What is the difference between a store-and-forward switch and a cut-through switch?

**Store-and-forward switch:** The layer 2 switch accepts a frame on an input line, buffers it briefly, and then routes it to the appropriate output line.

**Cut-through switch:** The layer 2 switch takes advantage of the fact that the destination address appears at the beginning of the MAC (medium access control) frame. The layer 2 switch begins repeating the incoming frame onto the appropriate output line as soon as the layer 2 switch recognizes the destination address.
Problems:

15.1 Instead of LLC, could HDLC be used as a data link control protocol for a LAN? If not, what is lacking? HDLC has only one address field. In a LAN, any station may transmit to any other station. The receiving station needs to see its own address in order to know that the data is intended for itself. It also needs to see the sending address in order to reply.

15.2 An asynchronous device, such as a teletype, transmits characters one at a time with unpredictable delays between characters. What problems, if any, do you foresee if such a device is connected to a LAN and allowed to transmit at will (subject to gaining access to the medium)? How might such problems be resolved?

Each individual character could be sent out as a separate packet, resulting in tremendous overhead. This problem could be overcome by buffering characters and only sending out blocks of characters.

15.3 Consider the transfer of a file containing one million 8-bit characters from one station to another. What is the total elapsed time and effective throughput for the following cases:

a. A circuit-switched, star-topology local network. Call setup time is negligible and the data rate on the medium is 64 kbps.

\[ T = \frac{#\ of\ bits}{data\ rate} = \frac{8 \times 10^6\ bits}{64 \times 10^3\ bps} = 125\ seconds \]

b. A bus topology local network with two stations a distance \( D \) apart, a data rate of \( B \) bps, and a frame size of \( P \) with 80 bits of overhead per frame. Each frame is acknowledged with an 88-bit frame before the next is sent. The propagation speed on the bus is 200 m/\( \mu \)s Solve for:

1. \( D = 1\ km, B = 1\ Mbps, P = 256\ bits \)
2. \( D = 1\ km, B = 10\ Mbps, P = 256\ bits \)
3. \( D = 10\ km, B = 1\ Mbps, P = 256\ bits \)
4. \( D = 1\ km, B = 50\ Mbps, P = 10,000\ bits \)

b. Transfer consists of a sequence of cycles. One cycle consists of:

Data Packet = Data Packet Transmission Time + Propagation Time
ACK Packet = ACK Packet Transmission Time + Propagation Time

Define:

- \( C \) = Cycle time
- \( Q \) = data bits per packet
- \( T \) = total time required
- \( Td \) = Data Packet Transmit Time
- \( Ta \) = ACK Packet Transmit Time
- \( Tp \) = Propagation Time

Then:

\[ Tp = \frac{(D)}{(200 \times 10^6\ m/sec)} \]
\[ Ta = \frac{(88\ bits)}{(B\ bps)} \]
\[ Td = \frac{(P\ bits)}{(B\ bps)} \]
\[ T = \frac{(8 \times 106\ bits \times C\ sec/cycle)}{(Q\ bits/cycle)} \]
\[ C = Ta + Td + 2Tp \]
\[ Q = P - 80 \]
\( b1 \quad C = \frac{88}{10^6} + \frac{256}{10^6} + \frac{2 \times 10^3}{200 \times 10^6} = 354 \times 10^{-6} \)

\( Q = 176 \)

\( T = \frac{8 \times 10^6 \times 354 \times 10^{-6}}{176} = 16 \text{ sec} \)

\( b2 \quad C = \frac{88}{10 \times 10^6} + \frac{256}{10 \times 10^6} + \frac{2 \times 10^4}{200 \times 10^6} = 44.4 \times 10^{-6} \)

\( Q = 176 \)

\( T = \frac{8 \times 10^6 \times 44.4 \times 10^{-6}}{176} = 2 \text{ sec} \)

\( b3 \quad C = \frac{88}{10^6} + \frac{256}{10^6} + \frac{2 \times 10^4}{200 \times 10^6} = 444 \times 10^{-6} \)

\( Q = 176 \)

\( T = \frac{8 \times 10^6 \times 444 \times 10^{-6}}{176} = 20 \text{ sec} \)

\( b4 \quad C = \frac{88}{50 \times 10^6} + \frac{10^4}{50 \times 10^6} + \frac{2 \times 10^3}{200 \times 10^6} = 211.8 \times 10^{-6} \)

\( Q = 9920 \)

\( T = \frac{8 \times 10^6 \times 211.6 \times 10^{-6}}{9920} = 0.17 \text{ seconds} \)

c. A ring topology local network with a total circular length of \( 2D \), with the two stations a distance \( D \) apart. Acknowledgment is achieved by allowing a frame to circulate past the destination station, back to the source station, with an acknowledgment bit set by the destination. There are \( N \) repeaters on the ring, each of which introduces a delay of one bit time. Repeat the calculation for each of \( b1 \) through \( b4 \) for \( N = 10 ; 100 ; 1000 \).

Define:

\( Tr = \text{Total repeater Delay} = N/B \)

Then

\( C = Td + 2Tp + Tr \)

\( Q = P - 80 \)

\( T = \frac{8 \times 10^6 \times C}{(Q)} \)

Apply these equations for \( N = 10 ; 100 ; 1000 \) for each part above.

15.4 Consider a baseband bus with a number of equally spaced stations with a data rate of 10 Mbps and a bus length of 1 km.

a. What is the mean time to send a frame of 1000 bits to another station, measured from the beginning of transmission to the end of reception? Assume a propagation speed of

Assume a mean distance between stations of 0.375 km. This is an approximation based on the following observation. For a station on one end, the average distance to any other station is 0.5 km. For a station in the center, the average distance is 0.25 km. With this assumption, the time to send equals transmission time plus propagation time.

\( T = (10^3 \text{ bits} / 10^7 \text{ bps}) + (375 \text{ m} / 200 \times 10^6 \text{ m/sec}) = 102 \mu \text{ sec} \)

b. If two stations begin to transmit at exactly the same time, their packets will interfere with each other. If each transmitting station monitors the bus during transmission, how long before it notices an interference, in seconds? In bit times?

\( T_{\text{interfere}} = 375 \text{ m} \times 200 \times 10^6 \text{ m/sec} = 1.875 \mu \text{ sec} \)

\( T_{\text{interfere(bit-times)}} = 10^7 \times 1.875 \times 10^\approx 6 = 18.75 \text{ bit – times} \)
15.6 At a propagation speed of 200 m/µs what is the effective length added to a ring by a bit delay at each repeater?

a. At 1 Mbps
   1 bit / 1Mbps = 1µsec
   Length = 200 m / µs * 1µsec = 200 m

b. At 40 Mbps
   1 bit / 40 Mbps = 0.025 µsec
   Length = 200 m / µs * 0.025 µsec = 5 m