ITS 323 – ASSIGNMENT 1

Due Thursday 24 July 2008, 9am

10% of the final course mark

Instructions

1. This is an individual assignment. You must complete the assignment *on your own*. You should not work with others on this assignment – if you need help, then you should ask the lecturer!
2. The assignment can be neatly handwritten or typed on a computer.
3. Read (and answer) the questions in order (all questions are related to the one scenario).
4. You must give the final answers for questions on the Answer Sheet at the back of this handout. This should also be the cover sheet of your submitted assignment. You must attach any additional calculations to the Answer Sheet.
5. Failing to show your calculations for a question may result in reduced or 0 marks, even if the answer is correct.
6. Copying and other forms of plagiarism (e.g. copying answers from the Internet or textbooks) will be penalised.
7. You must submit a hardcopy of the assignment, with the Answer Sheet as the first page, and the calculations attached. Staple at the top left hand corner. Do not include plastic covers or bind the assignment in other ways. Email submission is not accepted.
8. Hints and/or clarifications of questions may be posted on the ITS323 mailing list.

Assumptions

Unless it is stated in the question, you can make the following assumptions:

1. Speed of transmission is: 2×10^8 m/s
2. 1GB = 1000MB; 1MB = 1000KB; 1KB = 1000B; 1B = 8 bits
3. b = bit; B = Byte

Question 0 (Preliminaries)

You must correctly complete this step, as answers in the remainder of the assignment depend upon it. You do not receive any marks for this question, *but you may be penalised if you make mistakes.*

Your ID is a 10 digit decimal number. Perform the following calculations, and use the answers in the remaining questions.

a) (ID mod 10) + 1

b) (ID mod 1000)

c) (ID mod 100)

d) Decimal2Binary(B mod 4096), where Decimal2Binary converts the decimal number to a 12 bit binary number, and B is the answer of part (b).

Question 1 [5 marks]

Scenario:

You graduated from SIIT five years ago. After graduation you started an Internet Service Provider (ISP) company with your friends, and now it has become the number one ISP in Asia. From your hard work (and money earned) you have just purchased a new house on a remote island in the south of Thailand. To stay involved in the company activities while relaxing in your new home, you are planning a dedicated network connection between your home and the main office in Bangkok. Because of the remoteness of the island, satellite access is the option you are considering.

The network topology for connectivity between your laptop at home and server at the company office is shown in Figure 1. All links are full duplex (e.g. 10Mb/s from laptop and 10Mb/s to laptop at the same time).

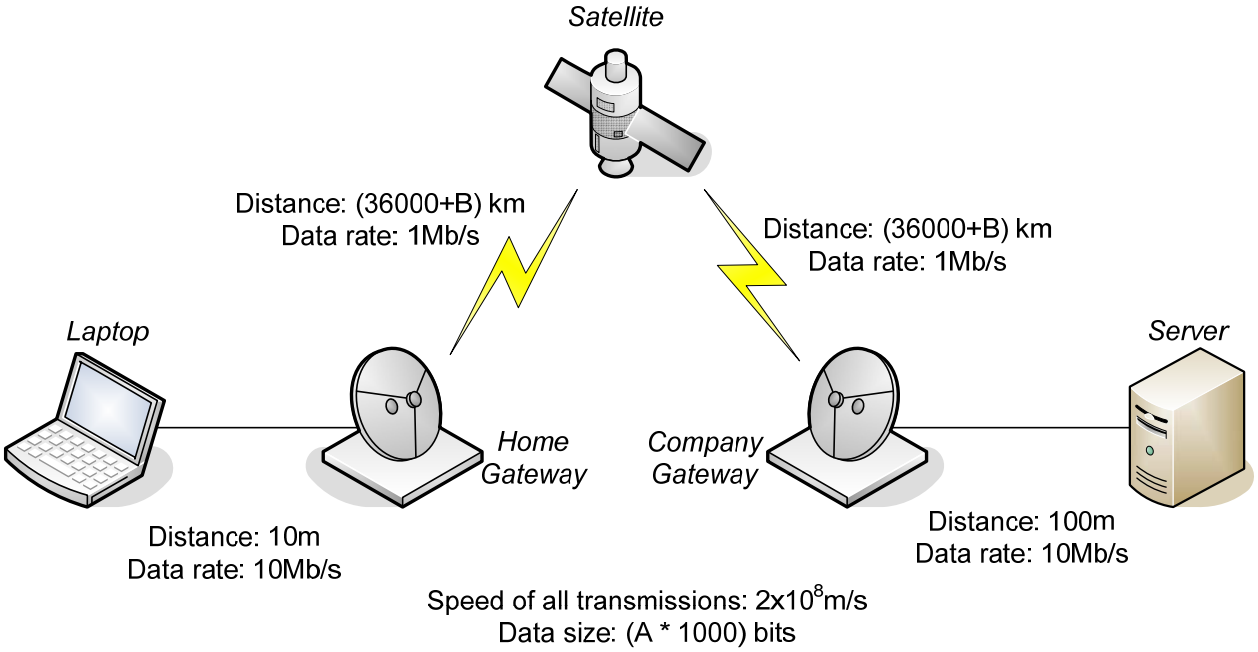

Figure 1

a) Assuming all processing and queuing delays are 0, calculate the one-way delay to send a packet of size (A x 1000) bits from your laptop to the server. (round to nearest millisecond) [5 marks]

Question 2 [10 marks]

a) Now consider only the satellite link from Home Gateway to Satellite. Assume the link has a signal-to-noise ratio of C dB, where C is calculated in Question 0. In theory, what is the required bandwidth of the link? (round to the nearest Hz) [5 marks]

b) If the bandwidth calculated in part (a) is used for the Home Gateway to Satellite link, in theory what is the minimum number of signal levels needed to achieve the data rate? (must be a power of 2) [5 marks]

Question 3 [40 marks]

Suppose an ARQ error control protocol is to be used over the Home Gateway to Satellite link. Assume each Data frame contains a 25 byte header, and each ACK frame is 25 bytes in length.

a) Calculate the maximum throughput that can be achieved for the following cases (round to the nearest bit per second):

   i. Stop and Wait ARQ; no errors. [10 marks]

   ii. Go-Back-N ARQ; Window field is A bits, where A is calculated in Question 0; no errors. [10 marks]

   iii. Selective Reject ARQ; Window field is A bits, where A is calculated in Question 0; no errors. [10 marks]

b) Compare the throughput (or efficiency) achieved for each of the above three ARQ protocols. For your particular case, explain the main reasons the throughput is as calculated (in other words, what are the main factors that result in the calculated throughput). Also, state which protocol is most appropriate for the link (and explain why you chose that protocol). [5 marks]

c) Consider Stop and Wait ARQ: if the processing time at the Satellite ranged from 2ms to 5ms (depending on the activities of the CPU on-board the satellite), then what is the minimum timeout value that the sender (Gateway) should use? (round to the nearest millisecond) [5 marks]

Question 4 [16 marks]

Under certain circumstances, the efficiency of the ARQ protocols is very low. It is even worse when there are errors. An alternative error control mechanism is to use Forward Error Correction. Assume the Gateway uses a Hamming FEC encoder/decoder for data transferred to the Satellite. The encoding scheme is shown in Table 1.

Data	*Codeword*	*Data*	*Codeword*
0000	010010	1000	101110
0001	101010	1001	001100
0010	001010	1010	100001
0011	000110	1011	001111
0100	110100	1100	010000
0101	010111	1101	101011
0110	010101	1110	000011
0111	110000	1111	110110

Table 1

a) If the 12 bits of data D (where D is calculated in Question 0) are received by the Satellite (in two blocks of 6 bits), explain the steps of the decoder at the satellite on each of the two blocks, including the final result. [8 marks]

b) What throughput can be achieved with the above FEC scheme? (round to nearest bit per second) [3 marks]

c) Increasing the codeword to 8 bits (instead of 6 bits) will reduce the efficiency of the FEC, but increase the error detection/correction capabilities. Explain how the error detection/correction capabilities are increased. [5 marks]

Question 5 [9 marks]

After significant design effort, and several tests, instead of satellite, you finally decide to use a terrestrial microwave link from your home to the mainland (about 30km from your island), and then optical fibre to Bangkok.

a) If you use the ARQ protocols of Question 3 over the microwave link, do you think the throughput will increase (compared to satellite). Explain why for each ARQ protocol. (You do not need to perform calculations; explain your answer). [9 marks]

ASSIGNMENT 1 – COVER AND ANSWER SHEET

ID: | | | | | | | | | | |

First name: _____

Last Name: _____

Section: IT / CS Mark (max 80): _____

I certify that, unless otherwise acknowledged, all work carried out in this assignment is my own.

Sign Name: _____ Date: _____

This sheet MUST be submitted as the cover sheet of your assignment. Attach your calculations and other workings to this sheet. Do not submit the assignment questions (only the answers and calculations).

Question 0

a) A | | |

b) B | | | |

c) C | | |

d) D | | | | | | | | | | | | |

Question 1

a) Delay (ms)

Calculations:

Question 2

a) Bandwidth (Hz)

b) Signal levels (must be power of 2)

Calculations for (a) and (b).

Question 3

a) Throughput (show calculations on *separate sheets*; include diagrams if necessary)

i. Stop and Wait Throughput (b/s)

ii. Go-ack-N Throughput (b/s)

iii. Selective Reject Throughput (b/s)

b) Compare and explain throughput of the three ARQ protocols.

c) Timeout value

Explanation:

Question 4

a) Receiver steps and results (explain for each block of 6 bits):

b) Throughput (bits per second)

Calculations:

c) Explain increase error detection/correction capabilities.

Question 5

a) ARQ efficiency over terrestrial microwave (explain for Stop and Wait, GoBackN, Selective Reject).