CPS 470/570: Final Exam **Name:**____________________________________

Instructor: Dr. Clark December 7, 1995

This test is closed book and closed notes. You may use a calculator. Answer the questions in the space provided. When answering questions, please state any and all assumptions you are making. For questions involving calculation, indicate your final answer by circling it.

Some formulas you may or may not find useful are:

- Nyquist: Capacity = 2×Bandwidth×log_2(# signaling levels)
- Shannon: Capacity = Bandwidth×$log_2(1 + \frac{S}{N})$
- Sampling Theorem: Must sample at twice the highest frequency.
- Flow Control Utilization $= \frac{1}{1+2a}$ where $a = \frac{PropagationDelay}{TransmissionTime}$
- MAC Utilization $= \frac{1}{1+a}$
- $log_a X = \frac{lnx}{lna}$
- $E = MC^2$
- Probability(A and B) = Probability(A) × Probability(B) if A and B are independent

Part 1 (25 points)

1. Define and give one example of each: simplex communication, half-duplex communication, full-duplex communication.

2. What is the difference between synchronous and asynchronous communications?

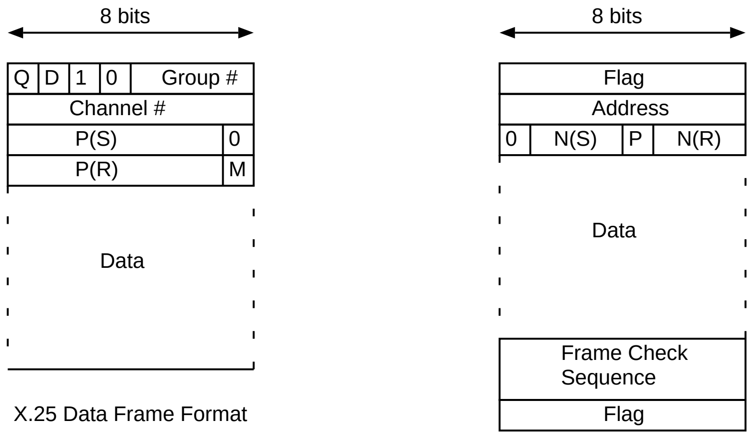
Part 2 (30 points)

1. For a layered architecture, explain the difference between a protocol's peer-to-peer interactions and a protocol's service interface. (You may want to use a picture in your explanation.)

2. In this class we have focused on problems and their solutions at the three lower layers of the OSI model. For each of these lower layers give the following: 1) the name of the layer, 2) the general function of the layer, 3) at least two protocols or techniques we discussed which operate at the layer.

Part 3 (25 points)

The following figure shows the frame formats for data frames in X.25 and LAP-B.



X.25 Data Frame Format

LAP-B Data Frame Format

Assume that the physical transmission link between a DCE and DTE is an analog channel with a bandwidth of 100,000Hz.

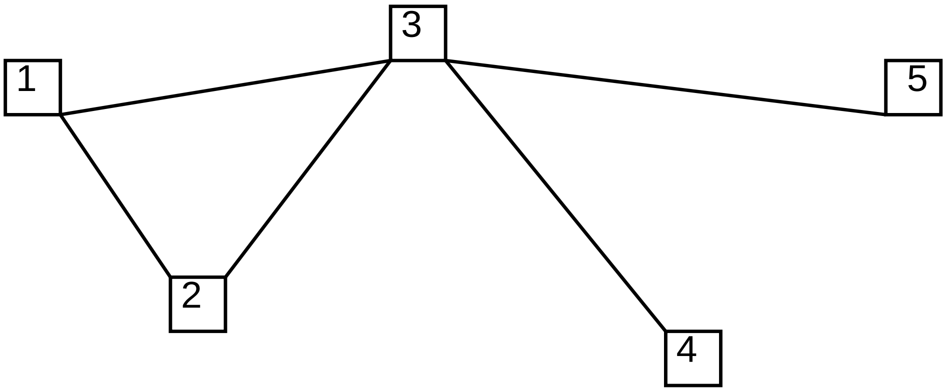
1. What is the maximum bit rate for the physical link between the DCE and DTE. Assume that there is no noise and that each signal level encodes 4-bits.

2. We define the effective data rate as the maximum rate at which *user data* is transmitted. What is the effective data rate of this channel for data transmitted between the user process at the DTE and the DCE?

3. Now, we want to send digitized analog data over this communication link using the protocols listed above. If we use 8-bits per sample, what is the highest frequency we can send?

Part 4 (20 points)

The following diagram depicts a packet switched network with five nodes. The end hosts are not shown.



1. Give the routing tables for each of the nodes if a static routing scheme is being used.

2. Another approach to routing in such a network is to use packet flooding. What is needed for this approach to work? What are the problems with this approach?

Part 5 (20 points)

1. We discover that node 3 in the packet switch network on the previous page is experiencing serious congestion. What are two techniques that can be used to reduce this congestion? (These techniques may be changes to the node operation, the end host operation or both.)

2. Why are congestion control techniques generally not needed in a circuit switched network?

Part 6 (30 points)

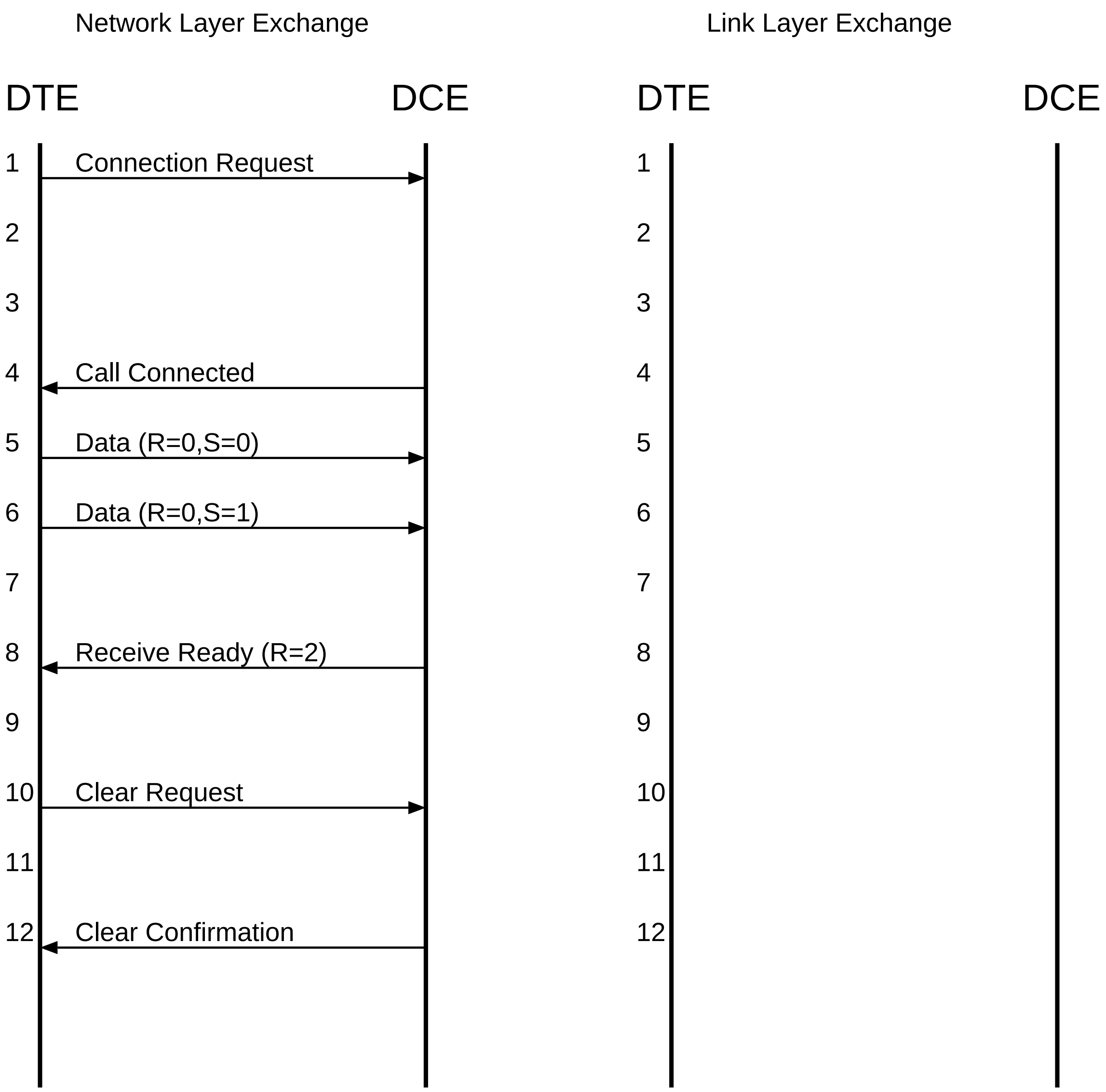
1. Which of the MAC layer protocols discussed in class are capable of guaranteeing that every transmitter will eventually gain access to the network?

2. A Collision Detection mechanism does nothing to prevent collisions on a shared medium. How then does it improve the utilization of the medium?

3. What is the function of the *Address Recognized* and *Frame Copied* bits in the Token Ring protocol?

Part 7 (20 points)

The following is a depiction of one side of a packet layer conversation in an X.25 network. This figure shows the packet layer exchange between the DTE and DCE for a single virtual circuit. The window size for the virtual circuit is 2. You are to show the exchange of frames over the LAP-B connection that underlies the packet exchange shown at the network layer. Assume that the LAP-B Window size is 7. Your answer should include all LAP-B layer send and receive sequence numbers and all LAP-B supervisory frames used. You may assume that the LAP-B ABM connections have already been set up.



Part 8 (30 points)

1. We want to design communications protocols for a wireless data network. The three transmission technologies we are considering for our network are: satellites in geosynchronous orbit, satellites in low earth orbit (LEOS), and cellular telephone. What are the most significant differences between these three technologies that will affect our protocol design? What are some appropriate choices we should make for each of the technologies for things like flow and error control?

2. Describe what happens when a cellular telephone moves from one cell to another during a call. (If you don't remember the details, at least give a summary of what needs to happen and the process for doing it.)