CSE 422 Homework #1 Fall 2009

Due at the **Beginning** of Class

Tuesday, November 3

Name: _____ Score: _____ /120

Please write your answers CLEARLY on these sheets, which will assist the TA in grading. You must show all your work! A correct numerical answer without the accompanying calculations will count only one point.

1. Network Architectures. (8 points total)

   (a) (2 points) True or False? The transport layer protocol is always connection-oriented. Explain briefly.

   (b) (2 points) Why are CRC checksums usually placed in the trailer of a frame, rather than in the header?

   (c) (2 points) True or False: A given (IP address, port number) pair can simultaneously be associated with more than one TCP connection. Explain your answer briefly.

   (d) (2 points) Consider a frame sent as part of an FTP (file transfer protocol application) session between two computers connected by an 802.3 local area network. Draw a picture of the frame, showing the relative location of the (1) data payload, (2) TCP header, (3) 802.3 header, (4) CRC checksum, (5) FTP header, (6) IP header.

2. (4 points) Consider a noiseless communication channel where the bandwidth is 50,000 Hz. What is the maximum bit rate using an encoding scheme that combines 3 amplitudes and 12 phases? You must show your work.

3. (8 pts.) (a) If the channel has a bandwidth of 32,000 Hz and a noise level of 20 dB, (a) what is the maximum data rate of the channel, using a signaling technique with 8 different signal elements? (b) What if the channel is noiseless?

4. (6 pts) Assume the highest frequency of the human voice is 4 kilohertz. If we sample the analog voice signal and encode it with 16 bits per sample, using NRZ encoding, then what is the minimum bandwidth required to carry the digital signal across a noiseless channel? Show your work. (Note: what is the necessary sampling frequency for a 4KHz signal?)

5. (16 points) Assume we are transmitting data between two nodes, A and D. The data traverses two intermediate nodes, B and C. Hence the data crosses THREE links. The size of our data is 2000 bytes (16000 bits). Assume the following:

   - datagram packet switching is used
   - the speed of each link is 64,000 bits per second
   - the length of each link is 1800 kilometers (1,800,000 meters)
   - the propagation speed of signals in copper is 2×10^8 meters per second
   - the amount of data in each packet is 1000 bytes (8000 bits)
   - the size of headers is 800 bits
   - the processing/queueing time for a packet at each intermediate node is 5 milliseconds

   (a) (4 points) How long does it take to transmit an individual packet on one of the links? (That is, how long does it take to put 8800 bits on the wire, at 64,000 bits per second?) Show your work.

   (b) (6 points) Draw a timing diagram showing how the message (broken up into packets) is delivered from node A to node D using DPS. (**NOTE:** Remember, in a store-and-forward network, a packet must *completely* arrive on an incoming link, before transmission of the packet can begin on an outgoing link.)

   (c) (6 points) Compute the total time to send the message from node A to node D using DPS? Show all your work.

6. (12 points) Assume we are transmitting data between two nodes, A and D. The data traverses two intermediate nodes, B and C. Hence the data crosses THREE links. The size of our data is 2000 bytes (16000 bits). Assume the following.

   - circuit switching (CS) is used
   - connection requests are acknowledged, but data is not
   - a connection request (setup) packet contains 800 bits
   - an acknowledgement packet contains 800 bits
   - the speed of each link is 64,000 bits per second
   - the length of each link is 1800 kilometers (1,800,000 meters)
   - the propagation speed of signals in copper is 2×10^8 meters per second
   - the processing/queueing time for a packet at each intermediate node is 5 milliseconds
   - ignore any headers on data

   (a) (6 points) Draw a timing diagram showing how the message (broken up into packets) is delivered from node A to node D using CS. (**NOTE:** Remember, in CS, once the connection is established, the constituent links act like a single (long) physical channel.)

   (b) (6 points) Compute the total time to send the message from node A to node D using CS? Show all your work.

7. Error detection (22 points total)

(a) (8 pts) Consider a CRC code with a generator polynomial of $G(x) = x^5 + x^4 + x^3 + x^2 + x + 1$. Compute the checksum generated on the following (very short) data frame: 11011011. You must show your work.

(b) (4 points) Can the above CRC code detect all burst errors in which the number of bits in error is odd? Explain why or why not.

(c) (6 points) Consider an error pattern that occurs in a frame. **1 1 0 0 0 0 1 1**, where **1** represents a bit in error and **0** represents a bit that is correct. Will the above CRC code detect this *particular* error? Explain why or why not.

(d) (4 points) What is the probability that the above CRC code will detect a burst error of length 6? Show your work.

8. (20 points total) Consider the Hamming Code for correcting 1-bit errors. Assume we want to correct all 1-bit errors on occurring in every 6 bits of data.

   (a) (6 points) How many check bits are needed for 6 data bits? Show your work.

   (b) (8 points) Compute the value of the check bits for the following data bits: 101101 (Use **even** parity.)

   (c) (6 points) Assume we have **already** computed the 4 check bits for 8 data bits, using even parity, and that the result is the following 12 bits: 111011101111. Bits are numbered from left to right, and bits 1, 2, 4, and 8 are check bits.

   Assume we transmit these 12 bits across the network, and the following three bits are flipped: 2, 3, and 10. The Hamming code always identifies at most a single bit in error, or reports no error. What will the code report in the above case? Please explain briefly.

9. Sockets (8 points total)

(a) (2 pts.) After invoking a `bind()` system call many socket programs subsequently invoke a `getsockname()` system call. What piece of information is usually being sought by the process when it invokes the `getsockname()` call? Circle one.

DNS hostname IP address port number file descriptor

(b) (2 pts.) True or False. A socket of type SOCK_STREAM does not need to be in a connected state before data can be sent on it. Briefly explain why or why not.

(c) (2 pts.) True or False. A program must always invoke the bind() system call before sending on a socket. Briefly explain your answer.

(d) (2 pts.) The `listen()` system call does not block and wait for connection requests. That is the job of `accept()`. What is the job of the *listen()* system call? Be specific.

10. (16 points) Assume we are designing a reliable data link protocol for a 100 Mbps (100,000,000 bits per second) channel connecting node A and node B. Assume the (one way) propagation delay of 0.6 milliseconds (0.0006 seconds). The size of each frame is 1500 bytes (12000 bits). You may ignore packet headers and the transmission time for acks (do not ignore their propagation delay).

    (a) (2 points) How many **frames** (not bits) fit on the channel from A to B (one direction)? Show your work.

    (b) (7 points) If selective repeat sliding window protocol is used, with 4-bit sequence numbers, what is the maximum utilization of the channel? Show your work.

    (c) (7 points) Assume we can change the frame size. If a stop-and-wait protocol is implemented, what frame size is needed so that the channel utilization will be at least 25% ? Show your work.