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Department of Computer Science and Engineering

CSE 3213: Computer Networks I (Summer 2008)

Quiz II

Date: July 3, 2008

Name:_____

Student number:_____

Instructions:

- Examination time: 60 minutes.
- Write your name and student number in the above provided space.
- You are not allowed to use laptop, textbook, cell phone and any kind of electronic devices during the quiz **except calculator**.
- Ensure that this quiz has 6 pages (including cover page) and 7 questions.
- Answer the questions in the provided spaces. If you run out of room for an answer, continue on the back of the page.
- Good Luck!

1. Consider a baseband transmission channel with a bandwidth of 10 MHz. What bit rates can be supported by the bipolar line code and by the Manchester line code? (4 marks)

A bipolar code with pulses T-seconds wide occupies a bandwidth of W = 1/T Hz. Therefore a 10 MHz bandwidth allows a signaling rate of 10 megabits/second.

It can also be seen that a Manchester code occupies twice the bandwidth. Hence a 10 MHz bandwidth allows a signaling rate of 5 megabits/second.

2. Suppose that a modem can transmit 8 distinct tones at distinct frequencies. Every T seconds the modem transmits an arbitrary combination of tones (that is, some are present, and some are not present).
    a. What bit rate can be transmitted using this modem? (2 marks)

Each tone is either present or absent, hence there are 28 possible combinations of tones that can be transmitted every T seconds. The corresponding transmitted bit rate is 8/T bps.

    b. Is there any relationship between T and the frequency of the signals? (2 marks)

Yes, there is a relationship. T must be long enough that enough of each sinusoid can be observed to determine its frequency. This implies that the periods of all the sinusoids must be less than T.

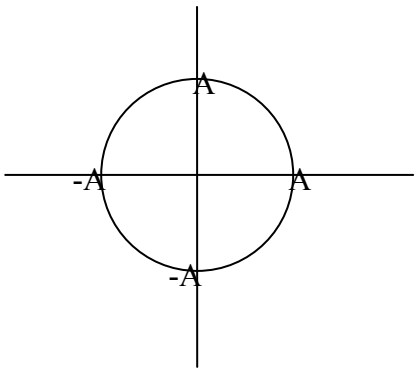
3. A phase modulation system transmits the modulated signal $A\cos(2\pi f_c t + \phi)$ where the phase φ is determined by the 2 information bits that are accepted every T-second interval:

   for 00, $\phi = 0$; for 01, $\phi = \pi/2$; for 10, $\phi = \pi$; for 11, $\phi = 3\pi/2$

   Plot the signal constellation for this modulation scheme. (4 marks)

   The transmitted signals corresponding to the phase values are as follows:

   for 00 $\phi = 0$, so $x(t) = A\cos(2\pi f_c t)$
   for 01 $\phi = \pi/2$, so $x(t) = A\cos(2\pi f_c t + \pi/2) = -A\sin(2\pi f_c t)$
   for 10 $\phi = \pi$, so $x(t) = A\cos(2\pi f_c t + \pi) = A\cos(2\pi f_c t + \varphi)$
   for 11 $\phi = 3\pi/2$, so $x(t) = A\cos(2\pi f_c t - \pi/2) = -A\sin(2\pi f_c t)$



4. Let g(x)=x3+x+1. Consider the information sequence 1001.

   a. Find the codeword corresponding to the preceding information sequence. (2 marks)

```
      1010
1011 | 1001000
       1011
       01000
        1011
        00110
```

Codeword = 1001110

   b. Suppose that the codeword has a transmission error in the first bit. What does the receiver obtain when it does its error checking? (2 marks)

```
      0001
1011 | 0001110
       1011
        101
```

CRC Calculated by the receiver = 101 → error

5. Consider the transfer of a single real-time telephone voice signal across a packet network. Suppose that each voice sample should not be delayed by more than 20 ms. Compare a hop-by-hop approach to an end-to-end approach to meeting the requirements of the voice signal. (4 marks)

Sequencing and timing are the most important requirements for real-time voice. These requirements are better met in a hop-by-hop approach than in an end-to-end approach because delay performance is critical. Resequencing on an end-to-end basis may lead to excessive delay. Hop-by-hop controls on transfer delay may be critical to achieving real-time transfer.

6. The Trivial File Transfer Protocol (RFC 1350) is an application layer protocol that uses the Stop-and-Wait protocol. To transfer a file from a server to a client, the server breaks the file into blocks of 512 bytes and sends these blocks to the client using Stop-and-Wait ARQ. Find the efficiency in transmitting a 1 MB file over a 10 Mbps Ethernet LAN. Assume the transmissions are error free, propagation delay and processing are negligible, each packet has 60 bytes of header attached, and acknowledgement packet is 8 bytes. (4 marks)

$t_0 = t_f + t_{ack} = \{8(512 + 60)/ 10 \times 10^6\} + \{64/10 \times 10^6\} = 4.64 \times 10^{-4}$

$\eta_0 = R_{eff} / R = ((n_f - n_0)/t_0)/R = (8 \times 512 /4.64 \times 10^{-4}) /(10 \times 10^6) = 0.8828 = 88.3\%$

7. Three possible strategies for sending ACK frames in a Go-Back-N setting are as follows: send an ACK frame immediately after each frame is received, send an ACK frame after every other frame is received, and send an ACK frame when the next piggyback opportunity arises. Which of these strategies are appropriate for the following situations?

    a. An interactive application produces a packet to send each keystroke from the client; the server echoes each keystroke that it receives from the client. (2 marks)

Since each keystroke is echoed, there will always be a piggyback opportunity. Thus, the piggyback method should be used. Indeed, the echo packet constitutes an acknowledgment.

    b. A bulk data transfer application where a server sends a large file that is segmented in a number of full-size packets that are to be transferred to the client. Consider two cases: low probability of error and high probability of error. (4 marks)

The upstream traffic to a server is generally much less than the downstream traffic. Thus, the piggybacking method is non-ideal in this case. If the channel has a low probability of error, the alternating ACK method is better, as it saves bandwidth. However, if the connection causes frequent errors, every frame should be acknowledged. Additional overhead traffic is caused by the ACK frames, but will compensate by the bandwidth savings that will arise when the errors are discovered more quickly.