ECE 2305: Introduction to Communications and Networks

Quiz #5

3:00-3:30 PM, 01-May-2014

Name: SOLUTION

Box #: ____________

Instructions:

- Do not open this quiz until you are instructed to do so.
- This quiz is closed book, but you are permitted to bring one two-sided 8.5" by 11" sheet of notes.
- Calculators are permitted.
- Laptops or other electronic devices with wireless capability are *not* permitted.
- No collaboration is permitted; the WPI academic honesty policy is in effect.
- You have 30 minutes to complete the quiz.
- No partial credit will be awarded for multiple choice problems.
- Please submit your sheet of notes when you turn in your quiz.

Problem	Points	Score
1	15	
2	10	
3	10	

Good luck!

1. 15 pts total. Consider the (7,2) block code shown below.

Data Bits	Codeword
00	0000000
01	0101010
10	1010101
11	1111111

(a) 5 pts. What is the number of guaranteed correctable errors for this code? Explain.

$d_{min} = 3$ for this code

$$t_c = \left\lceil \frac{d_{min} - 1}{2} \right\rceil = 1$$

Hence we can guarantee correction of 1 error.

(b) 5 pts. What is the number of guaranteed detectable errors for this code? Explain.

$t_d = d_{min} - 1$

Hence we can guarantee detection of 2 errors.

(c) 5 pts. Is this a good code? Can you provide an example of a better code?

This is not a good code because the redundancy is high for the error correction ability.

$$\text{Redundancy} = \frac{n-k}{k} = \frac{7-2}{2} = \frac{5}{2}$$

A better code that has the same error correcting capability is the (7, 4) Hamming code. It has redundancy $\frac{7-4}{4} = \frac{3}{4}$ which is much better than a (7, 2) code.

2. 10 pts total. Suppose you have a link using sliding window flow control with a frame time of $t_{\text{frame}} = 100\ \mu s$ and a propagation time of $t_{\text{prop}} = 2$ ms. Assumptions:

- processing and acknowledgement times are negligible
- all frames are received correctly (no errors or lost frames)
- the receiver sends an RR (receive ready) acknowledgment for every received frame
- the sender/receiver have a full-duplex link.

(a) 5 pts. How long should the sliding window be (in frames) to achieve 100% link utilization? Explain.

We need $W \geq 2a + 1$ with $a = \frac{t_{prop}}{t_{frame}} = \frac{2ms}{100\mu s} = 20$

Hence $\boxed{W \geq 41}$

(b) 5 pts. The total time to deliver n frames starts at the beginning of the transmission of the first frame and finishes at the end of the receipt of the last acknowledgement. Assuming a sliding window long enough such that no stalls occur, how long will it take to deliver 100 frames?

Total time $= 100 \cdot t_{frame} + 2 t_{prop} = 14$ ms

3. 10 pts. Suppose you have a link using go-back-N error control with a frame time of $t_{\text{frame}} = 100\ \mu s$ and a propagation time of $t_{\text{prop}} = 2$ ms. If the sliding window length $W = 127$, determine the maximum frame error probability such that the system achieves an average link utilization of at least 90%.

Since $W \geq 2a+1$, the average link utilization is

$$E[u] = \frac{1-P}{1+2aP}$$

We want

$$E[u] \geq 0.9$$

Hence

$$\frac{1-P}{1+2aP} \geq 0.9$$

$$\Rightarrow 1-P \geq 0.9 + 1.8aP$$

$$\Rightarrow 0.1 \geq (1.8a+1)P$$

$$\Rightarrow P \leq \frac{0.1}{1.8a+1} \qquad a = \frac{2ms}{100\mu s} = 20$$

$$\Rightarrow P \leq \frac{0.1}{37} \approx 0.0027$$

Hence $\boxed{P \leq 0.0027}$ will give a link utilization of at least 90%.