Chris Grimes
CS 35201 Second Exam
3/19/20

1. Assuming a framing protocol that uses bit stuffing.

(a) Show the bit sequence transmitted over the link when the frame contains one of the following bit sequence (4 bytes). Choose one of the following sequences according to the two least significant digits of your banner id. For example if your banner id is xxxxxxx12, then you choose (ii) 8 pts

i. odd-odd, choose: 11011101 11100111 11110001 11111011

ii. odd-even, choose 11100111 11110001 11111011 11011101

iii. even-odd, choose 11110001 11111011 11011101 11100111

iv. even-even, choose 11111011 11011101 11100111 11110001

My banner id ends with 27 so we'll use (iii) 11110001 11111011 11011101 11100111

The bit sequence transmitted will be:

111100011111010111101110111100111

(b) Suppose the following sequence of bits arrives over a link: 8 pts

1101111101000111110110011110111011

Show the resulting frame after any stuffed bits have been removed.

The un-stuffed sequence should be:

11011111100011111100111101110111011

(c) Indicate any errors that may have been introduced into the frame and can be detected. 4 pts

If after 5 consecutive 1's there were two more 1's this would be an error.

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2. Consider the Hamming Code of H(11, 7), where n = 11, r = 4, m = 7,

p1 p2 m3 p4 m5 m6 m7 p8 m9 m10 m11

(p1) (p2) 1 (p4) 0 1 0 (p8) 1 0 1

We want to transmit the message 1010101. Bits are numbered from left to right, as in the book.

(a) Calculate the parity bits according to H(11, 7). 5 pts

parity bit 1: covers positions 1,3,5,7,9

so: (p1) 1 0 0 1 → p1 must equal 0

parity bit 2: covers positions 2,3,6,7,10,11

so: (p2) 1 1 0 0 1 → p2 must equal 1

parity bit 4: covers positions 4,5,6,7

so: (p4) 0 1 0 → p4 must equal 1

parity bit 8: covers positions 8,9,10,11

so: (p8) 1 0 1 → p8 must equal 0

(b) Show how the encoded message transmitted. 5 pts

The resulting transmission from left to right with the form p1 p2 m3 p4 m5 m6 m7 p8 m9 m10 m11 is: 01110100101

(c) Suppose during the message transmission, bit m5 is flipped (1 → 0)

i. How the receiver can detect it? 2.5 pts

m5= 0, so if m5 is flipped a 1 will be received.

$S1= 0 \oplus 1 \oplus 1 \oplus 0 \oplus 1=1$

$S2=1 \oplus 1 \oplus 1 \oplus 0 \oplus 0 \oplus 1=0$

$S3= 1 \oplus 1 \oplus 1 \oplus 0=1$

$S4= 0 \oplus 1 \oplus 0 \oplus 1=0$

ii. How the receiver can correct it? 2.5 pts

S4S3S2S1=0101 so there is a bit error that is shared by S3 and S1, only M5 is shared between S3 and S1 while not occurring in S2 or S4

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3. Consider a 10 Mbps (10×2^{20} bps) point-to-point connection between two devices 10 meters apart. Assume that the signal travels at the speed of 2×10^8 meters/s in the medium. Assume that we are transmitting frames of 5 KB (5×2^{10} bytes).

(a) What is the length of the frame in time (T_f)? 5pts

T_f= Frame size/ bit rate= 5120 bits / 10×2^{20}= 4.8828125×10^{-4} seconds

(b) How long does it take for the frame to traverse the link (transmission time (T_f + propagation time (T_p))? 5pts

T_p= 10m/ 2×10^8 = $5*10^{-8}$ seconds

T_f+ T_p= 4.8828125×10^{-4} seconds + $5*10^{-8}$ seconds= 4.8833125×10^{-4} seconds

(c) What is the efficiency (utilization) of this channel with stop-and-wait protocol. 5pts

stop and wait utilization is:

$1/(1+2\alpha)$ where α= (distance*bitrate)/(frame size* speed of signal)

α= (10m * 10×2^{20})/ ($5120*2 \times 10^8$)= 1.024×10^{-4}

so, the efficiency of this channel is $1/(1+2(1.024\times10^{-4}))$= 0.9998976105

(d) By using the same logic in which during $T_f +2\times Tp$, we transmit one frame (T_f) in Stop-and-Wait protocol, we can generalize it for the sliding window and find its utilization,

$$U = \begin{cases} 1 & W \geq 2\alpha + 1 \\ W/2\alpha+1 & W < 2\alpha + 1 \end{cases} \quad (1)$$

i. Justify, if you can not prove (or derive) Equation 1. 2.5 pts

Because the utilization of a given channel is dependent on the size of W. If W is greater than $1+2\alpha$ the channel will be fully utilized, 100%. But if W is less than $1+2\alpha$ the channel utilization will be the ratio of W, what data is being sent, to $1+2\alpha$, the capacity of said channel.

ii. Compare the utilization of stop-and-wait protocol with sliding window 8 (W = 8). 2.5 pts

The utilization of a sliding window protocol with w=8 is:

$8/(1+2(1.024\times10^{-4}))$= 7.998361935 or 100%

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4. We are comparing the performance of adaptive tree walk protocol vs Basic Bit Map. Assume that we have 32 stations, numbered 1 through 32, are contending for the use of a shared channel. If all the stations whose addresses are prime numbers suddenly become ready at once, how long (number of slots) it takes to all stations to complete their transmission. Assume that data slots and control slots have the same length.

(a) Using the adaptive tree walk protocol 10 pts

The prime numbers from 1-32 are: 2,3,5,7,11,13,17,19,23,29,31. Using the bit tree below:

```
                                   .
                 /                                             \
                 .                                             .
         /                 \                         /                      \
         .                 .                         .                      .
     /       \         /           \            /            \          /           \
     .       .         .           .            .            .          .           .
  /    \   /   \    /      \     /      \     /      \     /      \     /      \     /      \
  .    .   .   .    .      .     .      .     .      .     .      .     .      .     .      .
/ \  / \ / \/ \ /   \  /   \  /   \  /   \  /   \  /   \  /   \  /   \  /   \  /   \  /   \  /   \
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
```

Since each time there is a collision nothing is sent and the left node tries again it will take 21 slots for the prime numbered stations to transmit.

(b) Using Basic Bit Map. 10 pts

The prime numbers from 1-32 are: 2,3,5,7,11,13,17,19,23,29,31

Given that each slot will transmit one at a time it will take 11 slots for the prime numbered stations to transmit.

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5. For a CSMA/CA with RTS/CTS (WiFi), suppose the propagation delay is t slots SIFS is t slots, DIFS is 3t slots, and RTS and CTS are t slots, respectively. See the picture on lecture notes.

(a) What is the earliest time for the receiver to send the CTS message? 5pts

DIFS(3t)+RTS(t)+SIFS(t)= 5t

The earliest the receiver can start to send the CTS is 5t slots after the initial DIFS is started.

(b) If the data packet is 100t long, what is the shortest time for the receiver to send the ACK signal? 5pts

DIFS(3t)+RTS(t)+SIFS(t)+CTS(t)+SIFS(t)+DATA(100t)+SIFS(t)=108t

The earliest the receiver can start to send the ACK is 108t after the initial DIFS is started.

(c) Explain why SIFS is kept smaller than DIFS. 5pts (d) Can you make SIFS = 0? 5pts

DIFS is kept larger than SIFS because you want the DIFS to be long enough so that other senders and receivers can receive the DIFS and keep the channel clear as to not have collision on said channel. SIFS cannot be 0 because the receiver needs time to ensure the message was received correctly, if it were 0 the message could not be checked before sending a response.